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Regional Power Integration

Structural and Regulatory Challenges

Central America Regional Programmatic Study for the Energy Sector

January 2011

David Reinstein
Almudena Mateos
Alberto Brugman
Todd Johnson
Laura Berman

Energy Unit
Sustainable Development Department
Latin America and Caribbean Region
The World Bank

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CENTRAL AMERICA REGIONAL PROGRAMMATIC STUDY FOR THE ENERGY SECTOR

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LIST OF ACRONYMS

AGC	Automatic Generation Control
AMM	*Administrador del Mercado Mayorista* (Administrator of the Wholesale Electricity Market, Guatemala)
ARESEP	*Autoridad Reguladora de los Servicios Públicos* (Public Utilities Regulatory Authority, Costa Rica)
ASEP	*Autoridad Nacional de los Servicios Públicos* (National Authority on Public Services, Panama)
CA	Central America(n)
CAF	*Corporación Andina de Fomento* (Andean Development Corporation)
CABEI	Central American Bank for Economic Integration
CAFTA	Central America Free Trade Agreement
CCHAC	*Comité de Cooperación de Hidrocarburos de América Central* (Central America Hydrocabons Cooperation Committee)
CEAC	*Consejo de Electrificación de América Latina* (Central America Electrification Council)
CEL	*Comisión Hidroeléctrica Ejecutiva del Río Lempa* (Salvadoran state-owned power utility)
CENACE	*Centro Nacional de Control de Energía* (National Center for Power Control, Mexico)
CFE	*Comisión Federal de Electricidad* (Mexican state-owned power utility)
CND	*Centro Nacional de Despacho* (National Dispatch Center, Panama)
CNDC	*Centro Nacional de Despacho de Carga* (National Dispatch Center, Nicaragua)
CNE	*Comisión Nacional de Electricidad* (National Electricity Commission, Honduras)
CNE	*Comisión Nacional de Energía* (National Energy Commission, Nicaragua)
CNE	*Consejo Nacional de Energía* (National Energy Council, El Salvador)
CNEE	*Comisión Nacional de Energía Eléctrica* (National Electricity Commission, Guatemala)
CNFL	*Compañía Nacional de Fuerza y Luz* (Costa Rican state-owned power utility)
CRIE	*Comisión Regional del Interconexión Eléctrica* (Regional Regulator)
CVT	*Cargos Variables de Transmisión* (Variable Transmission Charges)
DEE	*Dirección de Energía Eléctrica* (Power Directorate, El Salvador)
DT	*Derecho de Transmission* (Transmission Right)
EIA	Energy Information Administration
ENATREL	*Empresa Nacional de Transmisión Eléctrica* (National Transmission Company, Nicaragua)
ENDESA	Spanish power utility
ENEE	*Empresa Nacional de Energía Eléctrica* (Honduran state-owned power utility)
ENEL	*Empresa Nicaragüense de Electricidad* (Nicaraguan state-owned power utility)
EOR	*Ente Operador Regional* (Regional Operator)
EPR	*Empresa Propietaria de la Red* (Regional Transmission Company)
ERSP	*Ente Regulador de los Servicios Públicos* (Panamanian Public Services Regulatory Agency)
ETESAL	*Empresa Transmisora de El Salvador* (Salvadoran Transmission Company)
ETESA	*Empresa de Transmisión Eléctrica* (Panamanian Transmission Company)
GDP	Gross Domestic Product
GGD	*Grupo Generador a Despachar* (Dispatchable Generation Unit)
GGP	*Grupo Generador* (Generation Unit)
IDB	Inter-American Development Bank
IAR	*Ingreso Anual Autorizado* (Authorized Annual Income)

ICE	*Instituto Costarricense de Electricidad* (Costa Rican national power utility)
ICP	*Interconexión Eléctrica Colombia–Panamá (*binational company for the Colombia–Panama interconcection)
INDE	*Instituto Nacional de Electrificación* (Guatemalan state-owned power utility)
INE	*Insituto Nacional de Energía* (Nicaraguan state-owned power utility)
IRHE	*Instituto Nacional de Recursos Hidráulicos y Electrificación* (Panamanian state-owned power utility)
ISA	*Interconexión Eléctrica* (Colombian transmission company)
IPP	Independent Power Producer(s)
kWh	Kilowatt hour
LAC	Latin America and the Caribbean
LNG	Liquefied Natural Gas
MC	*Mercado de Contratos* (Contract Market)
MEM	*Ministerio de Energía y Minas* (Ministry of Energy and Mines, Guatemala)
MEM	*Ministerio de Energía y Minas* (Ministry of Energy and Mines, Nicaragua)
MEM	*Mercado de Electricidad Mayorista* (Wholesale Electricity Market, El Salvador)
MEMN	*Mercado de Energía Mayorista de Nicaragua* (Wholesale Electricity Market, Nicaragua)
MER	*Mercado Eléctrico Regional* (Regional Electricity Market)
MINAET	*Ministerio del Ambiente, Energía y Telecomunicaciones* (Ministry of Environment, Energy and Telecommunications, Costa Rica)
MM	*Mercado Mayorista* (Wholesale Electricity Market, Guatemala)
MME	*Mercado Mayorista de Electricidad* (Wholesale Electricity Market, Panama)
MM	*Mercado Mayorista* (Wholesale Electricity Market)
MWh	Megawatt hour(s)
MRS	*Mercado Regulador del Sistema* (System's Market Regulator)
OECD	Organisation for Economic Co-operation and Development
PIEM	*Programa de Integración Energética Mesoamericana* (Program for Mesoamerica's Energy Integration)
PM	*Participante del Mercado* (Market Participant)
PPA	Power Purchase Agreement
PPP	*Plan Puebla–Panamá*
REDCA	*Red Centroamericana de Fibras Ópticas* (Central American Telecommunications Network)
RMER	*Regulación del Mercado Eléctrico Regional* (MER regulations)
RTMER	*Reglamento Transitorio del Mercado Eléctrico Nacional* (Transitional MER regulations)
RTR	*Red de Transmisión Regional* (Regional Transmission Network)
SENER	*Secretaría de Energía* (Energy Ministry, Mexico)
SERNA	*Secretaría de Recursos Naturales y Ambiente* (Environment Ministry, Honduras)
SICA	*Sistema de Integración Centroamericana* (Central America Integration System)
SIEPAC	*Sistema de Interconexión Eléctrica para América Central* (Central American Electrical Interconnection System)
SIGET	*Superintendencia General de Electricidad y Telecomunicaciones* (General Superintendence of Power and Telecommunications, El Salvador)
SNI	*Sistema Nacional de Interconexión* (National Interconnected System)
TOE	Tonne(s) of Oil Equivalent
TPES	Total Primary Energy Supply
TWh	Terawatt hour(s)
US$	United States Dollars
UT	*Unidad de Transacciones* (System Operator/Market Administrator, El Salvador)

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PREFACE

Economic growth in Central America has increased rapidly over the past twenty years. The gross domestic product (GDP) per capita for the six Central American countries of Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua and Panama currently averages approximately US$3,600. However, masked behind this average figure is a subregion of 40 million people with a wide range of incomes, where more than half of the population lives in poverty.

Energy in general and electricity specifically are critical for economic development. Electricity is needed to power the machinery that supports income-generating opportunities. Capital (both domestic and foreign) is attracted to countries that are able to offer a reliable and affordable source of electricity for businesses. Households, schools and hospitals, among others, also require electricity for a variety of economic and social activities. As such, investments in secure, reliable and reasonably priced sources of energy are critical for sustained economic development.

Although the individual electricity markets of Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua and Panama are not large, together these six countries generate nearly 38 Terawatt-hours (TWh) of power, equivalent to around 70 percent of the annual electricity supply of a medium-sized country in Latin America. However, individual electricity markets in this subregion are very different, ranging from vertically integrated to totally unbundled systems. Electricity markets also vary significantly in their quality of service and in their efficiency in production and delivery. In addition, the fragmentation of the subregion's electricity market into small units has presented challenges for meeting growing demand and has raised supply costs.

The SIEPAC Electrical Interconnection System, whose physical investments were completed at the end of 2010, could bring a number of associated benefits such as the improvement of energy security through increased reserve margins, as well as efficiency gains and lower costs through economies of scale. Integration is necessary, but not sufficient, to meet the subregion's electricity needs. A number of steps remain to be taken in both the short and long terms to be able to fully exploit the benefits of integration. These include addressing physical, regulatory, institutional and political issues on national and regional levels as part of an effective integration plan.

The World Bank has undertaken a series of studies to better understand the energy challenges facing the six countries of Central America that are part of the SIEPAC system and to identify actions to promote the sound development of the sector. These studies have been prepared by a team of policy experts, engineers and economists as part of an integrated series, the Central America Programmatic Energy Studies, with a primary focus on the electricity subsector. The initial phase of this programmatic series includes three modules:

1. General Issues and Options: sets the stage for further analysis by systematically examining the electricity subsector and identifying major challenges at the individual country and regional levels.

2. Managing an Electricity Shortfall: evaluates the effectiveness of supply- and demand-side actions to address actual or looming shortages.

3. Regional Power Integration: identifies the structural and regulatory barriers to electricity integration and proposes actions to overcome them.

This particular document, the Structure and Regulatory Challenges module, analyzes options for adapting the current regulatory framework to address the development of regional supply and trade. The World Bank is also proposing additional modules, including one on the potential for further development of geothermal energy in the subregion.

It is our hope that this series of studies will help policy makers and other stakeholders in these six countries to address the issues necessary to create a reliable and efficient energy system that serves as a solid foundation for economic growth in the subregion.

Laura Frigenti
Country Director
Central America
Latin America and
the Caribbean Region

Philippe Benoit
Sector Manager
Energy Unit
Latin America and
the Caribbean Region

EXECUTIVE SUMMARY

I. INTRODUCTION

The search for a more reliable and secure electricity supply has been a determining factor worldwide in decisions to build power system interconnections and to enter into electricity exchange agreements among utilities in neighboring countries. Power system interconnections enable countries to exchange power, exporting excess power beyond their borders and importing power when there is a supply shortage. **In the Central American electricity subsector, a major step toward regional integration is the construction of the SIEPAC[1] interconnection line, which links Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua and Panama and is expected to be fully operational in early 2012.** The interconnection system in Central America, begun in the early 1990s, has been a long-term effort and has overcome numerous obstacles associated with the project's multi-country nature.

SIEPAC was designed to bring the benefits of integration to six Central American countries and to improve their national power systems. Due to the relatively small size of the power system in each country, the opening of a regional market was seen as a means for creating a larger market that would enhance competition among power producers. A goal for the regional market is to gradually allow qualified agents to buy or sell electricity regardless of where they are located in Central America. A regional market with clear and uniform rules is expected to offer incentives for building larger, more efficient power plants than many currently being planned at the national level. Such investments could help reduce the relatively high costs of electricity in the region and strengthen the reliability of national electricity systems.

This study on Regional Power Integration in Central America[2] is part of a series of reports that were prepared as part of a Programmatic Energy Study for the region. The Programmatic Energy Study analyzes a range of issues that the region faces in the energy sector. **This module, on the structural and regulatory challenges of regional power integration, is intended to examine the medium- to long-term requirements to promote a regional power market and to minimize long-term costs, which constitute key objectives of the SIEPAC Project.** As national markets evolve toward integration and increased trade, barriers remain to achieving full development of the necessary regulations and implementation of the Regional Electricity Market (*Mercado Eléctrico Regional*, MER). In assessing the prospects for regional power integration, this study outlines each of the national electricity

[1] SIEPAC is the acronym for the *Sistema de Interconexión Eléctrica para los Países de América Central* (Central American Electrical Interconnection System).

[2] The Central American Region covers the isthmus connecting Southern Mexico to South America at Colombia. It is composed of seven countries with a combined population of around 40 million people. These countries 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.

markets, including their rules for international transactions, and analyzes the legal, regulatory and institutional framework of the MER. The barriers to the development of the MER are identified as well as possible actions that could help overcome them, several of which are already being undertaken by regional and national electricity authorities.

The methodology used to identify the main challenges and potential solutions for Central American regional electricity market was a comparison and gap analysis of the Central American MER mechanism with the market mechanisms of other functioning electricity markets, as for example, those in the UK, Colombia and Chile. Additionally, some suggestions were extracted from dialogue with various Central American market sellers and buyers, as well as from a comparison of their suggestions with similar market rules in other electricity markets.

II. CHALLENGES FACED BY THE CENTRAL AMERICAN ENERGY SECTOR

The energy sector as a whole in Central America faces a series of important challenges.[3] These include: a) a tight balance between power supply and demand, which threatens the security and reliability of the region's power sector and raises concerns about the quality of supply; b) significant exposure to oil price volatility and shocks due to a general dependence on oil imports, which have increased significantly over the past fifteen years for power generation purposes; c) significant inefficiencies in the institutional and regulatory framework of several countries, which affect the financial sustainability of power utilities and their operations; and d) relatively low levels of electricity access in certain countries, particularly in rural areas.

The precarious balance of supply and demand makes Central America vulnerable to an electricity crisis. Because individual country markets are small, operating costs are disproportionately high. In general, system reliability is low due to insufficient generation capacity and/or transmission infrastructure. By taking needed measures to increase energy supply security, develop its renewable energy potential, improve the efficiency of power production and consumption, and address the integration agenda more decisively, Central America can avoid a looming energy crisis.

An integrated and well-functioning regional market would help Central America address some of the shortcomings of the electricity sector. Countries in the region are expected to benefit from increased security and reliability of electricity supply, even at the initial stages of interconnection. An improved investment environment that facilitates the financing of larger projects (e.g., regional hydroelectric or liquefied natural gas [LNG] plants) is expected to follow interconnection and bring both new supply and economies of scale in electricity generation. Savings from reduced operating and investment costs would be realized in the medium to long term as the regional market consolidates and eventually evolves into more advanced pool arrangements. According to the regional organization CEAC *(Consejo de Electrificación de América Latina)*, SIEPAC would produce operating cost savings of about

[3] See report for the Sector Overview module, with a comprehensive description of issues and challenges in the Central American energy sector.

4 percent and fuel savings of about 3 percent after eight to ten years, based on indicative expansion planning exercises.

III. BACKGROUND ON ELECTRICITY INTERCONNECTIONS AND POWER POOLS

Globally, the desire for dependable and secure power has been the primary reason why countries choose to build power system interconnections and to exchange power. Experiences from the operation of power pools in Europe and the United States indicate that power pooling arrangements have mostly evolved from simple interconnections between neighboring utilities that support each other in case of emergencies, to more sophisticated formal legal entities with differing responsibilities for system operation and power market regulation (ECA 2004). While "loose pools" rely on coordinated dispatch between the countries to conduct the power exchanges that are defined contractually through bilateral power purchase agreements, in more advanced pools (i.e., "tight pools") centralized dispatch takes the place of coordinated dispatch, requiring substantial investment in information technology systems and an advanced and harmonized regulatory framework (ECA 2004). In more advanced power pools, dispatching is not based on costs, but rather on the bid price of each generator (i.e., on a competitive basis), which means "open access" to the market, at least at the wholesale level. Annexes 1 and 2 provide a more detailed description of power integration and power pools.

The benefits of power pools are numerous and are gradually realized by the member countries as the regional market evolves. Power pools facilitate the delivery of reliable electricity supply at minimum cost by lowering generation capacity reserve requirements, achieving economies of scale in generation, increasing load and fuel diversity, creating opportunities for the sale of surplus firm energy, and providing emergency support in the event of major breakdowns (World Bank 2008). In the short to medium term, the two main benefits of power pools are increased security and reliability of electricity supply, and an improved environment for electricity sector investment. In the medium to long term, the main benefits would be reduced operating costs and reduced investment costs through integrated planning on a multisystem basis (USAID 2008).

A common and flexible legal regulatory framework and harmonized commercial rules are critical success factors in creating regional power pools. Once consensus is reached on putting in place a common legal and regulatory framework, it is critical to maintain flexibility when setting up a viable multi-country organizational structure to leverage the individual and collective capabilities of the system operators. Moreover, the deployment of fair, transparent and harmonized commercial rules of practice for cross-border trading in energy services (e.g., pricing principles, settlement of transactions, technical standards for metering, arbitration procedures) also requires the introduction of measures to enhance the capabilities of the system operators that will be responsible for the expansion of cross-border interconnection facilities (World Bank 2008).

The objective of the MER is to pool the demand of several small markets and in the process lower risks and better match supply and demand. In a developing country context, as is the case of the MER, the creation of a regional power market composed of a group of

smaller economies can reduce risk and help the power pool match supply and demand more efficiently. The existence of a pool enhances a project developer's ability to finance and construct power generation facilities that are closer to available energy sources situated in smaller economies. This is in part because the pool can make the development of a country's or sub-region's capital-intensive power projects more attractive to domestic and international investors and lenders and reduces risks by creating a broader pool of utilities and off-takers for the production of proposed generation facilities. In the medium to long term, as the MER evolves and the volume of exchanges increases, the planning and commissioning of additional cross-border interconnection facilities would be supported.

IV. THE CENTRAL AMERICAN REGIONAL ELECTRICITY MARKET (MER)

In the past, electricity trade in Central America was limited to mostly bilateral transactions in the spot market. The main objective of these transactions was to take advantage of energy surpluses and differences in marginal generation costs. Trade was active in the early 2000s, although restricted by the capacity of existing transmission links, but it has dwindled in recent years due to a tight supply–demand balance in most of the countries of the region. This situation is expected to change with the commissioning of the SIEPAC transmission line and the actions planned in most of the countries to expand generation capacity and increase capacity reserve margins.

The Central American Electrical Interconnection System (SIEPAC) is an initiative to create an integrated regional electricity market among six Central American countries. SIEPAC consists of a 1,800 kilometer-long, 230 kV single-circuit transmission line, with 15 substations and comprising 20 transmission segments, which were finished at the end of 2010.[4] With the completion of the system, the capacity of power exchanges between most countries in the region will increase to 300 MW.[5] The stated objectives of the SIEPAC Project are to: a) improve security of supply by widening reserve margins, b) reduce the problem of electricity rationing in capacity-deficit countries, c) achieve improved operating efficiency and reduce the amount of fuel consumption needed for generating electricity, d) spur greater competition in domestic markets, e) lower end-user electricity costs, f) attract foreign investment to the region's electricity sector, and g) contribute to the economic development of the region.

Restructuring of national power systems in Central America has resulted in quite different sectoral structures. In the 1990s many countries approved new laws and regulations that initiated restructuring processes in their respective power sectors. Those reforms aimed to promote private participation in a sector that had been traditionally controlled by fully integrated state-owned companies. Reforms in Costa Rica and Honduras were limited to opening up the generation segment to private participation. However, in El Salvador,

[4] An exception is one of the Costa Rican segments, which will be finalized in 2011.

[5] The second circuit of the SIEPAC Project could increase trade capacity between countries to 600 MW (450 MW between Costa Rica and Panama) and the Panama–Colombia DC link could provide a 300 MW capacity for power exchanges.

Guatemala, Nicaragua and Panama, significant reforms were implemented to liberalize entire electricity markets. These countries implemented vertical and horizontal unbundling of generation, transmission and distribution activities, creating specialized companies in the electricity sector, as well as permitting retail competition for large consumers. Likewise, the role of the State was restricted in varying degrees to the formulation of policies, the exercise of regulatory functions, and the administration of concessions.

In 1996, the six Central American countries agreed to create the Regional Electricity Market. The Framework Treaty for the Central American Electricity Market (MER) was ratified by the governments in 1998 based on the principles of competition, gradualism and reciprocity. To support the MER, the treaty also created the regional regulatory commission CRIE (*Comisión Regional de Interconexión Eléctrica*), the regional system operator EOR (*Ente Operador Regional*), and the company that owns the grid, EPR (*Empresa Propietaria de la Red*).

The MER was designed as a seventh market, not as a substitute for the national markets. The regional electricity market established in the treaty and developed in the rules governing the MER is not an integrated regional electricity market, but an additional market superimposed on the six national markets. As such, the MER has been designed as a "loose pool" arrangement in which dispatch will be coordinated but not centralized. The MER has its own rules and will operate based on the following premises: a) regional electricity trade can take place in a regional contract market and a spot market; b) all MER agents with the exception of the transmission companies can purchase and sell electricity freely and will have open access to the transmission systems; c) MER generation agents can install power plants in any of the member countries and sell energy at the regional level; and d) the MER is a market with its own rules, independent from the national markets, and carries out energy transactions using the regional transmission grid and national networks. However, without some changes to national markets to ensure the harmonization with regional regulations – equal treatment of agents in the regional market, elimination of price controls, and provision of long-term transmission rights – it will be difficult to meet the objectives of the regional market.

The Second MER Protocol, which was agreed in 2007, included a number of relevant adjustments and clarifications to the original agreement. While the MER established the high-level agreement for the market, the second protocol established more specific regulations to allow the market to function and for individual country markets to participate and interact. Among the key issues that the 2007 protocol established were: (1) the definition of MER agents (who could buy and sell in the MER), their legal rights and responsibilities; (2) the regulations governing the use of national and regional transmission infrastructure, including charges and tolls; and (3) the need for member countries to reform their national regulations to allow the MER to function. One of the main agreements included in the Second MER Protocol refers to the gradual regulatory harmonization for the implementation of the rules of the regional market, which gives priority to energy contracted through the MER.

V. BARRIERS TO REGIONAL POWER INTEGRATION AND SOLUTIONS

The MER's design provides a general framework whose ultimate objective is to enable and promote long-term power contracts for firm energy among Central American countries. Several regulatory and institutional barriers could hinder the achievement of this objective if they are not properly addressed, which are described below. In addition, lack of political will on the side of the national governments could also delay the successful development of the MER, regardless of the regulatory and institutional efforts. This section discusses the main regulatory barriers identified and options to address them.

Regulatory harmonization with national electricity systems must be completed in order to facilitate the operation of the MER. A range of issues, including who can buy and sell electricity, transmission charges, and tariffs, need to be addressed by the six countries participating in the MER. The harmonization of national and regional regulations is perhaps the most important task that must be completed in order to facilitate regional market operations and long-term power contracts among qualified agents.

The asymmetry among national markets can lead to the differential treatment of market agents. There is a lack of reciprocity between the vertically integrated national electricity markets prevailing in two Central American countries (Costa Rica and Honduras), and the more open electricity markets that exist in the other four countries (El Salvador, Guatemala, Nicaragua and Panama). This asymmetry means that regional generators (and national generators in the latter four countries) cannot directly contract electricity with potential distribution and commercial companies and large consumers located in Honduras and Costa Rica. Moreover, potential regional generators located in these two countries would not have clear rules permitting them access to the countries' own national transmission grids. However, both ICE (*Instituto Costarricense de Electricidad)* and ENEE (*Empresa Nacional de Energía Eléctrica)* will have the opportunity to sell to distribution and commercial companies and large consumers in El Salvador, Guatemala, Nicaragua and Panama. In order to resolve this lack of reciprocity, efforts are needed to implement the market reforms in Costa Rica and Honduras called for in the Second MER Protocol.

In most countries, domestic demand has priority in case of power shortages. This creates a risk for firm contracts in the regional market. The way in which the regional market has been designed allows all SIEPAC members to benefit from the surplus of one country to cover deficits in another country: a win-win situation. However, to ensure that all countries benefit equally from the regional interconnection, the national supply priority in case of power shortages will have to be adjusted in the national markets according to the Second MER Protocol in order to provide certainty for firm energy contracts in the MER. In this regard, the Framework Treaty, the Protocols and the associated regulations define the specific sanctions regime to be applied in cases of noncompliance with MER rules, as well as arbitration mechanisms for the resolution of disputes.

Price controls lead to a misallocation of resources and can endanger the success of a regional market. During the national reform processes in the power sector, the stated objective was to achieve a situation in which electricity would respond to market supply and demand signals (as in the case of oil products), rather than to managed criteria which either distort the wholesale price or institute unsustainable subsidies. However, political

considerations and influences have affected regulatory decisions, for example by setting ceilings for market prices. Because market-based pricing for regional electricity contracts will approximate marginal costs, it is important for national markets to avoid the introduction of price controls for electricity supply to domestic markets. Such differential pricing between national controlled prices and regional "free market" prices could also generate public discontent with regional electricity contracts.

Lack of long-term transmission rights can hinder the signing of long-term generation contracts. Regional long-term energy contracts for the development of new regional power plants are expected to have contract periods of 10 to 15 years. At present, however, no transmission contracts have been signed in the region for periods of more than one to two years. As such, the MER regulations would need to be adjusted to provide longer terms for the transmission rights; comprehensive methodologies that allow for clear forecasts of transmission fees would have to be developed.

Limited capacity and resources in CRIE, the regional regulator, make it vulnerable to national interests. Addressing the critical harmonization issues will require additional analysis and the preparation of a strategy that takes into account regional and national views and interests. However, there is a lack of technical staff and computerized support in CRIE, and the commissioners only meet about four times per year. Under these circumstances, there is a risk that national interests may prevail over regional ones. It is evident that CRIE requires urgent institutional strengthening to foster an adequate preparation of the platform for the MER's initial operations.

Bilateral agreements independent from the MER could limit the benefits of the interconnections with Mexico and Colombia. Guatemala and Mexico, as well as Panama and Colombia, are in the process of interconnecting their respective power systems, allowing for future bilateral electricity exchanges. In both cases, bilateral agreements are being discussed and their implementation is progressing. The Guatemala–Mexico interconnection is being developed separately and independently from the MER. In the case of the Colombia–Panama interconnection, the governments of both countries have decided that its development would be at the promoters' own risk, and that use of the line would be limited to its developers rather than open to qualified MER agents. Although not a barrier to regional market development per se, this issue would need to be analyzed in order to assess its interplay with MER regulations, which are interpreted as providing free access to those links. In the case of both interconnections, it will be important to evaluate whether the relevant commercial and regulatory frameworks support trade across the region from Mexico and Colombia, respectively.

The higher demand volumes that are facilitated by the MER allow the development of high-capacity regional plants. Local demand by the distributors, traders and large consumers and associated competitive processes to purchase electricity is for relatively small volumes. Under current market conditions, the volumes of individual long-term firm energy contracts are expected to be relatively minor (i.e., associated with 50 MW peak demands or lower). The development of the MER with high-capacity regional plants (i.e., with 150 MW of installed capacity or more) and with potential interconnections with Colombia and Mexico would require higher contracting volumes with agents that might be located in different countries. In order to facilitate this process, it will be necessary to implement rules and competitive processes for the coordination of energy purchases with multiple agents. This

could be done in one or more ways. One option would be to harmonize rules and regulations in order to promote long-term Power Purchasing Agreements (PPAs). A second option to promote regional generation investments would be to set up a scheme of guaranteed payments to the regional plant investors, for example with payments proportional to each country's electricity demand growth. In practice, a combination of both strategies could be used for long-term PPAs in order to ensure the long-run sustainability of the regional market.

VI. SPECIFIC ACTIONS AT THE COUNTRY AND REGIONAL LEVELS

Central American governments and their respective national regulators need to make some relevant decisions and carry out various actions in order to obtain the full benefits of the SIEPAC system (see Table ES1). Below is a list of some possible interventions for the different Central American countries as well as some potential regional-level actions.

Country level

All six Central American countries could benefit from completing regulatory harmonization with the MER and by ensuring that adequate resources are provided to strengthen CRIE. In Costa Rica, it is important for the government to approve the Second MER Protocol at the congressional level in order for the country to fully participate in the regional market. Costa Rica, El Salvador, Guatemala and Honduras could also improve regional integration by seeking to avoid government interventions aimed at lowering retail tariffs below costs, since this could jeopardize potential energy imports.

Another key action that can be taken is to strengthen the capacity and functioning of national regulatory bodies in each country. In Costa Rica, there is a need to redefine responsibilities between the regulator (ARESEP) and ICE in order to ensure a smoother institutional operation. In El Salvador, the organization and mission of the regulator (*Superintendencia General de Electricidad y Telecomunicaciones,* SIGET) could be revisited in order to avoid potential political influence that could lead, for example, to unsustainable and costly subsidies. In Guatemala, it is important to ensure that the regulator (*Comisión Nacional de Energía Eléctrica,* CNEE) maintains in a strong independent position from political authorities. Empowering the regulator (*Comisión Nacional de Electricidad*, CNE) of Honduras, which currently has little influence over the power utility, ENEE, is also a key action that could be taken. In Panama, the government could closely monitor the reorganization of its regulator (*Ente Regulador de los Servicios Públicos,* ERSP), which has proved to be a solid and responsible agency.

Improving national regulatory rules that encourage competition would contribute to power system integration. Honduras, Nicaragua and Panama could facilitate the use of the interconnected system by introducing flexibility in their power supply priorities for their domestic markets and removing the preferential treatment for the local markets in power trade. In Costa Rica, clear rules need to be developed for the participation of agents other than ICE in the MER in order to increase the exchange of power across borders. In Guatemala and Panama, governments could help strengthen the functioning of power exchanges within the regional market by making sure that bilateral agreements with Mexico and Colombia are

coordinated with MER regulations so that the rest of the countries in the region can benefit from these interconnections.

Regional level

At the regional level, further work to strengthen the capacity of regional regulatory bodies is essential to ensure the proper functioning of the interconnected system. To be most effective, CRIE's work could be concentrated on two specific areas: a) standardization of terms and clauses for long-term regional energy contracts, and b) institutionalization of regional competitive processes and mechanisms for the consolidation of regional coordinated contractual electricity purchases by multiple agents.

Table ES1. National and regional actions to promote MER

	Potential Actions at National and Regional Level to Overcome Regulatory and Institutional Barriers to MER Development
National Level	Harmonize national electricity regulations with regional regulations
	Revise national supply priority for firm energy contracts in the MER
	Avoid price controls in the electricity supply of domestic markets
	Prevent stakeholder pressure and interests from influencing the design of power exchange mechanisms
	Evaluate the potential for interconnections with Mexico and Colombia to support trade across the region
Regional Level	Provide additional financial and technical support to strengthen the regional institutions
	Standardize long-term regional firm energy contracts
	Institutionalize regional competitive processes and mechanisms

VII. SUMMARY AND CONCLUSIONS

The SIEPAC initiative illustrates that it is possible to create a relatively advanced regional electricity trading arrangement among countries at different stages of market development and with different electricity industry structures and institutional schemes. However, while the regional electricity market is in its formative stages, Central American governments and national regulators need to make relevant decisions and take actions (as outlined in section VI above) to expedite the use of the transmission system and to ensure that the region fully benefits from the potential offered by the new infrastructure and by the market architecture that has been under development for over a decade.

A major challenge facing the MER is to overcome supply constraints, such as by attracting investment in a regional-scale generation project. To exploit the potential offered by the SIEPAC transmission lines and the MER regulatory and institutional framework, there is a need for new generation capacity at regional scale. For this to happen, the regulatory framework and the regional institutions must demonstrate their credibility to investors. In this sense, the early use and performance of the line, which will be fully operational by 2012, will serve as a pilot in this process of building trust (Economic Consulting Associates 2009).

The development of a regional-scale plant could create the necessary incentives to overcome some of the existing regulatory barriers. Two different paths can be taken toward successful development of regional generation in the MER. The first one would entail waiting for the complete definition of the market rules and the full implementation of institutional arrangements before large investments in generation are undertaken. The second alternative would consist of the development, in the short-term, of a medium-sized regional generation plant with the participation of private investors and national governments. Such an initiative would generate strong incentives for the different players in the market to find workable solutions in order to overcome the barriers (mentioned in section V above) arising from incomplete regulatory harmonization and underdeveloped MER rules.

The consolidation of MER's regulatory framework could benefit from additional short- and medium-term support to the regional institutions. Further activities should address: a) CRIE's ability to develop appropriate regulations for "firm energy" of power plants in order to support reliability and certainty in regional long-term energy exchanges; b) the standardization of the terms and clauses of long-term regional firm energy contracts, taking into account the local regulations for firm power exchanges and the regional regulations regarding MER transmission rights; and c) the preparation by CRIE and EOR of a proposal for the institutionalization of regional competitive processes and mechanisms to ensure coordinated regional electricity purchases by multiple agents.

The interconnections with Mexico and Colombia could prove critical in overcoming the supply and demand imbalances in the region. The interconnections between Mexico and Guatemala, and between Colombia and Panama, if integrated with the regional transmission system and MER rules, have the potential to provide enough power to address the imbalance of supply and demand affecting all countries in the Central American region. These interconnections could eventually deliver the greatest regional power integration benefits for the region. For this and other reasons, a mutually agreed and carefully designed regional expansion strategy that considers potential imports from Mexico and Colombia is urgently needed, so that existing human, technical and financial resources are used in the most efficient manner. This would also be a test for the rules of the regional market; these rules need to be flexible enough to accommodate ongoing changes and to benefit more fully from the opportunities offered by an expanded market.

CHAPTER ONE
INTRODUCTION

1. The Central America Regional Electricity Market (MER) trades electricity and transmission capacity among six Central American countries: Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua and Panama. The market differs from other electricity markets worldwide because it has its own regulatory body and system operator.

2. Economic integration of the Central American countries has followed a natural evolution.[6] The continuous increase in the demand for goods and services has been accompanied by political and institutional arrangements leading to the materialization of commercial and trade agreements aimed at benefiting the nationals of all the integrated nations at the lowest possible cost. This is particularly true in the electricity sector, which provides a key development service for the achievement of sustainable growth. In fact, electricity integration through cross-border power trade has been discussed by the Central American countries since the late 1970s.

3. Integration initiatives in the region are channeled through the Central American Integration System (*Sistema de la Integración Centroamericana*, SICA), which was created in 1991 and manages the different organizations under it. In the energy sector, two regional organizations are part of SICA: the Central America Electrification Committee (CEAC), and the Central America Hydrocarbons Cooperation Committee (*Comité de Cooperación de Hidrocarburos de América Central*, CCHAC), which were organized over 15 years ago.

4. Since its creation, CEAC has progressively acquired a high-profile role in the electrical integration of the region. It is composed of representatives of the different countries' energy authorities, and it has provided a forum for supporting initiatives such as the regional power market, the SIEPAC Project, and the interconnections with Mexico and Colombia.

5. **SIEPAC.** Small national markets and poor market integration have been obstacles to the benefits of the economies of scale associated with the development of large-scale energy projects. The concept of a regional market was first discussed in 1987 and materialized with the SIEPAC initiative. SIEPAC consists of two interdependent projects: the development of a Regional Electricity Market (MER) and the construction of a 1,800 km power line that will interconnect the six Central American countries, thereby facilitating the exchange of electricity among them and opening the potential for trade with Mexico and Colombia. SIEPAC would also bring efficiency gains through integrated economic dispatch, shared reserve margins, and exploitation of complementarities in supply and demand. According to CEAC, SIEPAC would produce savings in operation costs on the order of 4 percent and fuel

[6] The six Central American countries of Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua and Panama share a long tradition of regional integration, including a common market, substantial intraregional trade, as well as coordinated commercial policies, such as the Central American Free Trade Association (CAFTA) with the US. Belize, in contrast, has developed largely in isolation from the other countries of Central America, with little trade with its regional neighbors and an orientation toward partnerships with Caribbean countries.

savings of about 3 percent after 8 to 10 years, based on indicative expansion planning exercises.

6. SIEPAC is not the only energy sector development and integration initiative in the region. The Program for Mesoamerica's Energy Integration (*Programa de Integración Energética Mesoamericana*, PIEM) includes a project to build a natural gas transmission system connecting the Central American countries to gas supplies from Mexico and Colombia. PIEM also includes a project to build a petroleum refinery and an LNG terminal in the region. Expanded natural gas and oil product availability would diversify the sources of fuel for electricity production and potentially lead to reduced short- and long-run generation costs. In addition to providing support to larger-scale generation projects, the regional transmission network would also create the larger market scale needed to anchor large investments such as the LNG terminal or the gas transmission network included in the PIEM.

7. **Interconnection versus integration.** Interconnection and integration have very different meanings. Interconnection is the linking together of different electricity systems, often thought of as the physical infrastructure (transmission lines, substations) that connects the systems. Integration, which is the means by which the full benefits of the interconnection can be captured, calls for a wide range of institutional coordination measures. The theory of power sector integration is detailed in Annex 1. Specific examples of interconnections and power pools are discussed in Annex 2.

8. Many aspects of regional integration have already been established in Central America, such as the creation of the regional regulator (CRIE) and the regional operator (EOR). These entities have put in place procedures for dispatching regional power resources at least cost, but a gap remains with regard to the procedures and guarantees to develop regional power plants and, in general, to fully integrate the market. For instance, there are still gaps and barriers to achieving long-term firm power transfers that include: the lack of reciprocity between countries with market-based sectors (Panama, Nicaragua, Guatemala and Honduras) and those countries that maintain an integrated sector (Honduras and Costa Rica); rules for prioritizing domestic demand (Honduras and Panama); price controls and generalized subsidies (El Salvador and Nicaragua); transmission rights that still need to be defined on a long-term basis; the lack of harmonization between national and regional regulations; and the limited capacity of CRIE.

9. In order to take full advantage of the opportunities presented by the SIEPAC transmission network and by the more harmonized regulatory framework, a number of hurdles need to be overcome. Strong regulations and a sound institutional framework will be key factors to attract future investment in regional power plants.[7]

10. Once the SIEPAC line is commissioned, there will be pressure to use it in order to generate revenues to meet the existing debt servicing obligations. This may prove to be an important incentive to motivate the development of regional generation projects since the shareholders of EPR, the company that owns the transmission line, are also major market

[7] A generation project is considered to be regional when part of its generation is assigned to cover the demand of another country. A regional plant will have long-term contracts with neighboring countries. In the case of a merchant plant that operates exclusively in the spot market and does not have associated long-term contracts, it will be considered regional generation if the neighboring countries can rely on its supply to balance their supply/demand equation.

players with government backing. Therefore, they are well positioned to bear the demonstration risk associated with pilot regional projects.

11. This report analyzes the progress of the Central American integrated electricity market, including the institutional, legal, regulatory and contractual framework of the MER and of each of the six national markets. It then identifies the main barriers that would have to be addressed in order to ensure a successful evolution to full operation of the SIEPAC interconnection system and achieve true market integration.

12. The methodology used to identify the main challenges of Central American electricity markets and to provide some suggestions on how to improve the performance of these markets was a comparison and gap analysis of the Central American MER mechanism with the market mechanisms of other functioning power pools, as for example, the UK, Colombian and Chilean power pools. Additionally, some suggestions were extracted from dialogue with various Central American market sellers and buyers, as well as from a comparison of their suggestions with similar market rules in other electricity markets.

CHAPTER TWO

POWER SECTOR IN CENTRAL AMERICA[8]

2.1 Introduction

13. A discussion of the challenges of a regional electricity market in Central America requires an understanding of the overall energy and power sector in the region. This chapter provides an overview of the energy and power sectors in the region, including current electricity supply and pricing, the future outlook for the power sector, and an introduction to Central America's regional power system (MER). Through the use of simulations, the chapter concludes with a look at the possible implications of a fully functioning regional power market for electricity supply in the six participating countries.

14. The energy subsector of the Central American countries (Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua and Panama) presents broad similarities as a consequence of common geographic features, such as mountain ranges that have a good potential for developing hydropower, substantial geothermal resources in several countries, and very limited oil resources. In fact, in terms of indigenous energy production, biomass accounts for 67 percent, followed by other renewables such as hydro, geothermal and wind (28 percent), and only 5 percent from regional oil production.

15. Central America yields a primary energy matrix, which is indicative of developing countries that still lack penetration of modern technologies for power generation, as evidenced by 37 percent of Total Primary Energy Supply (TPES) coming from firewood and residues. In the more developed countries, such as Costa Rica and Panama, this value is only about 17 percent. The proportion of firewood and residues as a percentage of total demand in Central America is on the order of 42 percent (around 18 to 20 percent for Costa Rica and Panama), which confirms the former statement. In contrast, values for South America and the US are 19 percent and 3 percent, respectively.

16. Due to the differences in the growth rate of electricity supply among countries in the region, the combined share of electricity supply from Panama and Nicaragua in the regional market has decreased from 34 percent to 24 percent, while Honduras and Guatemala have increased their combined share from 26 percent to 38 percent. El Salvador and Costa Rica have maintained their shares at about 15 percent and 25 percent, respectively. In 2007, Nicaragua was the smallest market in the region with an 8 percent share, followed by El Salvador, Panama and Honduras with about 16 percent, Guatemala with 21 percent and Costa Rica with 24 percent.

17. In terms of consumption sectors, the residential sector in Central America is the major consumer, with a 43 percent share, which contrasts with only 17 percent in South America and 19 percent in the US. Other subsectors that account for the remainder of energy consumption in Central America are transportation (29 percent) and industry (21 percent). The share of

[8] Sections 2.1, 2.2 and 2.3 have been extracted from the report: "Central America. Regional Programmatic Study for the Energy Sector–General Issues and Options Module." For a more complete analysis of the energy sector in Central America, please refer to that report.

electricity in total energy consumption is still low compared to South America (17 percent) or the US (20 percent), and is an indication of low electricity use and electricity coverage.

18. Primary energy supply per capita is around 0.67 toe (tonnes of oil equivalent), an increase from 0.57 toe in 1985, but it remains low by Latin American and Caribbean (LAC) standards, which average 1.1 toe per capita. This is indicative of low GDP; GDP per capita in the US is about 7 times greater than in Central America, and energy use is about 11 times greater. Energy intensity, i.e., the energy per dollar of GDP, was around 143 toe per million dollars, which is low by US standards (213 toe/$M) but comparable to the European countries that make up the Organisation for Economic Co-operation and Development (OECD) (154 toe/$M).

2.2 Electricity Supply and Prices

19. With regard to electricity supply, the region generated around 38 TWh in 2007, which is equivalent to around 70 percent of the annual electricity supply of a medium-sized country in LAC, such as Chile or Colombia. Generation as a whole has grown at a rate of about 6 percent per year since 1990, with a lower rate since 2000 (higher in Guatemala, lower in Panama). Generation capacity is around 9,700 MW, again similar to 70 percent of capacity in Colombia or Chile.

20. The composition of installed capacity varies quite widely among countries with similar endowments (70 percent hydro in Costa Rica and only 13 percent in Nicaragua), in good measure as a result of the institutional developments that took place in the mid- and late 1990s. In those years several countries implemented vertical unbundling, and only two (Costa Rica and Honduras) retained a vertically integrated state-owned company. However, all countries allowed the entry of private sector enterprises either through the sale of assets or by purchasing power from new companies.

21. The participation of new private generation enterprises had both positive and negative consequences. Because of system size and the perception of investment risk, private investors chose to install thermal plants that required less capital and could eventually be moved out of the country if necessary. The thermal option was also least cost during the late 1990s due to high efficiencies associated with diesel plants fueled with bunker oil, and low oil prices. In fact, some of the initial investors, as in Guatemala, chose to install barge-mounted plants. Private sector investment provided much-needed relief to public sector companies with little access to capital. However, it also made the region increasingly dependent on oil products and on the fluctuations of the oil market, with extreme financial consequences in 2006–2008 when the costs of fuel purchases skyrocketed.

22. As a result of the new power sector organization, hydro's share decreased from 85 percent to around 50 percent, while the share of diesel generation running on residual fuel increased from almost zero to 30 percent. The changes in the generation mix were not uniform: they were felt less in Costa Rica and most in Honduras, where the share of hydro declined from 100 percent in 1990 to 37 percent in the early 2000s.

23. Electricity consumption per capita (780 kWh per year) exhibits substantial growth (it has grown by 100 percent over the last 20 years) but continues to be low compared to developed countries, with wide variations within the region: yearly consumption in Costa Rica (1,832 kWh) and Panama (1,586 kWh) is substantially higher than in the other countries,

which consume less than 700 kWh/yr in per capita terms. By comparison, OECD Europe is around 6,000 kWh/yr and the US around 13,000 kWh/yr.

24. Electricity sales in the region have a high residential sector component (37 percent). Monthly residential consumption per user is around 145 kWh, with higher values in Costa Rica (237 kWh), Panama (206 kWh) and Honduras (180 kWh). It is interesting to note that large consumers who can choose their supplier account for 32 percent of the market in Guatemala, 10 percent in El Salvador and 6 percent in Nicaragua.

25. Electricity access remains a problem in Central America, particularly in Honduras and Nicaragua with coverage ratios of 71 percent and 61 percent, respectively, and with people lacking electricity who are concentrated in the rural and scarcely populated areas. The population without electricity amounts to about 8 million people in the region, out of a total population of around 40 million. With the exception of Costa Rica (where coverage is 99 percent), access is a high-visibility problem that should be tackled on a priority basis.

26. Retail electricity prices in Central America vary according to two sets: the high-price countries (El Salvador, Guatemala, Nicaragua and Panama) with residential prices around US$0.16/kWh, and Costa Rica and Honduras with residential prices on the order of US$0.08/kWh. Governments have struggled to keep retail prices low for the residential sector in order to avoid the political fallout resulting from increases due to the increase in fuel prices and generation costs. This has given rise to bitter disputes between the regulators and the power companies, whether public or private. To avoid increasing prices, governments have resorted to instituting subsidies, with varying degrees of success; in Guatemala, El Salvador and Nicaragua, hydropower plants owned by state enterprises financed a substantial portion of the subsidies; in Honduras, Costa Rica and Panama, subsidies were financed directly through the national budgets.

27. Targeting of subsidies has been diverse in the region. At one extreme, the Salvadoran authorities intervened in the wholesale market and instituted a generalized subsidy that quickly got out of hand in late 2008 with the increase in oil prices. In the other countries, subsidies have generally been limited to domestic consumers within a range of about 0–150 kWh of consumption per month, although the upper bound is as high as 500 kWh per month in Panama.

28. Electricity losses continue to be a problem for many of the utilities in the region. Privatization improved loss control in Panama (down from 25 percent in 1990 to around 12 percent in 2007), but was unable to do so in Nicaragua (up from 18 percent in 1990 to 28 percent in 2007). Otherwise, loss levels remain acceptable in El Salvador, low in Costa Rica, and high in Honduras; in Guatemala they have remained more or less static at around 16 percent, with room for improvement.

2.3 Power Sector Outlook

29. National expansion plans are prepared by all the countries in the region, using similar tools. The common characteristic of the plans prepared for 2008–2020 (years may differ from one country to another) is the reliance on local resources, i.e., an autarchic outlook regarding energy supplies. With the exceptions of El Salvador (imports of 30 MW from Guatemala) and Guatemala (imports of 200 MW from Mexico), the national plans do not consider imported

energy on a long-term basis for supplying their respective markets, as opposed to the integrated approach pursued by the regional market.

30. Central America has a large untapped potential for renewable generation, mostly in hydroelectric generation. The hydroelectric potential in the region is estimated at about 25,000 MW, of which a capacity of only about 4,000 MW or 16 percent was installed in 2007. Costa Rica, Guatemala and Honduras hold about 70 percent of the hydro potential in the region. A common characteristic of the national expansion plans is the development of renewables, which leads to investments that are expected to change the energy matrix of the countries and to reduce the reliance on oil imports. Renewables account for 56 to 87 percent of capacity additions in Costa Rica, Guatemala, Nicaragua and Honduras. The exceptions are El Salvador, which does not exhibit a substantial potential in new hydro resources, and Panama, whose development plan omits some hydro expansion possibilities due to lack of information from private developers.

31. The switch to renewables can be justified when the costs of specific projects are compared to those of thermal alternatives. Levelized costs for hydro plants in the region vary between low-cost projects (US$50–60/MWh), and high-cost ones (US$90–116/MWh), as compared to open cycle gas turbines and medium speed diesels (in the range of US$140–170/MWh). Coal-fired plants can be competitive (around US$100–120/MWh, depending on the fuel price scenario), together with combined cycle gas turbines. The latter options, if adopted, would also contribute to diversifying the energy supply in the region by making it less dependent on imported oil. However, the introduction of new gas turbines would probably require a regional supply outlook due to scale limitations, including consideration of LNG infrastructure.

32. A regional plan was prepared by the Executive Secretariat for the SIEPAC Project. The plan envisages a large participation of hydro generation, together with LNG-based production, complemented with large coal plants. The latter take advantage of economies of scale and become feasible when a regional outlook is taken into account. The larger share of conventional thermal generation in the regional plan, as compared to the national plans, results from the benefit of developing larger plants that replace hydro plants with high capital costs.

33. Developing new hydro in a regional context calls for a realistic assessment of site costs, which would be provided by feasibility studies of different projects. Unfortunately, there is a lack of information regarding project costs, and much of the publicly available technical data in the region (with the exception of Costa Rica) is from the 1980s and 1990s, before the reforms after which the private sector took the initiative in future power sector development.

34. Reliance on private sector development for hydro projects will require support from governments in addressing the environmental and social risks if acceptable development costs are to be found (Guatemala was unsuccessful in attracting private sector interest for one of its hydro projects, Xalalá, despite its low estimated development cost). Alternately, as shown in the case of Panama, a combination of long-term contracts and high oil prices provided enough incentives for the development of about 700 MW in hydroelectric projects by private investors. In most cases, innovative schemes will be required, such as those being developed in Costa Rica; these keep valuable information such as feasibility studies in the public domain while allowing for private development.

2.4 The Central America Regional Electricity Market (MER)

35. During the past decade, the six Central American countries agreed to develop a Regional Electricity Market (MER) with its own rules, supported by the SIEPAC interconnection project that will increase the size of the electricity markets and facilitate competition and entry of new players in the market.

36. The MER is the seventh electricity market established in Central America and it could be accessed by agents participating in any of the six national power markets. The main figures for demand/supply and international exchanges are summarized in Table 1 below.

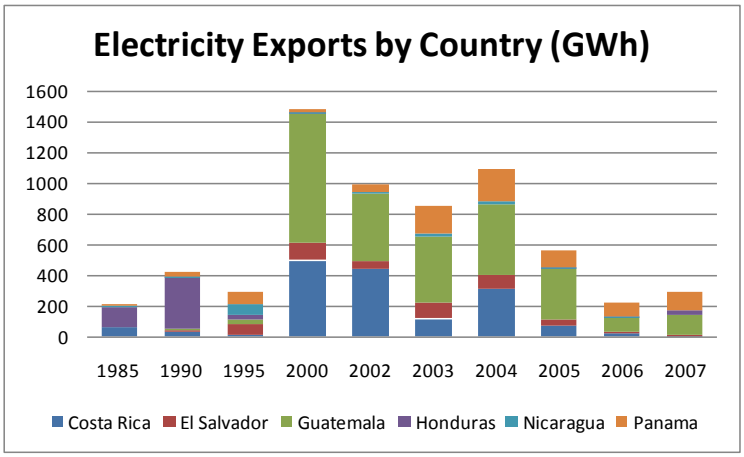
Table 1. Central America: Electricity markets, 2007

	Guatemala	El Salvador	Honduras	Nicaragua	Costa Rica	Panama	Total (MER)
Inst. Cap. MW	2154.0	1436.5	1572.8	822.3	2182.0	1551.5	9719.4
% Hydro	36%	34%	33%	13%	69%	55%	44%
Peak Dem. MW	1443.4	906.0	1126.0	505.2	1500.4	1024.2	6505.2
Margin %	49%	58%	39%	63%	45%	51%	49%
Net. Gen. GWh	7940.4	5749.4	6333.6	2934.6	8989.5	6286.7	38233.8
Exports GWh	131.9	6.7	23.4	0	5.0	125.0	291.9 (MER)
Imports GWh	8.1	38.4	11.8	64.0	162.1	8.7	293.1 (MER)
No. of Users	2,265.419	1,375,795	1,043,299	643,803	1,322,795	738,211	7,389,322
Sales GWh	6533.6	4888.8	4979.3	2096.0	8174.0	5299.4	31971.2
Sales (% of total in CA)	20.4%	15.3%	15.6%	6.6%	25.6%	16.6%	100.0%
Avg. Spot Price (US/MWh)	89.7	88.9	n.a.	123.4	n.a.	108.5	
Avg. Reg. Price (US/MWh)	178.7	140.1	104.4	158.7	88.8	157.5	
Avg. Reg. Price (% of Costa Rica Avg.)	201%	158%	118%	179%	100%	177%	

Source: CEPAL.

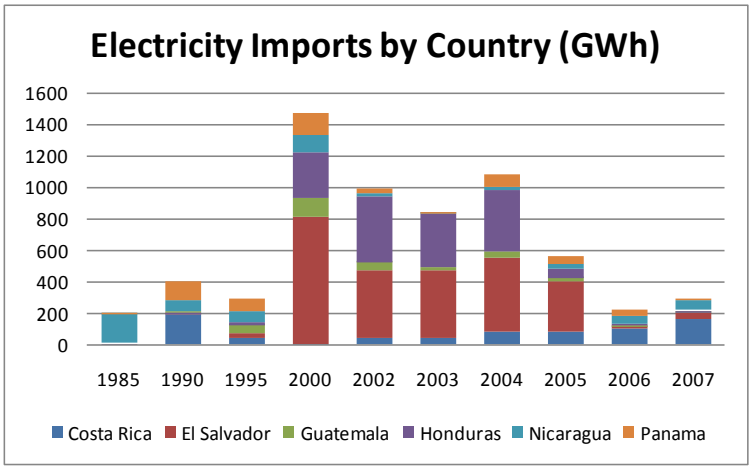
37. In 2007, total installed generation capacity in the six Central American power markets was 9,719 MW, with each country having enough capacity to cover its peak demand. Total net electricity generated in the region was 38,234 GWh, of which 31,971 GWh were sold to final consumers with significant regulated prices differences, the lowest being Costa Rica. International electricity trade in the region through the MER was 293 GWh, representing less than 1 percent of total electricity sales. The main exporting countries were Guatemala and Panama, while imports were concentrated in Costa Rica, Nicaragua and El Salvador. However, historical international electricity trade reached 1,489 GWh in 2000 (around 6.5 percent of regional electricity sales), as illustrated in Figure 1 and Figure 2. The lowering of electricity trade in the MER is related to a generalized reduction in the potential for economic electricity exports in all countries, due to lower firm energy reserve margins and the lower hydroelectric capacity share of regional installed capacity.

Figure 1. Electricity exports by country (1985–2007)



Source: CEPAL and consultant processing

Figure 2. Electricity imports by country (1985–2007)



Source: CEPAL and consultant processing

2.5 MER Illustrative Power Exchanges and Marginal Cost Perspective

2.5.1 Simulation of MER power exchanges

38. International electricity exchanges in the MER were examined under a reference demand/expansion scenario and without considering exchanges with other neighboring countries (i.e., Mexico and Colombia). This exercise was performed through an illustrative demand and supply model with a marginal cost estimation obtained with the SDDP model[9] and

[9] The SDDP (Stochastic Dual Dynamic Programming) model was developed by the Brazilian firm PSR. It is an optimization/simulation model of complex hydrothermal power system operations that is used extensively in the Central American countries. Annex 3 includes additional details.

using a database updated by XM[10] in February 2009 (an illustrative, unofficial, rough estimate[11]).

39. Annex 3 includes a brief description of the SDDP model and a synthesis of the database used. Prices of Fuel Oil No. 6 and No. 2, the main electricity price drivers in the CA electricity markets, were adjusted to US$0.96/gal and US$2.97/gal, respectively; according to 2009 forecasts made by the Panamanian Transmission Company (*Empresa de Transmisión Eléctrica*, ETESA) based on recent short-term EIA (Energy Information Administration) forecasts. In the illustrative simulation, a variable transmission charge of US$7.5/MWh was used for each of the international interconnections. Table 2 summarizes the result of the simulations.

Table 2. Central America aggregated power demand/supply balance and international exchanges

	DEMAND	G. HYDRO	G.THERMAL	IMPORT	EXPORT	MW IMP-EXP 1/
	GWH	GWH	GWH	GWH	GWH	MW
2009	42,634	19,509	23,121	1,564	1,564	325
2010	44,631	20,360	24,272	2,228	2,228	462
2,011	47,008	23,396	23,611	2,438	2,438	506
2012	49,425	24,810	24,615	2,200	2,200	457
2013	51,957	26,183	25,775	2,341	2,341	486
2014	54,568	28,624	25,944	3,128	3,128	649
2015	57,247	31,492	25,755	2,774	2,774	576
2016	60,029	35,339	24,690	4,262	4,262	885

1/ Estimated with 0.55 load factor

40. In summary, the results obtained from the SDDP illustrative power market simulation suggest that international power exchanges among Central American (CA) countries could increase to about 2,500 GWh/year during the next five years. Illustrative forecasts for each country are presented in Figure 3, Figure 4 and Figure 5, with electricity demand in black, average hydroelectric generation in blue, average thermal generation in red, and maximum additional thermal generation in pink (assuming maximal thermal generation with 85 percent average availability).

41. Panama shows a balance of initial net exports to Costa Rica and, even with increasing hydro generation by 2012, it becomes a net importer from Costa Rica after 2014 as a means to reduce fuel costs. Costa Rica appears as an initial net importer due to a tight initial available capacity with respect to demand, a situation that changes with additional thermal capacity being installed by 2010 and with new hydroelectric plants commissioned from 2010 through 2016. It becomes a net exporter after 2011.

[10] XM (www.xm.com.co) is the Colombian firm in charge of the Colombian power market's administration and system operation. Each month, this company updates the SDDP (MPODE in Colombia) model database of the Ecuadoran, Colombian and Central American power systems.

[11] The scope of work was limited to the SDDP application without major analysis and without updating or reviewing the available database.

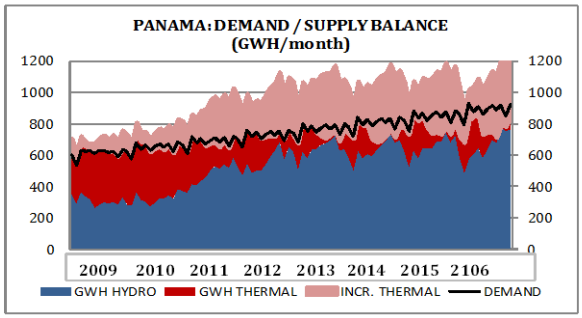
Figure 3. Illustrative national demand/supply balances for Panama and Costa Rica

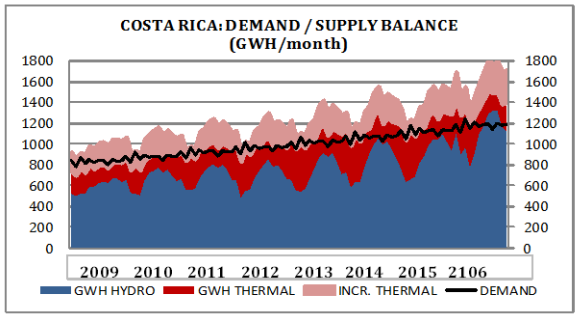
PANAMA (GWH)

	DEMAND	G. HYDRO	G.THERMAL	IMPORT	EXPORT
2,009	7,343	3,681	3,907	96	345
2,010	7,730	3,775	4,063	112	219
2,011	8,202	5,609	2,538	186	131
2,012	8,671	6,672	2,160	150	311
2,013	9,141	7,610	1,310	464	243
2,014	9,613	7,553	1,367	791	97
2,015	10,093	7,787	1,570	803	66
2,016	10,602	7,744	1,540	1,345	28

COSTA RICA (GWH)

	DEMAND	G. HYDRO	G.THERMAL	IMPORT	EXPORT
2,009	10,043	7,132	2,199	873	161
2,010	10,556	7,938	2,407	490	279
2,011	11,083	8,342	3,023	263	545
2,012	11,636	8,329	3,363	416	472
2,013	12,218	8,870	3,992	334	978
2,014	12,834	10,137	3,883	242	1,428
2,015	13,485	10,588	3,934	292	1,330
2,016	14,176	13,153	3,448	115	2,540





Source: SDDP illustrative simulations of the CA power markets

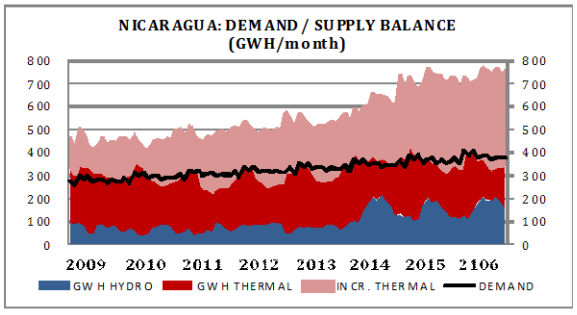
Figure 4. Illustrative national demand/supply balances for Nicaragua and El Salvador

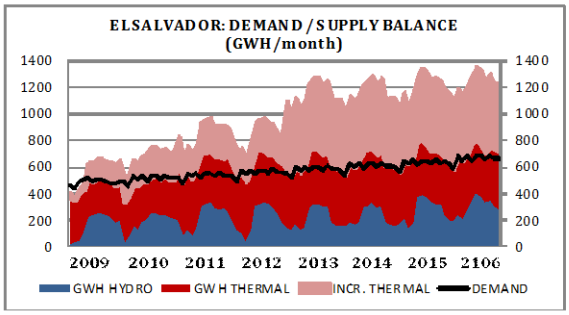
NICARAGUA (GWH)

	DEMAND	G. HYDRO	G.THERMAL	IMPORT	EXPORT
2,009	3,350	893	2,914	72	529
2,010	3,523	760	2,854	179	271
2,011	3,680	738	2,629	464	151
2,012	3,844	982	2,604	383	126
2,013	4,016	861	2,917	518	279
2,014	4,201	1,785	2,693	639	916
2,015	4,397	1,771	2,716	531	620
2,016	4,596	1,934	2,437	1,197	971

EL SALVADOR (GWH)

	DEMAND	G. HYDRO	G.THERMAL	IMPORT	EXPORT
2,009	5,839	1,988	3,494	414	57
2,010	6,092	2,186	3,494	508	97
2,011	6,353	2,721	4,873	38	1,278
2,012	6,626	2,566	4,986	95	1,021
2,013	6,911	2,566	5,054	27	736
2,014	7,208	2,742	5,060	15	608
2,015	7,518	3,183	5,039	15	719
2,016	7,842	3,474	5,004	21	657





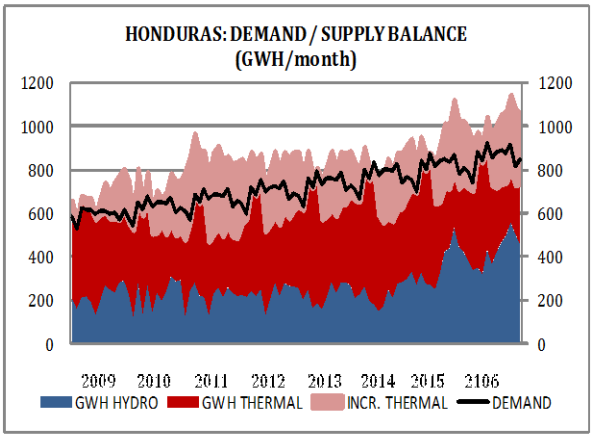
Source: SDDP illustrative simulations of the CA power markets

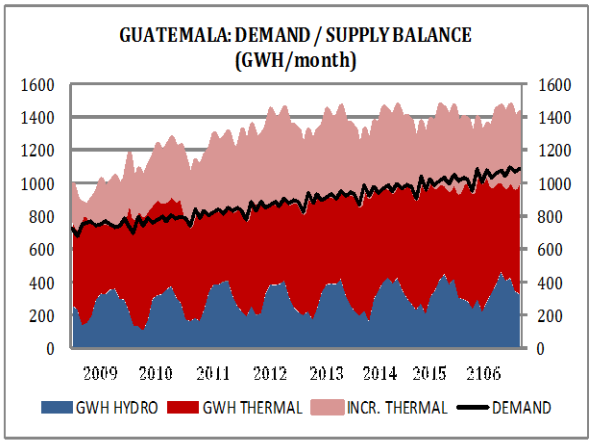
42. Nicaragua is initially a net exporter due to optimization exchanges. It becomes a net importer to reduce fuel costs during 2011–2013; it becomes a net exporter again during 2014–2015 due to new hydro plants; and it turns into a net importer in 2016 to reduce fuel costs. El Salvador changes its importer status by 2013 due to new high-capacity LNG generation for this market.

Figure 5. Illustrative national demand/supply balances for Honduras and Guatemala

HONDURAS (GWH)					
	DEMAND	G. HYDRO	G.THERMAL	IMPORT	EXPORT
2,009	7,164	2,616	4,601	99	152
2,010	7,539	2,714	3,896	939	11
2,011	7,941	2,598	3,960	1,487	105
2,012	8,337	2,766	4,483	1,150	62
2,013	8,793	2,745	5,062	991	5
2,014	9,261	2,688	5,153	1,424	4
2,015	9,741	4,289	4,558	917	22
2,016	10,234	5,063	4,105	1,132	66

GUATEMALA (GWH)					
	DEMAND	G. HYDRO	G.THERMAL	IMPORT	EXPORT
2,009	8,896	3,200	6,007	10	320
2,010	9,192	2,986	7,557	0	1,351
2,011	9,749	3,390	6,588	1	230
2,012	10,311	3,497	7,019	5	210
2,013	10,878	3,530	7,441	8	101
2,014	11,450	3,719	7,789	17	75
2,015	12,012	3,875	7,938	216	16
2,016	12,579	3,971	8,157	452	2





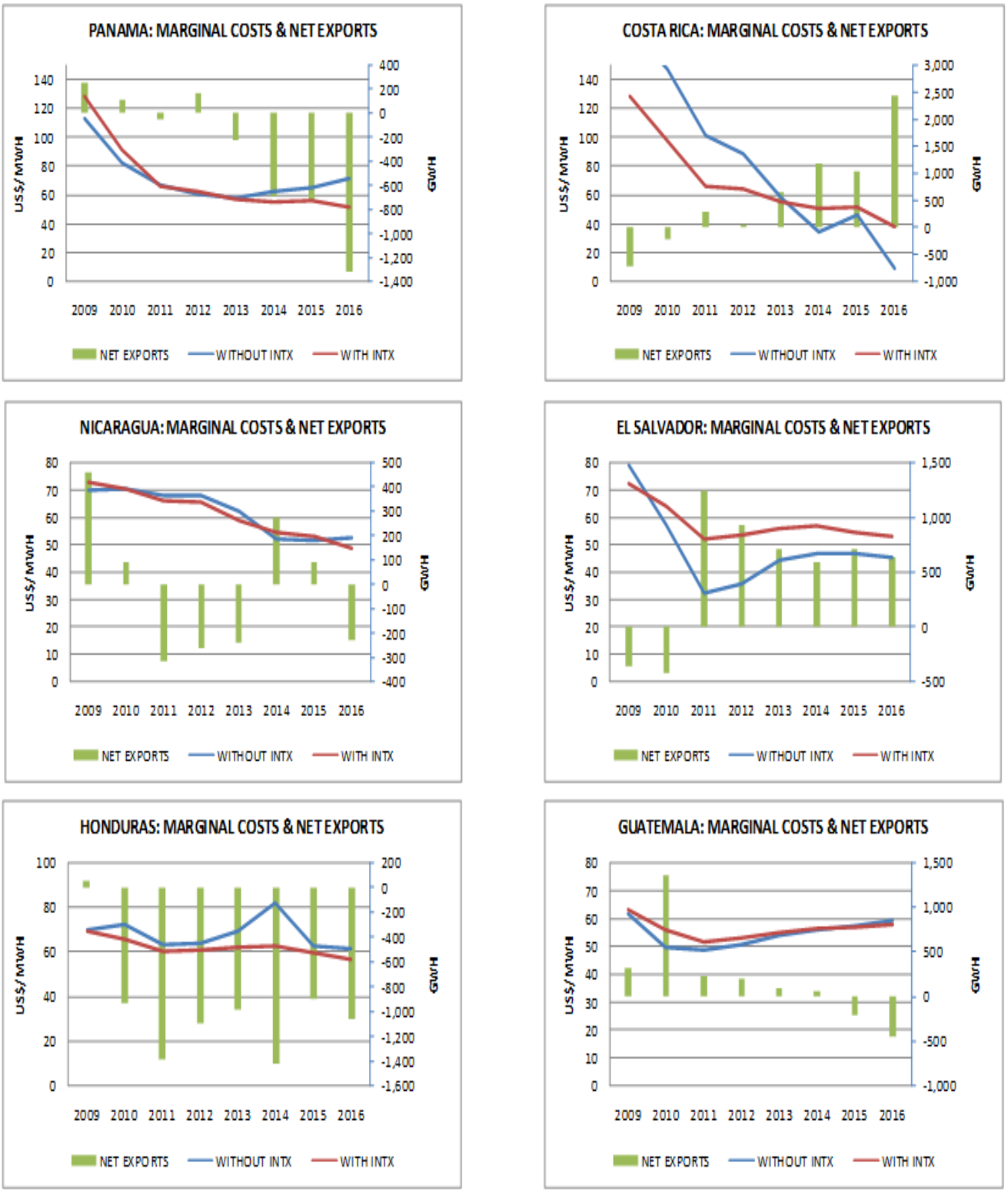
Source: SDDP illustrative simulations of the CA power markets

43. Given a moderate thermal-based expansion program, Honduras remains mainly a net importer during 2010–2016 in order to reduce fuel costs. Guatemala remains basically a self-sufficient market, based on assumed coal power plant expansion, up to 2014, and becomes a net importer during 2015 and 2016 to reduce fuel costs.

2.5.2 Potential impact of international power trade on national marginal costs

44. The illustrative simulation made with the SDDP model enables estimations of the evolution of short-term marginal costs of electricity in each of the countries; these costs would also govern the evolution of wholesale electricity prices. In general, marginal costs decrease after 2009 due to the reduction assumed for fuel oil prices and the increase in hydroelectric power generation with new hydropower plants expected to be commissioned in the region after 2009. For comparative effects, each country was also simulated individually and the impact of the increase in prices with exports and the decrease associated with imports were established. These effects are summarized in Figure 6.

Figure 6. Illustrative impact of international power exchanges on national marginal costs



Source: SDDP illustrative simulations of the CA power markets

CHAPTER THREE

CENTRAL AMERICAN ELECTRICITY MARKETS: INSTITUTIONAL AND REGULATORY FRAMEWORK

3.1 Introduction

45. The structure of existing national electricity markets, in terms of institutions, laws, and regulations, is critical to the functioning of the regional market (MER). This chapter discusses the structural and regulatory changes that have taken place over the past two decades in the six Central American countries, how this has led to the creation of the MER, and how the current structure affects the prospects for the MER.

46. In the 1990s, the CA countries approved new laws and regulations that initiated restructuring processes in their power sectors. The aim of these reforms was to promote private participation in a sector traditionally controlled by state-owned companies that were fully integrated (i.e., vertically and horizontally). Significant reforms to liberalize electricity markets were implemented in Guatemala, El Salvador, Nicaragua and Panama, while in Costa Rica and Honduras reforms were limited to the opening of the generation segment to private participation. The new regulatory frameworks redefined the conditions for electricity service in most CA countries. The role of the States was restricted, completely or partially, to the formulation of policies, the exercise of regulatory functions, and the administration of concessions.

47. During the past decade, El Salvador, Guatemala, Nicaragua and Panama established competitive wholesale electricity markets and implemented vertical and horizontal unbundling of generation, transmission and distribution activities, creating specialized companies in the electricity sector and permitting retail competition for large consumers. In addition, Costa Rica and Honduras opened their markets to several generators in the form of independent power producers (IPPs). The design of the national wholesale markets took into consideration the limitations to competition caused by the small size of the national markets, so that the exercise of market power could be adequately controlled. In all cases, economic dispatch is centralized and based on audited variable costs (except in El Salvador, where it was based on prices but is now changing to variable costs).

48. Table 3 summarizes the main normative, regulatory and entrepreneurial characteristics of the CA electricity markets. Figure 7 illustrates the evolution of the wholesale electricity markets and of the ownership structure in the CA power markets.

49. In 2007 there were 151 generators in the CA electricity markets. Most of them are small (i.e., below 5 MW) or passive players (i.e., small generators that sell their production to a distribution company or to a single buyer or large generator and operate under PPAs that do not trade in the spot market). Data indicate that only 48 generators participate in the national wholesale electricity markets (including ICE and ENEE, which are the sole generation marketers in Costa Rica and Honduras, respectively).

50. On the demand side, there are 39 distribution companies, several of which are controlled by two corporate groups, AES and Unión Fenosa.[12] In all cases, the distribution companies are required to contract the supply of a substantial portion of projected demand using competitive bidding procedures. Today there are 53 large consumers that purchase power directly from several generators in CA. Development of retail competition has been modest in all countries except Guatemala, where it represents about 37 percent of demand. In Guatemala, a significant number of large consumers participate directly in the wholesale market and hundreds of smaller consumers are served by traders.

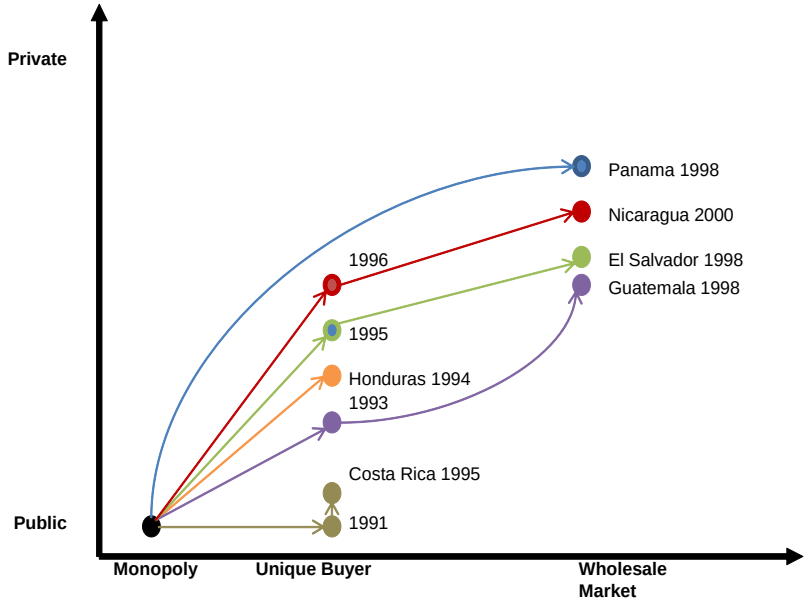
Table 3. Central America: Characteristics of electricity markets

COUNTRY	Guatemala	El Salvador	Honduras	Nicaragua	Costa Rica	Panama
First year of Reforms	1998	1997	1994	2000	1995	1998
Market environment						
Normative entity	MEM	DGE	GE and SERNA	CNE (MEM)	MINAET	CPE
Regulator	CNEE	SIGET	CNE	INE	ARESEP	ERSP
System operator	AMM	UT	ENEE	CNDC of ENATREL	ICE	CND of ETESA
Market administrator	AMM	UT	ENEE	CNDC	ICE	CND
Transmission company	ETCEE	ETESAL	ENEE	ENTRESA	ICE	ETESA
Vertical integration	No	Yes sep. account.	Yes	No	Yes	No
Horizontal integration	Yes	Yes	Yes	Yes, less 25%	Yes	G 25% D 50%
Industry structure						
Market model	Wholesale competition	Retail competition	Integrated	Wholesale competition	Integrated	Wholesale competition
Generators	42	16	31	12	37	13
Transmitters	3	1	1	1	1	1
Distributors	17	5	1	5	1	3
Traders	14	11	0	0	0	0
Large consumers	37	2	1	9	0	4
Wholesale market						
Economic dispatch	Cost-based	Price bids	Cost-based	Cost-based	Cost-based	Cost-based
Spot market price	SRMC with no T constraints	Average of prices based on bid prices of dispatched generators with T constraints	N.A.	SRMC with no T constraints	N.A.	SRMC with no T constraints
Capacity scheme	Yes	No	N.A.	Yes	N.A.	Yes
Capacity price	Regulated	Not applicable	N.A.	Regulated	N.A.	Market based
Long-term contracts	Competitive biding	Negotiated	N.A.	Tender 80% Demand	N.A.	Tender 80% Demand
Contracts	Financial	Physical	N.A.	Financial	N.A.	Financial
Limit of large consumers	100 kW	0 kW	1000 kW	2000 kW	N.A.	1000 kW
Transmission Charges						
Global remuneration	Annual revenues established for the national grid and O&M costs each 2 years	N.A.	N.A.	Annual revenues established for the national grid and O&M costs each 5 years	N.A.	Annual revenues established for the national grid and O&M costs each 2 years
Tolls	Uninodal charges for the users (generation & demand): connection, maximum demand and use by tension level	Transmission congestion costs paid by agents involved	N.A.	Uninodal charges for the users (generation & demand): connection, maximum demand and use by tension level	N.A.	Connection and regional use of the system charges by MW (generation and demand) by tension level
Losses	Transmission losses pay by demand	Transmission losses paid by generators	N.A.	Transmission losses pay by demand	N.A.	Transmission losses pay by demand
Distribution Markets						
Obligation for contracts	Yes	No	N.A.	Yes	N.A.	Yes
Pass-through costs	Contracts and Spot	Spot	N.A.	Contracts and Spot	N.A.	Contracts and Spot
Distribution charges	VADs	VADs	N.A.	VADs	N.A.	VADs
Retail tariffs	Pass-through of efficient G-T-D costs	Pass-through of efficient G-T-D costs	Tariff schedule and adjustments	Pass-through of efficient G-T-D costs	Cost plus methodology	Pass-through of efficient G-T-D costs

Source: *Integración Eléctrica–Retos y Oportunidades*, T. de la Torre, M. Dussan et al. 2008

[12] AES controls four distribution companies with 75 percent of total sales in El Salvador. Unión Fenosa controls two distribution companies with 98 percent of sales in Nicaragua, two in Panama with 59 percent of sales and two in Guatemala with 26 percent of sales.

Figure 7. Evolution of the Central American electricity markets



Source: CEPAL

3.2 Costa Rica

51. Power service in Costa Rica is largely under the control of ICE *(Instituto Costarricense de Electricidad)*, its subsidiary CNFL *(Compañía Nacional de Fuerza y Luz)*, and some small municipal utilities and cooperatives. The government also plays a very prominent role in the power sector, in the policy, planning and regulatory areas, and in sector operations. National energy policy and planning are the responsibility of MINAET (Ministry of Environment, Energy and Telecommunications), which serves as the Technical Secretariat to the Energy Board. The power industry regulator is ARESEP (Public Utilities Regulatory Authority), which sets public tariffs for all Costa Rican electricity consumers by using cost-of-service pricing.

52. Two laws approved in 1990 (Autonomous or Parallel Power Generation Law 7200) and in 1995 (Law 7508, amending Law 7200, which introduced entry competition for private generation) allowed for up to 30 percent participation in the market of IPPs with generation capacity below 50 MW. This decision was mainly aimed at spurring the development of renewable power plants supported through PPAs (Power Purchase Agreements). However, the development of hydroelectric plants under IPP schemes has been hindered by legal bottlenecks that affect the extension of water concessions beyond 2010 and by the lack of clarity in setting electricity prices in PPAs.

53. As a result, as PPAs terminate and water concessions expire, about 120 MW of hydro capacity will be gradually phased out. This situation is particularly critical in the short term, since private generation contributes 17 percent to net electricity sales. By 2010, 86 percent of this capacity would be lost, increasing the risk of rationing and affecting the system's economic and financial outlook. At present, four proposed legal solutions have been blocked in Congress and the last proposal submitted by MINAET is currently pending congressional approval (future treatment of water concessions is included in draft Water Resources Law 14585, already

submitted by MINAET). In light of this situation, the investment climate for independent producers appears to be extremely difficult.

54. The creation and operation of a comprehensive wholesale electricity market in Costa Rica requires efficient institutional coordination. Additional initiatives for a more comprehensive power sector restructuring have not been successful. MINAET has recently completed a draft for a new Electricity Law that lays out a significant structural reform, including the creation of a national wholesale electricity market, short-term electricity trade, and bilateral long-term electricity purchase/sale contracts. For the creation of such a competitive market, the proposed law includes the unbundling of ICE and the creation of new entities (i.e., a system operator, a market administrator and a regulatory body that is autonomous from ARESEP).

55. The Vice Minister of Energy in MINAET unsuccessfully maintained the initiative for a new Electricity Law, given the extensive and ambitious versions presented to the Costa Rican Legislative Assembly. However, the new Minister is working on a simplified version aimed at the participation of co-generators and independent power producers in the MER and at support for the regional market to supply power demand in Costa Rica.

3.3 Honduras

56. ENEE (the National Electricity Company) is the vertically and horizontally integrated state-owned company in charge of generation, transmission, distribution and commercialization of electricity in Honduras. The Electricity Law, which was issued in 1994, defined a new institutional structure and industrial organization for the Honduran power industry. Through this law, the policy-making function was assigned to an Energy Cabinet chaired by the President or by the Minister in SERNA (the Natural Resources and Environmental Secretariat), whose role was to provide technical support. A new regulatory agency, CNE (the National Energy Commission), was also created.

57. However, the Energy Cabinet has met less than once a year since its inception. Furthermore, SERNA, as secretariat and coordinator of the Cabinet, has not played an active role in defining energy policy and in providing the technical groundwork for decision making. CNE has also played only a marginal role due to a lack of political support and resources. ENEE has thus become the de facto reference for setting energy policy and regulation. This situation has led to a weak separation of roles among the public service provider, the regulator and the Ministry.

58. In addition, ENEE is the sole entity responsible for transmission and system operations through its dispatch center, which determines the marginal cost of generation. The 1994 law also mandated, subject to approval by Congress, the unbundling and privatization of ENEE's distribution networks by region, but this reform has also failed to take place. As a result, ENEE still operates as a fully integrated company and is the single buyer responsible for ensuring availability of sufficient power to meet demand. According to the law, power generation can be performed by state agencies or by private or mixed-ownership companies. These entities are authorized to sell power both to large consumers and to ENEE. Under this legal framework, private investors mainly embark on new generation projects, including hydropower, and sell electricity to ENEE through PPAs.

59. In summary, the implementation of the new sector model established in the 1994 law was partial and had limited success in addressing the issues that had motivated the reform in the first place. A crucial point is that distribution networks were not privatized as mandated by the law, leaving ENEE as a vertically integrated utility, as the sole distributor served from the transmission grid, and in control of all generation facilities (as the single buyer in the system), either as owner or through PPAs.

3.4 Nicaragua

60. Prior to sector reforms, INE (the National Energy Institute) was the Nicaraguan state-owned company in control of the electricity sector, with supply functions as well as responsibility for sector policy making, planning, development and pricing. In 1994 the government created ENEL (the Nicaraguan Electricity Company) as a vertically and horizontally integrated government-owned company in charge of generation, transmission, distribution and commercialization of electricity. ENEL also assumed tasks related to the development and use of energy resources, planning of the electricity sector, and system operations. INE remained in charge of the normative and regulatory functions of the sector.

61. In 1998 the Power Sector Law introduced significant reforms. CNE (the National Energy Commission) was created to set the sector's policies, strategies and objectives and to approve the indicative plan for the electricity sector. INE was left with regulatory and supervisory functions and concession licensing. ENEL's commercial and operational activities in the power sector were divested by separating transmission activities, system operations and market administration, which were assigned to ENATREL (the National Transmission Company). CNDC (the National Dispatch Center) is the unit within ENATREL in charge of the operation of the system and of the commercial administration of the Wholesale Electricity Market of Nicaragua (MEMN).

62. ENEL's generation assets were segregated, as well as its distribution assets and functions, which were assigned to two new companies, Disnorte and Dissur. The privatization process resulted in one privatized thermal power company, a management contract for a geothermal power plant, and the sale of the two distribution companies to a single private investor/operator. ENEL remains in control of some hydro and thermal generation and is in charge of some diesel power generators developed through PPAs.

63. A new law issued in 2007 created MEM (the Ministry of Energy and Mines) as successor to CNE, with additional functions that were transferred from INE such as licensing and oil and hydrocarbons policies, as well as the approval of regulations and norms in the energy and mines sector.

64. A cost-based wholesale electricity market has operated in Nicaragua since the end of the 1990s. Generators, distributors and large consumers (i.e., with peak demand above 2,000 kW) participate in this market, which was created to include hourly, short-term opportunity electricity transactions and long-term bilateral purchase/sale electricity contracts. Small consumers served by distribution companies buy electricity at regulated prices. However, in 2005, Law 554 declared an energy crisis and established temporary measures to reduce the impact of high fuel prices on electricity tariffs, including a market intervention by which spot prices were not calculated based on marginal costs, but on a weighted average of the variable

costs of dispatched thermal units plus 10 percent. Moreover, in September 2008, Law 672 mandated maintaining this market intervention until December 2009.[13]

3.5 El Salvador

65. Prior to the reforms introduced in the late 1990s, the power sector in El Salvador operated through the state-owned company CEL (the Lempa River Hydroelectric Commission), which provided horizontally and vertically integrated generation, transmission and distribution services. The reforms required separation of policy-making, regulatory and ownership functions. DEE (the Power Directorate) was created in 2001 as an administrative unit within the Ministry of Economy. It is in charge of preparing, proposing, coordinating and executing policies, programs, projects and other actions in the electricity sector. SIGET (the General Superintendence of Power and Telecommunications) is the regulatory body for both the electricity and telecommunications sectors and is in charge of regulating the power market, distribution companies and consumer prices. Finally, CNE (the National Energy Council), created in 2006, is responsible for analyzing the country's energy situation.

66. The restructuring carried out during 1996–2000 led to the unbundling of generation, transmission and distribution activities and to the horizontal division of generation and distribution into several companies. All the distribution and thermal generation companies were privatized; however, the state-owned generator, CEL, maintained ownership of the hydroelectric plants and created ETESAL (the Salvadoran Transmission Company) as a subsidiary company. UT (the Transaction Unit) was also created as a private company in charge of system operations and of the administration of the wholesale electricity market (MEM).

67. The electricity Law in El Salvador grants a high degree of freedom to market agents and explicitly authorizes vertical integration in generation, transmission, distribution and supply. The only limitation is the prohibition for generation, distribution and supply companies to own shares in ETESAL. This restriction, together with the existence of a price-based spot market and a commercialization activity with retail competition for all consumers, makes the wholesale electricity market in El Salvador very different from those in other CA countries.

68. Nevertheless, the market has undergone significant adjustments, initially the result of the fact that the remuneration of generators in the spot market did not generate enough returns to encourage new capacity developments. To address this problem, rules were implemented to allow for competitively bidded, long-term contract prices to be reflected in consumer tariffs. In addition, the government empowered the regulator to shift to a cost-based market if evidence of market manipulation emerged. Moreover, in early 2005, facing high spot prices due to increasing fuel prices, the remuneration of generators at the marginal cost of generation in the spot market was replaced by a "pay-as-bid" scheme. The spot price was then determined by the weighted average of price bids of generation plants dispatched to meet demand. In addition, in 2006, because this new pricing scheme was not effective in controlling further increases in the spot price, the government decided to subsidize any increase in generation costs above US$91.1/MWh.

[13] Maintaining this percentage at 10 percent if international Bunker C prices are lower than US$50/B but reducing it to 7 percent or 5 percent if international Bunker C prices are US$50–75/B or higher than US$75/B, respectively.

3.6 Guatemala

69. Prior to sector reforms, electricity service in Guatemala was provided by the state-owned company INDE (the National Electrification Institute) through horizontally and vertically integrated generation, transmission and distribution services. The Guatemalan power sector was reformed based on the law issued in 1996 (General Electricity Law, recently updated by *Acuerdos Gubernativos* 68-2007 and 69-2007), which included separation of policy-making, regulatory and ownership functions.

70. Today, the policy and regulatory bodies are MEM (the Ministry of Energy and Mines) and CNEE (the National Electricity Commission), respectively. MEM is responsible for overall energy planning, including planning of the power system, but has limited capacity to carry out such tasks. Currently, least-cost power sector expansion planning (both in generation and transmission) is undertaken by CNEE but, as mandated in the new legislation, this responsibility will be transferred to MEM when it builds adequate capacity. The 1996 law also created AMM (the Wholesale Electricity Market Administrator) as a private body in charge of system operations and of the commercial administration of the wholesale electricity market (MM).

71. The electricity sector restructuring carried out during 1996–2000 led to the unbundling of INDE's generation, transmission and distribution activities with a horizontal division of generation and distribution into several companies, including retail competition for large consumers with peak demand above 100 kW. However, INDE still owns about 60 percent of the hydro plants and also owns and operates about 85 percent of the transmission network. The remaining transmission lines are privately owned and operated.

72. The Guatemalan distribution system is largely privatized, with three major private regional distribution companies: Deorsa, Deocsa and Eegsa. Most of the generation capacity is also owned by various private companies that have developed significant thermal generation capacity under PPAs and as merchant plants.

3.7 Panama

73. In 1997, Panama reformed its power sector through the Institutional and Regulatory Framework for the Public Electricity Service Law, regulated by the Executive Decree 22 of 1998. Electricity service in Panama had previously been provided by IRHE (the National Institute of Hydraulic Resources and Electrification), a state-owned company in charge of integrated generation, transmission and distribution services. The new law introduced the separation of policy-making, regulation and ownership functions.

74. In 1998, ASEP (the National Authority on Public Services) was created as the regulatory body responsible for overseeing the electricity, water and telecommunications sectors. That same year, IRHE was unbundled into generation, transmission and distribution activities. Eight generation and three distribution companies were privatized. Transmission activities, market administration and system operations were assumed by the state-owned ETESA (the Transmission Company), which is also responsible for identifying and executing transmission expansion programs as well as for providing indicative generation expansion programs. CND (the National Dispatch Center) is the section within ETESA that is in charge of system operations and of the commercial administration of the wholesale electricity market (MME).

CHAPTER FOUR

CENTRAL AMERICAN ELECTRICITY MARKETS: CONTRACTING FRAMEWORK

4.1 National Wholesale Electricity Markets

75. While the previous chapter deals with the overall structure and evolution of national electricity markets in Central America, this chapter describes the functioning of the national power markets, including the framework for international power trade. For each of the six countries, it describes the nature of wholesale power markets, the roles and obligations of market participants, contracting processes, existing contracts, and the rules for international power transactions. The key issue for the MER is the harmonization of national rules and regulations for electricity contracts with those of the regional market.

76. The structure of wholesale electricity supply in Central American countries is considerably diverse. While Costa Rica and Honduras operate with fully integrated power companies responsible for national electricity supply (ICE and ENEE, respectively, the sole wholesale electricity traders in each country), the other four countries have developed competitive wholesale electricity markets with multiple participating agents.

77. All of these markets are administered by independent market administration bodies: two private companies (UT in El Salvador and AMM in Guatemala), and two agencies of the national transmission companies (CNDC in Nicaragua, a unit within ENATREL; and CND in Panama, a division of ETESA).

78. In all four markets, the traded products are energy (MWh) and power (MW). The "firmness" or "reliability" of electricity supply is associated with power exchanges through the concept of "firm" or "reliable" power (MW), which is generated with certainty in the power plants owned by the generators (producers) and contracted by the consumers (distributors, large consumers) to supply a percentage of their forecasted "peak" demand (MW) and "associated" energy (MWh).[14] Power exchanges are agreed in the contract markets (with or without "associated" energy) through long-term contracts that respond to rules and conditions, different for each market, that define the concepts of "firmness" or "reliability."

79. Short-term markets operate according to economic dispatch based on audited variable generation costs in Nicaragua,[15] Guatemala and Panama, and on price generation offers in

[14] The same percentage is usually applied to contracted peak and energy demands, although in some markets it is possible to contract only firm power.

[15] During 2005–2008, Laws 554 (Energy Stability Law), 600 and 664 (Additions and Reforms to the Energy Stability Law) were issued in Nicaragua to prevent the adverse price impacts of the increase in international oil prices on electricity consumers. These laws allowed the control of spot prices, which were not calculated based on marginal costs, but on a weighted average of the variable costs of thermal units plus 10 percent.

El Salvador.[16] These markets match demand with supply every hour through spot transactions (hourly differences between actual generation or demand versus contracted quantities), which are traded at spot prices. In all the spot markets, electricity imports are considered as additional generation, while exports count as additional demand for the economic dispatch of generation and for the definition of spot prices. Table 4 below summarizes the main market rules and provides a description of wholesale electricity markets in Nicaragua, El Salvador, Guatemala and Panama.

Table 4. Central America: National wholesale electricity markets

	COSTA RICA	HONDURAS	NICARAGUA	EL SALVADOR	GUATEMALA	PANAMA
Name of the market	Nonexistent	Nonexistent	Mercado de Energía Mayorista (MEMN)	Mercado Mayorista de Energía (MME)	Mercado Mayorista (MM)	Mercado Mayorista de Electricidad (MME)
System operator and market admin.	ICE	ENEE	Centro Nacional de Despacho (CNDC), a unit of ENATREL	Unidad de Transacciones (UT), private	Administrador del Mercado Mayorista (AMM), private	Centro Nacional de Despacho (CND), a section of ETESA
Traded products	N.A.	N.A.	Power (MW) and Energy (MWh)	Power (MW) and Energy (MWh)	Power (MW) and Energy (MWh)	Power (MW) and Energy (MWh)
Agents	N.A.	N.A.	Producer and consumer agents	Market participants (Gen., Distr., Traders)	Producer and consumer participants	Producer and consumer participants
Electricity demand	N.A.	N.A.	Hourly energy (MWh) and daily peak power (MW)	Hourly energy (MWh) and annual peak power (MW)	Hourly energy (MWh) and monthly peak power (MW)	Hourly energy (MWh) and monthly peak power (MW)
Power supply reliability (plant limits to power contracts)	N.A.	N.A.	"Guaranteed Maximum Power" determined for each power plant	"Firm Capacity" (adjusted to peak demand) determined for each power plant	"Efficient Firm Capacity" (adjusted to peak demand) determined for each power plant	"Maximum Power" determined for each power plant

[16] In 2005, facing high spot prices due to an increase in fuel prices and a tight supply/demand, the Government of El Salvador decided to change the rules for the remuneration of generators in the spot market. Payments of transactions in the spot market at marginal generation costs were replaced by a "pay-as-bid" scheme. The spot price was then determined by the weighted average of price bids of generation plants dispatched to meet demand. Price bids by the state-owned enterprise, determined on the basis of financial considerations, played a role in the stabilization of spot prices. However, in 2006, the new price scheme was not effective in controlling further increases in spot prices. Executive Decree No 57 of 2006 introduced reforms in Article 67 of the Electricity Law Regulations (Articles 67-A through 67-M), making it mandatory to reflect variable costs in the MRS (the spot market). This situation also allowed the government to subsidize any increase of generation costs above US$91.1/MWh.

	COSTA RICA	HONDURAS	NICARAGUA	EL SALVADOR	GUATEMALA	PANAMA
Spot market	N.A.	N.A.	"Mercado de Ocasión"	"Mercado Regulador del Sistema (MRS)"	"Mercado de Oportunidad"	"Mercado Ocasional"
			Economic dispatch based on variable costs[17]-	Economic dispatch based on prices[18] and transmission capacities	Economic dispatch based on variable costs	Economic dispatch based on variable costs
			Hourly energy price: marginal cost	Hourly energy price: marginal price	Hourly energy price: marginal cost	Hourly energy price: marginal cost
			Daily power price: market	Annual power price: regulated capacity charge	Monthly power price: regulated reference price	Power price: contracted (by year or shorter)
Contract market	N.A.	N.A.	Bilateral transactions of hourly energy and daily power	Bilateral transactions of energy ejection, injection and transfer	Bilateral transactions of power with or without associated energy	Bilateral transactions of power and/or energy
Imports	Considered as power plant	Considered as power plant	Considered as producer agent	Considered as power plant	Considered as power plant	Considered as power plant
Exports	Considered add. demand	Considered add. demand	Considered as consumer agent	Considered as large consumer	Considered as large consumer	Considered as large consumer

N.A. Not applicable

4.2 Contracting Obligations

80. Power service in CA wholesale electricity markets is subject to regulatory obligations for contracted power purchases for the consumers (distribution companies, large consumers). The aim is to enforce electricity supply reliability and reduce spot price risks through contracted power with generators. In Nicaragua and Panama, power supply contracts are established through the Supply Guarantee Obligations (*Obligaciones de Garantía de Suministro*) concept; Guatemala applies demand coverage through Firm Efficient Supply (*Oferta Firme Eficiente*); and El Salvador uses long-term contracts subject to Firm Capacity (*Capacidad Firme*) availability.

81. At the end of each year, distributors in Nicaragua must have contracted, in advance, 80 percent of their forecasted demand (for power and energy) for the following year and 60 percent for the subsequent year. In El Salvador, distributors must contract 50 percent of their forecasted demand (for the first year), with a maximum of 25 percent for each independent contract. In Guatemala and Panama, this commitment refers to 100 percent of peak demand. Large consumers do not have specific contracting obligations in El Salvador and Panama, while they have to contract 100 percent of their peak demand in Guatemala and 50 percent of energy demand in Nicaragua.

[17] With price controls during 2005–2008 (see footnote 15).
[18] With price controls during 2006–2008 (see footnote 16).

82. The main rules related to power purchase contracting obligations in the CA markets are summarized in Table 5.

Table 5. Central America: Wholesale electricity contracting obligations

	COSTA RICA	HONDURAS	NICARAGUA	EL SALVADOR	GUATEMALA	PANAMA
Regulations related to long-term contracting	N.A.	N.A.	Supply Guarantee Obligations ("Obligaciones de Garantía de Suministro")	Long-term Contracts and Firm Capacity ("Contratos de Largo Plazo")	Covering of Firm Demand with Firm Efficient Supply ("Oferta Firme Eficiente")	Supply Guarantee Obligations ("Obligacio-nes de Garantía de Suministro")
Contracting obligations for distributors	N.A.	N.A.	Power and Energy: 80% of total demand 1 yr. 60% of total demand 2 yrs.	Power and Energy: 50% of total demand Max. 25% of total demand in one contract	Power [1/]: 100% of peak demand	Power [1/]: 100% of peak demand
Contracting obligations for large consumers	N.A.	N.A.	Energy: 50% of total demand	Free	Power [1/]: 100% of peak demand	Free

[1/] Long-term power supply (MW) should be contracted to cover 100 percent of peak demand (MW). Contracted power (MW) may be also associated with contracted energy supply (MWh). If contracted energy supply is lower than energy demand, total energy supply to cover demand must be complemented with short-term energy purchases at spot prices.

4.3 Contracting Processes

83. Public tenders are the mechanisms used by the distribution companies in CA wholesale electricity markets to select the most favorable electricity supply contracts with the generation companies. Such processes are regulated and supervised by the regulatory bodies of each country (SIGET in El Salvador, CNEE in Guatemala and ASEP in Panama). Different standard terms are applied in each country: a) over 5-year contracts agreed 3 to 5 years in advance or under 5-year contracts agreed at least 3 months in advance in El Salvador, b) minimum of 5-year contracts and maximum of 15-year contracts in Guatemala, and c) typically 1-year contracts agreed 60 days in advance and up to 15-year contracts in Panama. In some cases, such as in El Salvador, maximum confidential prices may be previously ruled for each tender.

84. Table 6 below summarizes these processes, including related documentation and guarantees, schedules for presentation of proposals, schedules for study and selection of offers and contract formalization procedures.

Table 6. Central America: Competitive electricity contracting mechanisms

	COSTA RICA	HONDURAS	NICARAGUA	EL SALVADOR	GUATEMALA	PANAMA
Mechanism	N.A.	N.A.	N.A.	Public Tenders	Public Tenders	Public Tenders
Conditions	N.A.	N.A.	N.A.	3–5 years in advance for more than 5-year contracts, 3 months in advance for less than 5-year contracts	Minimum of 5-year and maximum of 15-year contracts	60 days in advance for 1-year supply (typical)
Type of contract				Standard contracts of Firm Capacity and Associated Energy	Firm Capacity and Associated Energy, in some cases linked to new power plants	Firm Capacity and Associated Energy
Price constraints	N.A.	N.A.	N.A.	Energy: SIGET confidential reference max. price Power: SIGET regulated price	Free	Free
Multiple buyers	N.A.	N.A.	N.A.	Several distributors may participate as buyers	N.A.	N.A.
Terms and conditions	N.A.	N.A.	N.A.	Standardized terms and procedures supervised by SIGET	Terms and procedures approved by CNEE	Terms and procedures regulated by ASEP

4.4 Existing contracts

85. Existing power supply contracts have been executed by 118 distributors and large consumers with 66 producers in the Central American wholesale electricity markets. Nicaragua and Panama have contracted 1,083 MW, El Salvador 170 GWh/month (around 350 MW) and Guatemala 7,922 GWh/year (around 1,350 MW). The existing contracts in these four countries add up to a total of about 2,783 MW. The main information related to these contracts is summarized in Table 7.

Table 7. Central America: Existing Power Purchase Agreements (distributors and large users)

	COSTA RICA	HONDURAS	NICARAGUA[1/]	EL SALVADOR	GUATEMALA	PANAMA
Date	N.A.	N.A.	March 2009	March 2009	2008	2008
Contracted quantity	N.A.	N.A.	219 MW	170 GWh/month	7,922 GWh/year	864 MW
Number of buyers	N.A.	N.A.	5	11	99	3
Number of producers [2/]	N.A.	N.A.	5	12	39	10

[1/] Not including five PPAs (Unión Fenosa and IPPs), [2/] Not including co-generators and IPPs

4.5 National Frameworks for International Power Transactions

86. The four existing CA wholesale electricity markets include rules for international electricity transactions. International transactions among regional agents are coordinated by the system operators and market administrators. These bodies may also participate in the regional market through spot transactions under specific temporary circumstances (i.e., emergency exchanges).

87. International power transactions are contracted directly by agents participating in the national wholesale electricity markets. Such contracts are currently subject to the same regulations as the national contracts (i.e., long-term contracts involving power exchanges that must be supported by "firm" available capacity and other regulations).

88. Currently, the regulatory frameworks of all electricity markets foresee actions to guarantee local self-sufficiency in electricity supply, such as: a) generation–transmission expansion planning (centralized in Costa Rica and indicative in the other four countries), and b) preferential treatment for supplying local markets is embedded in long-term firm energy contracts in the regulated markets (in Honduras, Nicaragua and Panama). For example, in Panama E.D. No. 22 (Article 30) explicitly establishes that the National Dispatch Center will give priority to supplying the domestic market.

89. However, El Salvador and Guatemala have already progressed in the implementation of national market rules to support the MER:

- *El Salvador*: the regulatory framework in this country is clear with respect to MER transactions. The system operator UT is responsible for coordinating the operational and commercial requirements for the MER, considering the EOR as a regional counterpart to coordinate the transactions for the import and export of electricity. The UT will manage the bilateral transactions for import and export contracts in accordance with the provisions in the regulation of the regional electricity market adopted by the CRIE and coordinated by the EOR. Each import or export contract involving a Salvadoran agent shall be reported to the UT as a bilateral transaction.
- *Guatemala*: the recent *Acuerdo Gubernativo* No. 692007 issued in Guatemala recognizes international transactions as the purchase or sale of power and energy from other countries. It also recognizes that the characteristics of the contracts could

be considered as a firm offer or firm demand within the wholesale market, as appropriate. Agents and large users of the wholesale electricity market may transact imports or exports through the MER or with the market of any other country with which the National Interconnected System is connected.

90. Table 8 summarizes the main national regulations governing international exchanges in the CA wholesale electricity markets.

Table 8. Central America: National frameworks for international power transactions

	COSTA RICA	HONDURAS	NICARAGUA	EL SALVADOR	GUATEMALA	PANAMA
Trading Agents	ICE	ENEE	Producer agents (exports) and consumer agents (imports)	Generators (exports), distributors (imports), traders (exports and imports)	Producer participants (exports) and consumer participants (imports)	Producer participants (exports)and consumer participants (imports)
Coordinator of Exchanges	ICE	ENEE	CNDC	UT	AMM	CND
Spot Exchanges	N.A.	N.A.	Coordinated by CNDC with other market coordinators. Prices include transmission and losses charges.	Coordinated by UT with other market coordinators.	Traded directly by market participants or by AMM (emergency exchanges).	Coordinated by CND with other market coordinators. Prices include local market charges.
Contracts	N.A.	N.A.	Physical commitments. Daily power commitments. Hourly energy commitments. Long term (>6m), medium term (6m-7d), short term(<7d). Prices include market charges.	Subject to SIGET supervision. Explicitly subject to MER rules (i.e., long-term firm power exchanges are allowed).	Imports and exports subject to "Firm Efficient Availability" for traded power. Additional associated energy trading.	Subject to ASEP supervision. Power and energy commitments for at least 12 months Exports subject to generation and transmission capacity availabilities. Priority of local supply (long-term local supply studies)
Transition-al priority for local power supply	No	Yes	Yes	No	Yes	Yes

CHAPTER FIVE

THE CENTRAL AMERICAN REGIONAL ELECTRICITY MARKET (MER)

5.1 Introduction

91. This chapter describes in more detail the development of the Central America Regional Electricity Market (MER), including the legal and regulatory framework, construction of the regional interconnection system, and the nature of regional electricity trade. It concludes with an analysis of energy contracts and transmission rights, and actions taken to standardize the contracts and processes of the MER.

92. Central America's MER is quite unique in the sense that it is the only example of an international electricity market which has its own regulatory body and system operator with participating agents from the national electricity markets of several countries. This market is designed to trade mainly electricity and transmission capacity. More importantly, the SIEPAC initiative illustrates that it is possible to create a relatively advanced regional electricity trading arrangement between countries that are at differing stages of internal market development.

93. Small national markets and poor market integration have been obstacles to the benefits of the economies of scale associated with the development of large-scale energy projects. The concept of a regional market was first discussed in 1987 and materialized with the SIEPAC initiative. SIEPAC consists of two interdependent projects, the development of a regional electricity market (MER) and the construction of a 1,800 km power line that will interconnect the six Central American countries, thereby facilitating the exchange of electricity among them and opening the potential for trade with Mexico and Colombia. SIEPAC would also bring efficiency gains through integrated economic dispatch, shared reserve margins and exploitation of complementarities in demand and supply.

5.2 Regional Interconnection System

94. The development of a regional power market in Central America is constrained, among other reasons, by the power flows allowed by the interconnection grid and by regulatory and institutional barriers. The transmission capacity to make power exchanges between countries increases as new transmission links are commissioned (see Table 9).

95. The Mexico–Guatemala interconnection, commissioned in 2009, can support 200 MW power flows from Mexico to Guatemala. The Central American Electrical Interconnection System (SIEPAC) Project would increase to 300 MW the capacity of power exchanges between most countries in the region. New transmission projects that are being considered would further increase the transmission capacity to develop a regional market. The second circuit of the SIEPAC Project could increase trade capacity to 600 MW between countries (450 MW between Costa Rica and Panama) and the Panama–Colombia DC link could provide a 300 MW capacity for power exchanges.

96. Figure 8 illustrates the existing regional transmission grid, denominated RTR *(Red de Transmisión Regional)* as it was defined during the transition period up to the commissioning of

the SIEPAC Project. It consists of single 220 kV interconnection links connecting the power systems of neighboring countries, which could not provide firm transportation capacity to support firm international electricity exchanges based on long-term contracts. Current international electricity exchanges are agreed on the basis of emergency requirements or for short-term economic exchanges.

Table 9. Central America: Transmission links

INTERCONEXIONES	GU-ES	GU-HO	ES-HO	HO-NI	NI-CR	CR-PA	MX-GU	CO-PA *
	N-S / S-N	N-S / S-N	N-S / S-N	N-S / S-N	N-S / S-N	N-S / S-N	N-S / S-N	N-S / S-N
Sistema Actual	67 / 44	0 / 0	125 / 101	42 / 54	48 / 78	39 / 0	0 / 0	0 / 0
México - Guatemala (Inicial)	67 / 44	0 / 0	125 / 101	42 / 54	48 / 78	39 / 0	200 / 70	0 / 0
Siepac 1er Circuito	300 / 300	300 / 300	300 / 300	300 / 300	300 / 300	90 / 300	200 / 70	0 / 0
México - Guatemala (Incr)	300 / 300	300 / 300	300 / 300	300 / 300	300 / 300	90 / 300	300 / 300	0 / 0
Siepac 2do Circuito (Contigencia dos circuitos)	600 / 600	596 / 600	450 / 350	300 / 350	330 / 350	300 / 300	300 / 300	0 / 0
Siepac 2do Circuito (Contigencia un circuito)	600 / 600	600 / 600	550 / 600	564 / 600	500 / 600	450 / 450	300 / 300	0 / 0
Colombia - Panamá	600 / 600	600 / 600	550 / 600	564 / 600	500 / 600	450 / 450	300 / 300	300 / 300

Source: *Estudio del segundo circuito del proyecto SIEPAC como obra planificada y fecha óptima de entradaen operación* (Study of the second round of the SIEPAC Project as a planned work and optimum date for start-up of operation). SNC-Lavalin International Inc. October 2008.

Figure 8. Regional interconnection grid, 2006

Source: *Integración Eléctrica: Retos y Oportunidades* (Electricity Integration: Challenges and Opportunities),

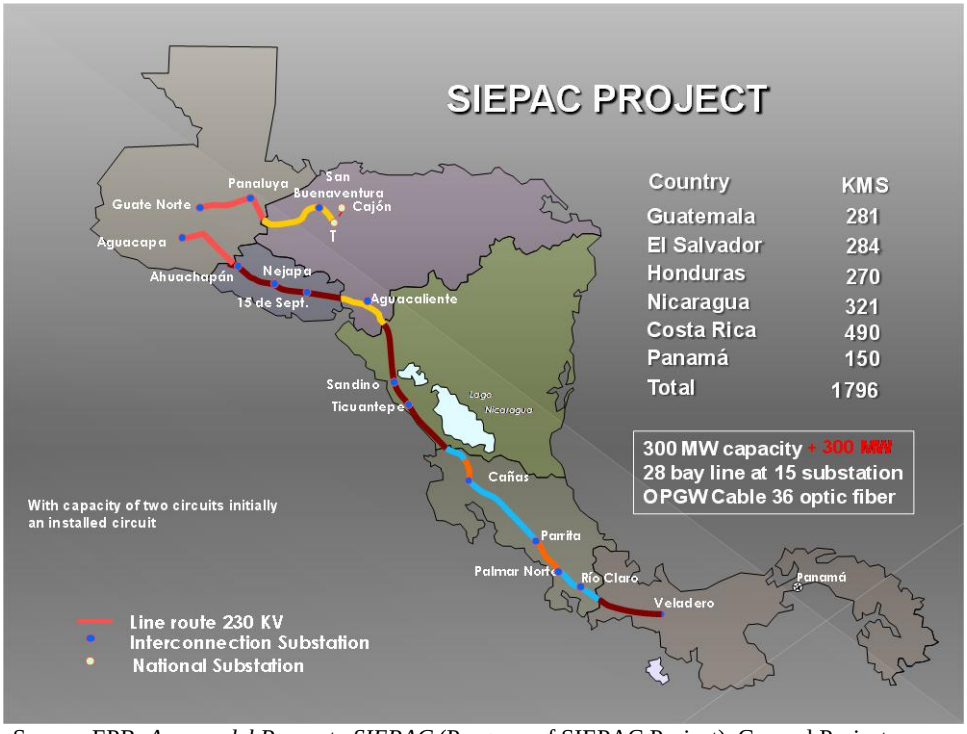
5.3 The SIEPAC interconnection project

97. The Central American Electrical Interconnection System Project is an initiative to create an integrated regional electricity market among the six Central American countries. It consists of a 1,800 km-long, 230 kV single-circuit transmission line,[19] with 15 substations, comprising 20 transmission segments (see Figure 9).

98. The project investment cost is estimated at about US$405 million, financed mainly by Inter-American Development Bank (IDB, US$240 million), the Central American Bank for Economic Integration (CABEI, US$100 million) and US$50 million of equity contributions from the nine shareholders of the EPR[20] (the six Central American countries, ENDESA of Spain, ISA of Colombia and CFE of Mexico).

99. SIEPAC is part of a broader regional initiative under the Mesoamerica Project (formerly known as *Plan Puebla–Panama*, PPP). The Mesoamerica Project aims to develop and integrate 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. Although the SIEPAC line is contained within the Central America region, an interconnection with the Mexican system was commissioned in 2009 and there are plans to build on the interconnection with Colombia.

Figure 9. SIEPAC Project



Source: EPR–*Avance del Proyecto SIEPAC* (Progress of SIEPAC Project), General Project Presentation. August 2008

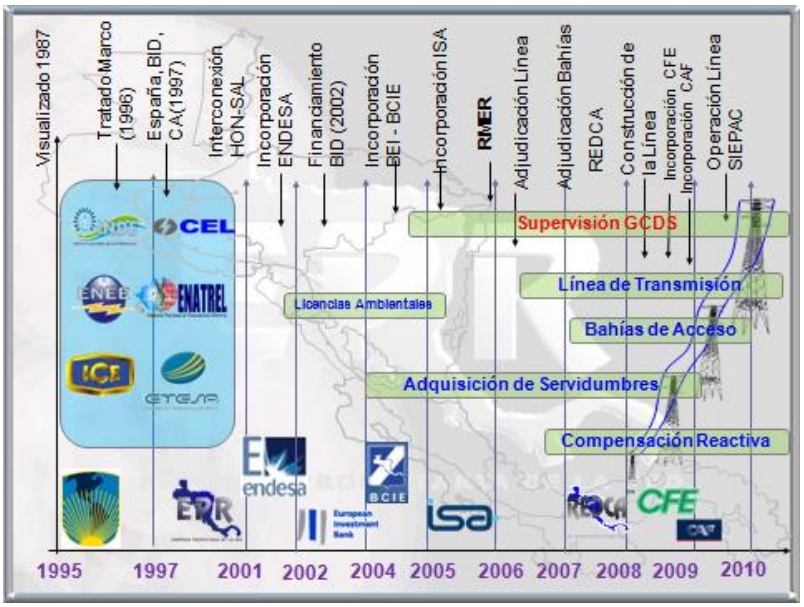
[19] A fiber optic cable is also being installed with the transmission cable to strengthen the telecommunications infrastructure of the region (the "Mesoamerican Information Highway").
[20] The remaining US$15 million have been financed by CAF loans.

100. The stated objectives of the SIEPAC Project are to: a) improve security of supply by widening reserve margins, b) reduce the problem of electricity rationing in capacity-deficit countries (such as Nicaragua), c) achieve improved operating efficiency and reduce generation fuel consumption, d) introduce greater competition into the domestic markets, e) lower end-user electricity costs, f) attract foreign investment to the region's energy sector, and g) contribute to the economic development of the region.

101. In addition, preliminary estimates show that SIEPAC will result in 1 million tons of avoided CO_2 equivalent per year.[21] This estimate 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.

102. The evolution of the SIEPAC Project is summarized in Figure 10. The transmission company (*Empresa Propietaria de la Red*, EPR) was created in 1998, ENDESA joined in 2001, ISA in 2005 and CFE in 2008. Project financing by IDB was obtained in 2002. The main norms and regulations for the operation of the regional market (*Reglamento del Mercado Regional*, RMER) were adopted by the end of 2005.

Figure 10. History of the SIEPAC Project



Source: *EPR-Avance del Proyecto SIEPAC* (Progress of SIEPAC Project), General Project Presentation, August 2008

103. The main contracts for the construction of transmission lines and acquisition of equipment and materials were awarded in 2006 and the construction started in 2008. A new telecommunications company, REDCA, which is responsible for the commercial operation of the optic fiber cable installed on the line, was created in 2007. According to the construction schedule revised in October 2008, the transmission segment in Panama would be completed in September 2009, the segments in Guatemala and Honduras would be ready by December 2009

[21] ENDESA, *"Descripción del PDD del Proyecto SIEPAC"* ("Description of the PDD of the SIEPAC Project"), presentation. March 2007.

and in El Salvador and Nicaragua in March 2010. Construction of the transmission line in Costa Rica is delayed due to difficulties in obtaining rights of way. All segments would be ready by June 2010, except for segment 17, Palmar Norte–Parrita, which would be delayed at least until 2011 if rights of way are finally obtained.

104. In 1996 the six Central American countries signed the Framework Treaty for the Central American Electricity Market, ratified in 1998, which creates the regional electricity market (MER), based on the principles of competition, gradualism and reciprocity. The treaty establishes that the regional market will include a spot market, based on regional economic generation dispatch, and a medium- and long-term contract market, and that the governments will establish adequate conditions for the future development of regional power plants.

105. The regional electricity market established in the treaty and developed in the RMER (final MER regulations) is not an integrated regional electricity market, but a seventh market superimposed on the six national markets. This design takes into account the broad range of institutional development and capacity in the six national electricity sectors and seeks to allow the individual countries to develop their sectors at their own pace while at the same time enabling trade within the region. The points of connection between the MER and the national markets are the nodes of the regional transmission grid (RTR). As agreed in the Second Protocol, the national interconnection systems and lines that make possible the regional energy transfers will form part of the RTR together with the SIEPAC transmission system. It is worth noting however, that without some changes to national markets to ensure the harmonization of national and regional regulations, such as an elimination of the differential treatment of market agents, the national supply priority for firm energy and price controls and the provision of long-term transmission rights, it will be more costly and difficult to meet the SIEPAC project's objectives to promote a regional power market and to minimize long-term costs.

106. The following sections describe in detail MER's legal framework and the main characteristics of the regional market.

5.4 MER's Legal Framework

5.4.1 Framework treaties for the Central American Electricity Market

107. In 1996, the six Central American countries agreed to the creation of the MER through the Framework Treaty for the Central American Electricity Market, which was ratified by the governments in 1998. 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 rules. Article 4 of the treaty indicates that the MER will operate as a permanent activity of commercial international electricity transactions with short-term exchanges, based on economic generation dispatches in the participant countries, with regional economic criteria, and with medium- and long-term electricity exchange contracts among the market agents. Article 9 of the treaty indicates that the governments will establish proper conditions for the future development of regional power plants, aiming at an efficient regional market development.

108. To support the MER, the Treaty also created the regional regulatory commission CRIE[22] (*Comision Regional de Interconexión Eléctrica*), the regional system operator EOR[23] (*Ente Operador Regional*), and the company owner of the grid EPR (*Empresa Propietaria de la Red*). CRIE and EOR are outside the jurisdiction of national courts because they were established as supranational entities governed by international law through the Central American Court of Justice. CRIE's legal status, which creates a potentially powerful institution at the regional level, represents a serious commitment on the part of the national governments that have ceded authority to it through the treaty.[24]

109. The treaty also established the scheme of protocols for future treaty adjustments and clarifications. The First Protocol was agreed in 1998 and consisted of several clarifications and corrections to the text of the treaty, such as: a) EPR cannot have a single controlling partner, b) EOR directors are named by each government from representative agents, and c) disagreements among governments are resolved by arbitration.

5.4.2 The Second Protocol for MER Treaty amendments

110. Agreement on the Second Protocol, with additional adjustments to the Framework Treaty for the MER, was reached in 2007. It has been ratified by five countries and is only awaiting ratification by the Costa Rican Legislative Assembly. The objectives of this protocol are to: a) complement the treaty's clauses, adapting it to the MER's development requirements, b) define actions or omissions that would constitute failure of CRIE's regulations, and establish the respective sanctions, and c) establish regional regulation and operation charges to provide financing for CRIE and EOR. This protocol also creates the MER's Board of Directors, composed of representatives of all the governments, and establishes its responsibilities. The following paragraphs summarize the main adjustments to the MER introduced through the Second Protocol.

Agents and accounting separations

111. Article 3 ratifies that MER agents could be generation, transmission, distribution and commercialization companies as well as large consumers. All agents of the national markets, as ratified by the legislation of each country, are MER agents and they could participate in regional electricity trading[25]. As established in Article 5, if a country permits the existence of companies with integrated activities, they must be separated in business units with independent accounting.

Transmission and charges

112. Article 4 states that national interconnection systems and lines that enable the regional energy transfers are part of the regional transmission grid. Article 5 stipulates that regional transmission companies cannot participate in generation, distribution or commercialization activities and cannot be large consumers. Article 6 states that the availability and use of the regional transmission grid charges will consider variable transmission charges, the toll and the complementary charge.

[22] CRIE was created in 2002 and is based in Guatemala.
[23] EOR was created in 2001 and is based in El Salvador.
[24] Economic Consulting Associates (ECA). "Regional Power Sector Integration: SIEPAC Case Study," July 2009.
[25] The RMER does not include specific regulations for regional generators, which should be developed by CRIE.

Regulatory harmonization

113. Article 12 specifies that the governments will perform the necessary actions to gradually harmonize their national framework with the regional regulations, permitting the regulatory coexistence of the regional and national markets for the harmonious functioning of the MER. Each country will define the gradualism for this regulatory harmonization.

Various

114. Other articles of this Second Protocol deal mainly with establishing the basic penalty scheme for failure to comply with CRIE's regulations, as well as the related procedures and the corresponding sanctions. These articles provide CRIE with significant power to mandate specific national regulatory adjustments and to impose penalties due to regional regulation failures. In addition, regulatory and operational service charges to be paid by MER agents are established to support the operations of CRIE and EOR.

115. One of the main agreements included in the Second Protocol refers to the gradual regulatory harmonization for the implementation of the RMER (Article 12). It is understood that this will allow firm energy trading in the MER, implying that the contracted energy will have priority to supply the demand of the buyer in the country where it is located, instead of having priority to supply the demand of the country in which the seller is located. This basic concept will make it necessary to modify the national regulations that provide for supply priority for national demand in most CA countries.

5.4.3 Specific MER regulations

116. MER operations are currently governed by a transitional regulation, RTMER (*Reglamento Transitorio del MER*), which includes the transitional market rules for its operation and administration. These rules cover database management, coordination of regional ancillary services, quality and reliability of service parameters, analysis and preparation of reports related to system disruptions, MER technical operations and electrical studies, MER commercial organization, settlement of international transactions and coordination of generation pre-dispatch. The RTMER will be valid until the commissioning of the SIEPAC Project (scheduled for 2010). Afterwards, the definitive market regulations, RMER (*Reglamento del MER*, a set of detailed market rules prepared in 2005), will be operational.

5.5 Regional Electricity Trade in the MER

117. The MER is a wholesale electricity market at the regional level whose organization and operation are based on the following premises: a) MER electricity transactions could be carried out as opportunity exchanges identified through a regional economic dispatch or by means of contracts between market agents; b) all MER agents, with the exception of transmission agents, can purchase and sell electricity freely without discrimination, while the free transit of electricity is guaranteed by MER member countries; c) MER generation agents can install power plants in any network of the member countries for commercialization of the energy produced at the regional level; d) MER agents have free access to the regional and national transmission networks that comprise the RTR; and e) the MER is a market with its own rules, independent of the national markets of the member countries, in which transactions are made through the infrastructure of the RTR and the national networks. The points of connection between the MER and national markets are the nodes of the RTR.

118. As mentioned above, according to the MER's general design there are two main forums for international electricity trade in Central America: a) the regional contract Market, and b) the opportunity market. The main characteristics and rules associated with these commercial transactions are summarized in the sections below.

5.5.1 The regional contract market

Objective

119. The terms, prices and other conditions in regional contracts will be freely agreed among the parties (agents from different countries), with a minimum duration of one day. The contracts must specify the hourly energy committed during the contract period and the flexibility conditions that could be applied to it.

120. These flexibility offers can also be used to manage transmission restrictions by reducing the committed energy and limiting it to the available transmission capacity, if necessary. Each national operator will inform the EOR daily on the hourly contractual exchanges associated with each regional contract in the nodes of the RTR. The regional regulation also establishes the coordination and administration requirements for transactions using the RTR.

121. The regional contract market was designed with the objective of creating formal conditions and a regional administration to enable regional investments and expansion in generation and transmission infrastructure. Nevertheless, at the same time it was deemed necessary that this market should allow and encourage the maximization of the use of the available transmission and generation capacity through opportunity contracts. There are two types of contracts in the MER, depending on the firmness agreed for delivery of the contracted energy: a) firm contracts, which establish priority of supply for the purchasing agent, and b) non-firm contracts, which do not establish such provision for the purchasing agent. Firm contracts must have associated transmission rights between the nodes of injection and withdrawal.

Regional energy contracts during the transition phase

122. According to the RTMER, the regional energy contracts during the transition phase have only been non-firm contracts that must comply with the national legal and regulatory framework. Today, the regional market contracts are therefore all contracts for import or export of electricity between agents represented by their respective national operators.

123. To meet MER requirements, such regional contracts must indicate the hourly energy committed for the duration of the contract and the injection and ejection nodes. These contracts are not firm or financial, and their physical performance is subject to daily dispatch, based on injection and ejection bids. The parties must report daily to their national operators on the decreasing bids required in the pre-dispatch phase. Contracts are freely agreed between the parties and must comply with the respective national regulations. These contracts are considered to be interruptible due to: a) technical constraints, b) quality and safety criteria, and c) priority of supply of a national operator.

Regional firm energy contracts after the transition phase

124. According to the RMER, after the transition phase, the objectives of the regional firm energy contracts will be to:

- Provide each party (buyer and seller) with security and obligations related to the agreed sales/purchases with agents located in another country of the region.
- Enable the development of power plants at regional scale.
- Promote long-term exchanges of large volumes, permitting the expansion of the RTR.

125. In these contracts, the selling agent commits to the delivery of firm energy to the buyer in one or more nodes of the RTR, as required by the purchasing agent. The selling agent must cover his commitment in each node with his own generation and/or purchases in the regional opportunity market, and/or, if allowed by the corresponding national regulation, in the national opportunity market of the purchasing agent. Due to its characteristics, in general this type of long-term contracts will be associated with investments. Nevertheless, their terms of duration are subject to the decision of the parties since they are not governed by regional regulations.

126. The regional firm energy contract establishes a supply priority that is different from that which would arise if it is based on the physical location of the committed (seller) power plant. All the generation that is sold in a regional firm energy contract will be considered regional generation. The buyer's demand will have priority of supply over the demand of the country where the seller is located. As a result, the contracted energy cannot be "firm" (with priority of supply) for the demand of the country in which the seller is physically located. Therefore, the local operator cannot interrupt the contracted delivery due to demand requirements in its national market.

127. CRIE, in coordination with EOR, the regulatory bodies and the system operators and market administrators of each country, will calculate the amount of firm energy that can be committed in regional contracts, according to appropriate periods of time for each country. In order to establish the regional criteria for firm energy, CRIE will consider, among other factors, the generation capacity, the availability of power resources, the maximum demand of each national system, the regional and national reserve requirements, and the existing contracts.

128. This type of regional contract is not yet operational,[26] mainly due to the absence of an organized regional electricity trade environment (RMER, which will be mandatory in 2010) and to the nonexistence of firm transmission capacity among the national markets (the SIEPAC transmission system). As discussed later, one of the contracting parties in a firm contract must own the transmission rights between the injection and the ejections nodes.

129. Finally, in order to guarantee efficiency and competition in the MER, each national system must permit the inclusion of the "regional" energy exchanges in its national market, using similar criteria in the economic dispatch and allowing for transparent and

[26] In December 2008, El Salvador Disco (CAESS) awarded a firm 30 MW power and energy sell/purchase contract for 15 years, starting in January 2012, to the Guatemalan Genco (HIDRO XABCAL). This was the first long-term contract signed in the MER.

nondiscriminatory treatment. In countries with wholesale electricity markets, each of these regional contracts would then be part of a national contract. An adequate assessment should be carried out in each case to determine the effect of regional contracts on national prices.

Regional non-firm energy contracts

130. The objective of regional non-firm energy contracts is to enable economic opportunity from energy exchanges between agents, aiming at the maximization of net income, and also to promote the development of the regional contract market and to maximize the use of the available transmission capacity. Short-term selling/purchasing commitments with a minimum duration of one day are characteristic of these transactions, which are agreed upon daily and indicate the hourly energy exchange required for the following day. Because they are non-firm, these contracts are interruptible under specific conditions established for the MER.

131. Non-firm contracts can be of two types: a) financial, which do not affect the regional pre-dispatch and count only for reconciling the transactions, and b) physically flexible, which are physical commitments of energy that can be made more flexible in the regional pre-dispatch by means of opportunity bids associated with the contracts. These types of contracts may also have maximum bids for variable transportation charges (*Cargos Variables de Transporte*, CVT).

5.5.2 The regional opportunity market

132. The regional opportunity market makes it possible to obtain economic advantages from delivering excess generation from one country to another country, where it will supply a deficit or replace more expensive generation. This will happen based on the opportunities that the countries make available to the MER through their respective country system operators.

133. The objectives of these transactions in the regional opportunity market are to:

- Optimize the use of the resources available in the region, independent of the country in which they are located, under a common regulatory framework (an organized market of opportunity exchanges) based on competition;
- Promote the use of the installed generation capacity not committed in contracts and of the capacity of regional transmission, facilitating the recovery of investments;
- Enable an efficient coverage of the deflections that arise from the regional contract market, reducing risks associated with contracts'
- Create an efficient mechanism to cover the deviations that arise, due to quality and security or emergency criteria, in the real-time programming and operation of the scheduled exchanges; and
- Create additional tools for risk coverage in the national electricity markets.

134. The transactions in the regional opportunity market are on a spot basis and therefore interruptible by the national operator of the selling or buying country. The volume of spot market transactions will be limited by the transmission capacity in each node of the RTR not occupied by the exchanges resulting from contractual commitments, considering quality and security criteria.

5.6 Firm Energy Contracts and Transmission Rights

135. A regional firm contract relies on the availability of the necessary transmission capacity to guarantee its firmness. In the MER, agents with firm energy contracts must have access to transmission rights. That is, firm regional contracts are only signed when the required transmission capacity is available to ensure its fulfillment.

5.6.1 Transmission rights auctions and transmission expansion planning

136. The exchange of transmission rights (DTs, *derechos de transmisión*) will be free if it does not lead to abuse of market power. CRIE will have the responsibility to supervise the DTs, verifying that they will not affect free competition in the MER. In this sense, RMER foresees monthly auctions that offer the DTs. In these auctions, the DTs will be assigned by month or by annual periods. CRIE will be able to authorize the assignment of the transmission rights for longer periods and to modify the frequency of the auctions. The EOR will carry out, for each auction, probabilistic forecasts of the nodal prices in the RTR for a two-year horizon,[27] which will give the agents a reference on the prices of the DTs.

137. Long-term transmission expansion planning will be a responsibility of the EOR. The regional operator will have to identify extensions of the RTR that maximize the social benefits of injecting and ejecting agents, improve reliability at the regional level, and increase competition in the MER. Long-term planning will be conducted with a horizon of at least ten years, which may be extended by the EOR if deemed necessary. The long-term planning process should include information such as transmission expansion plans for each country and the indicative planning for generation.

5.6.2 Regional transmission charges

138. The CA Regional Transmission Service was conceived as a relatively complex contract carrier power transportation service with transactions of transmission rights among specific RTR nodes applicable to acceptable power shipments for its owners, instead of as a common carrier service for MER agents. The conditions of access and use, quality of service, and tariffs were established as indicated in the RMER. The general design is described below.

General design included in the RMER

139. The methodology to define the charges for the use of the RTR, a nodal price scheme, was conceived with the objective of originating efficient economic signals. This system automatically calculates a monetary amount from the result of the price difference between two nodes of the RTR by the flow of energy transmitted in each hour and then adding it for each month. This amount is assigned to remunerate the regional transmission service, thus constituting the tariff revenue.

140. Considering the diversity of the current national regulations related to transmission charges, the methodology of nodal prices was established only for its application to the RTR. The cost attributable to transmission losses due to the transactions in the MER will be covered within the methodology. Nevertheless, it is expected that the tariff revenue generated by the nodal prices scheme would not be enough to cover the average transmission costs since, due to the economies of scale in electricity transmission, under normal situations the marginal costs are

[27] For this task, the EOR will use the MER's simulation model, which is used for midterm planning studies of the RTR.

lower than the average costs. This application generally allows for covering about 15 to 20 percent of the capital and operation and maintenance transmission costs. The tariff revenue must then be complemented by tolls and complementary charges to suitably remunerate each of the investments (lines and substations) in this segment of the market.

141. As presented below, the remuneration of transmission in the MER is derived from a rather complex and detailed scheme, whose advantage is that it would avoid potential disputes among MER agents while providing better economic signals to the market. However, this scheme may also be a disadvantage due to the significant effort that agents will have to make in terms of understanding this market segment and its economics. This would imply higher costs and potentially discourage the agents, a situation that might be avoided with a simpler transmission charging mechanism.

Transmission charges during the transition phase (RTMER)

142. The transmission charges currently applied in the MER during the transition phase essentially consist of variable transmission costs curves (*costos variables de transmisión, CVT*), associated with the national transmission systems, which are prepared weekly by each country, and operational tolls defined for each international link. This scheme is applied daily by resolving an optimization dispatch problem for 14 nodes, 10 interconnectors and 4 CVT curves associated with the non-extreme interconnected countries.

Definitive transmission charges (RMER)

143. The detailed scheme for transmission charges included in the RMER (Book III: Transmission) is much more complex and has replaced the CVT curves with a detailed representation of the RTR and the determination of hourly nodal prices (implying losses and transmission congestion estimates). The operational tolls associated with the international links are eliminated and a methodology to determine the authorized regional transmission revenue (*ingreso anual autorizado*, IAR) is established with a scheme of penalties due to unavailability. The RTR's tariff regime is composed of: a) the IAR transmission revenue that will be received by each transmitting agent; b) the regional transmission charges paid by the agents, and c) the processes of reconciling, invoicing and liquidating the regional transmission charges.

5.6 Standardization of Regional Power Contracts and Processes

5.6.1 Introduction

144. In the six Central American countries, electricity markets were independently developed but with interconnections among them. This allowed international electricity transactions, mainly to support emergency exchanges or for economic reasons when there was excess hydroelectric energy generation in some countries. Initially, minimum incidences of the interactions with neighboring markets were expected; this situation that would evolve gradually until the regional electricity market (MER) is formed.

145. Future MER development relies to a great extent on the implementation of adequate rules and practices for long-term firm international energy exchanges. Standard processes and terms are proposed to achieve improvements and higher efficiency in the long-term firm energy contracting process in Central America.

5.6.2 Rules for a "Firm Energy" Regional Concept

146. In the national wholesale markets operating in CA, energy and power are traded as commodities and security of supply is agreed by means of contracts that essentially commit the "firm" or "reliable" power availability (MW) required to supply consumers' peak demand (MW). However, in the MER, security of supply is governed by the concept of "firm energy" (MWh) to supply consumers' energy demand (MWh) and does not involve power transactions (MW). As an initial step for the standardization of regional firm energy contracts, it becomes necessary to regulate in detail the concept of "firm energy" in a way that is compatible with the concepts of firm power (or similar power-related concepts) already established in the national markets.

147. In compliance with the concept of firm energy delivery, two types of contracts would be executed in the MER: a) firm contracts, which establish energy supply priority for the buyer; and b) non-firm contracts, which do not establish such a supply priority. In a regional firm energy contract, the selling agent is committed to sell "firm energy" to the purchasing agent in the node of electricity withdrawal of the RTR designated in the contract (in addition, one of the parties of the contract must hold the associated transmission rights between the injection and ejection nodes in the RTR).

148. The criteria to calculate "firm energy" have not yet been regulated in detail. The RMER gives CRIE, the regional regulator, the mandate to define these criteria, taking into consideration elements such as generation capacity factors, the availability of power resources, the maximum demand of each national system, the regional and national reserve requirements, and the existing national and regional contracts.

149. The amount of energy that a market agent can sell or buy in a regional firm energy contract will be limited by: a) the amount of "firm energy" authorized by the regulator of the country where the selling agent is located, based on the regional criteria established by CRIE; and b) the transmission rights between the nodes of associated injection and withdrawal to the contract, owned by the party designated in the contract.

150. CRIE, in coordination with the EOR, the regulatory organizations and the system operators and market administrators of each country, will calculate the amount of "firm energy" that can be committed in regional contracts by each power plant, based on appropriate time periods for each country.

5.6.3 Options for standardization of regional power contracts and processes

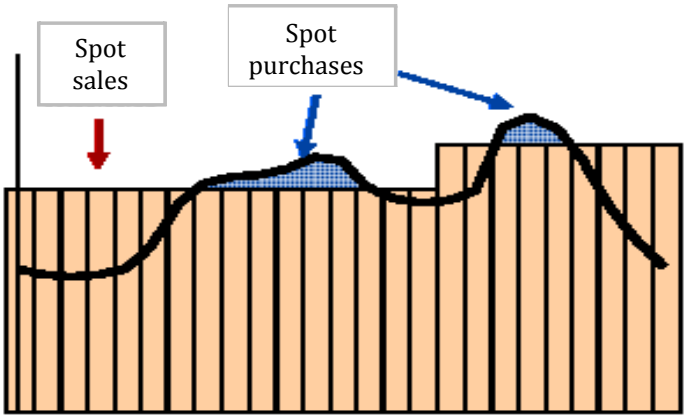
151. Additional aspects related to the standardization of regional firm energy contracts are discussed in this section. Its consideration and eventual introduction in the design of such contracts would mainly serve the purpose of improving the adaptation of the contracted patterns and conditions of the energy to be supplied by producers to the demand requirements of consumers. This would reduce the risks of additional costs to the buyers, stemming from energy transactions in the spot market.

5.6.4 Contract types

152. In addition to the mutual agreements on the price and amount of firm energy that a contract would include, several types of contracts could be standardized for the regional market.

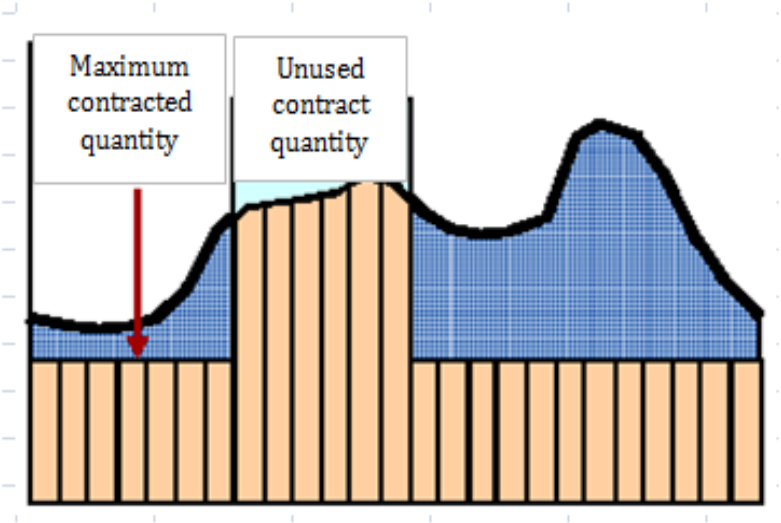
153. ***Pay as contracted***: Type of contract in which the buyer is committed to pay all the contracted energy at the contracted price each hour, regardless of whether the energy is consumed or not. If the buyer's demand is greater than the contracted energy, the difference is paid by the buyer at the spot market cost. If the buyer's demand is lower than the contracted energy, the difference is sold by the buyer to the spot market at the spot price. This type of contract is illustrated in Figure 11.

Figure 11. Type of contract: "Pay as contracted"



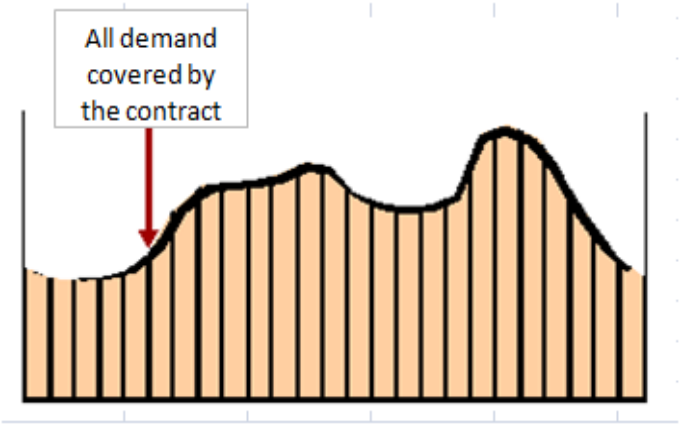
154. ***Pay as demanded***: Type of contract in which the buying agent only pays (at the contract price) the consumed energy each hour, provided that this is lower than or equal to its contracted quantity (upper limit). If consumption is above the contracted quantity, the buyer will pay the difference at the spot market cost, as presented in Figure 12.

Figure 12. Type of contract: "Pay as demanded"



155. ***Pay as demanded without cap***: Type of contract in which the buyer only pays (at the contract price and with demand risk assumed by the seller) its total demand less other contracts, as illustrated in Figure 13.

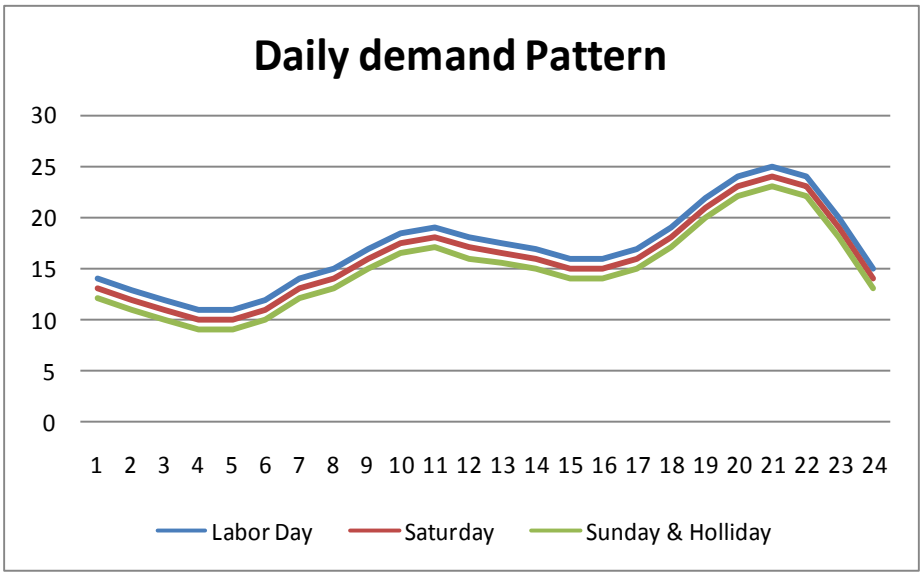
Figure 13. Type of contract: "Pay as demanded without cap"



5.6.5 Load patterns

156. It would also be possible to standardize the daily load curves by type of day (workdays, Saturdays, Sundays and holidays), establishing different contractual quantities for each type of day, as presented in Figure 14. This would increase the potential adaptation of contracted energy to the load pattern of buyers without losing simplicity in contracting.

Figure 14. Daily demand pattern



Labor Day	Saturday	Sunday & Holiday
1 MWh	0.9 MWh	0.85 MWh

5.6.7 Standardization of contract clauses

157. Some CA countries have already introduced standard clauses that are divulged prior to the competitive tenders for long-term power supply contracts, with the objective of facilitating the contracting processes. This type of standardization could also be adopted to support the contracting of MER international firm energy exchanges.

5.6.8 Institutionalization of competitive processes

158. In order to increase the firm energy volumes to be contracted to supply the demand in the MER through public tenders or auctions, several buyers may participate jointly. This would enable economies of scale because it would allow for participation in these processes by producers that could develop larger-scale generation plants. These procedures could be institutionalized to promote this type of competitive processes at the regional level, including the regulation of voluntary (large consumers) and mandatory (distributors and traders with users at regulated tariffs) participation. This would require CRIE to play an active role in the promotion and supervision of such activities, including the creation of a centralized process to estimate the total demand to be tendered or auctioned.

159. In addition, the international competitive processes for long-term firm energy contracting could be institutionalized by introducing appropriate public tenders or auctions (for example, "descending clock"-type auctions) with pre-established schedules. This would improve and increase the efficiency of the competitive processes for long-term energy contracting at the regional level, thus facilitating the future development of the MER.

CHAPTER SIX

MER POWER TRADE WITH MEXICO AND COLOMBIA

6.1 Status of the Mexico–Guatemala Power Interconnection

160. With their relatively large electricity markets and potential ability to meet the supply-demand gap in Central America, Mexico and Colombia represent an alternative for supplying the MER with power, which would otherwise rely on building new regional power plants. This chapter describes the history of the northern and southern interconnections to the MER.

6.1.1 Origin and project development

161. The Mexico–Guatemala power interconnection was conceived within the Plan Puebla–Panama, agreed in 2001, to foster the development of the Central American countries and the southern areas of Mexico. For the power sector, this plan includes: a) the development of the interconnection of the Central American power systems through the SIEPAC Project, b) the Mexico–Guatemala power interconnection, and c) the Mexico–Belize power interconnection.

162. For the Mexico–Guatemala power interconnection, in 2003 the two governments, through SENER (the Energy Secretariat) of Mexico and MME (the Ministry of Mines and Energy) of Guatemala, signed a Memorandum of Agreement to develop the project. This memorandum contains the basic project description, the proposed schedule for the project's construction, and the proposed financing scheme. It also assigns to CFE (Comisión Federal de Electricidad, Mexico) and INDE (Instituto Nacional de Electrificación, Guatemala) the responsibility for the following two agreements, which were signed along with the participation of CENACE (Centro Nacional de Control de Energía, México) and AMM (Administrador del Mercado Mayorista, Guatemala): a) construction (studies, design, specifications and construction phases) and maintenance agreements signed by these two institutions, and b) operation (technical and operational aspects of the interconnected systems and power dispatch) and exchanges administration (energy supply conditions, power transactions, guarantees and payments).

163. The Memorandum of Agreement also defined a professional team to assess the technical, regulatory and commercial barriers for the free trade of energy between the two countries and the design of the required solutions.

6.1.2 Description and financing

164. The Mexico–Guatemala power interconnection system was commissioned in 2009. It consists of a 400 kV transmission line, 103 km in length (70 percent in Guatemalan territory and 30 percent in Mexican territory), and associated substation expansions (Tapachula in Mexico and Los Brillantes in Guatemala). Total transmission capacity is estimated at 200 MW from Mexico to Guatemala and 70 MW in the opposite direction. The total project cost was US$55.8 million, of which US$12 million were provided by CFE and US$43.8 million were

financed by Guatemala (US$5.8 million by INDE and US$37.5 million by a loan from the IDB).

6.1.3 Operation and maintenance agreement

165. CFE and INDE signed the operation and maintenance agreement in 2003. This agreement includes the transmission interconnection components and the general operational and maintenance aspects. It also defines the interconnection point between the Mexican and Guatemalan systems and states that the transmission and ancillary services provided by the two parties will be governed by the regulations of each country.

166. It also states that each of the participants will be responsible for the maintenance and inspection of its own components of the infrastructure, including telecommunications, control and metering, and for the installation and calibration of the protection systems, energy meters and registers. This agreement also defines the responsibilities of the parties, events of force majeure and other complementary aspects, and establishes the design of a coordination committee.

6.1.4 Operational coordination and exchanges administration agreement

167. A master operational coordination and power exchanges administration agreement was also signed in 2003 by AMM of Guatemala and CFE and CENAC of Mexico. The objective of this agreement is to establish the coordination mechanisms for interconnected power systems operations in the two countries and the terms and conditions for the administration of transactions of products (energy and power) and services (ancillary services, etc.) provided to the parties through the international interconnection system.

168. With regard to operational coordination, the agreement establishes the following procedures: a) transaction programming, b) real-time operational coordination, c) communications, and d) metering and commercial transactions. Other complementary aspects are also included, such as the technical description of components, force majeure, responsibilities, authorizations, etc.

6.1.5 Mexico–Guatemala power transactions

169. INDE has already contracted with CFE for the purchase of 120 MW and the remaining capacity of the line is expected to be traded in the Guatemalan opportunity market. If required, Guatemala could also sell up to 70 MW to Mexico. The contract was signed in 2008 as a long-term firm energy purchase contract to import 120 MW of firm power and associated energy to Guatemala from the time of the commissioning date of the new interconnection link to April 2011. The basic prices agreed are: a) US$4/kW per month for firm power, including generation and transmission charges, indexed to GDP inflation in United States, and b) US$79.61/MWh (2009) and US$73.26/MWh (2010–2011) for associated energy, indexed using a formula including international prices for Bunker C and Natural Gas.

170. The firm power payment carries a “take-or-pay” commitment, while real energy imports will be the result of the economic dispatch operated by AMM in such a way that energy payments will correspond to real imported energy priced at agreed prices. The firm power conditions agreed upon state that imported power would be interrupted by CFE only under emergency conditions. The executed contract includes provisions for: a) scheduling of daily energy exchanges coordinated by AMM and CENACE, b) regulation of the exchanges by AMM, c) the delivery point, d) metering, and e) other complementary aspects.

6.1.6 MER's harmonization with the Mexican power market

171. The Mexico–Guatemala electricity trade agreements have progressed essentially as a bilateral relationship. They have been included within the Guatemalan electricity market regulations with this focus, which has been followed cautiously by other MER participants. In this regard, the SIEPAC Executing Unit has promoted the inclusion of a first phase of the MER–Mexico harmonization within the CEAC–IDB Technical Cooperation.

172. This Technical Cooperation consists of a consultancy assessment to propose, for the MER and Mexico, the required regulatory harmonization, including the interfaces with and adjustments to each country's legislation and regulation, for suitable interaction of the MER regulations and the regulation of the Mexican electricity market. This harmonization would include the elimination of technical and commercial barriers.

6.2 Status of the Colombia–Panama Power Interconnection

173. Following the results to be obtained from the MER–Mexico regulatory harmonization task, a similar exercise would be conducted for the case of the MER and the Colombian electricity market regulations in order to define the potential power exchanges and MER electricity trading through the future Panama–Colombia interconnection link. This project constitutes a step toward interconnecting the Andean region and the Central American electricity markets. Its execution, accompanied by a process to harmonize the institutional, normative and regulatory electricity frameworks, will be the basis for extending international power exchanges between these two regions.

174. The project consists of the construction of a direct current (DC) power transmission line at 250–400 kV (HVDC) and with capacity of 300 MW and a possible expansion to 600 MW. Its length is 614 km: 340 km in Colombia and 274 km in Panama. Investment costs are estimated at US$210 million, including the expansion of the Cerromatoso (Colombia) and Panama II (Panama) substations. The project will benefit from technical and environmental feasibility studies developed under the frameworks established by the energy and environmental authorities of both countries. These studies have been financed by the Inter-American Development Bank (IDB) through non-reimbursable technical cooperation.

175. Currently, ISA (the Colombian transmission company) and ETESA (the Panamanian transmission company) are moving forward with the technical and environmental studies and project design. In addition, the regulators of both countries are advancing with the process of regulatory harmonization of their respective electricity market regulations. In this regard, an additional regulatory analysis is under way.

176. In order to develop this project, in April 2009 ISA and ETESA constituted, in Panama City and with equal participation, the bi-national company *Interconexión Eléctrica Colombia–Panama S.A.* (ICP). Prior to the constitution of this company, in August 2008 the presidents of both countries signed a Letter of Intent in Cartagena (Colombia) that gave new impetus to this project. This document was ratified in 2009 through an Agreement Protocol between the National Secretariat of Energy of Panama and the Ministry of Mines and Energy of Colombia, with the aim of developing and implementing the operational and commercial schemes that will allow the international exchange of power.

CHAPTER SEVEN

REGULATORY AND INSTITUTIONAL BARRIERS TO MER DEVELOPMENT AND ACTIONS BY COUNTRY

7.1 Regulatory and Institutional Barriers

177. Having described the structure and functioning of the six national electricity markets and those of the regional market in previous chapters, this section discusses the key barriers to the success of the MER and the key actions that are needed by individual countries to help overcome these barriers.

178. The SIEPAC initiative illustrates that it is possible to create a relatively advanced regional electricity trading arrangement between countries that are at differing stages of internal market development and have different types of electricity industries and institutional schemes. However, while the regional electricity market is in its current transition stage, the Central American governments and national regulators need to make some relevant decisions and take actions to expedite the use of the transmission line and ensure that the region fully benefits from the potential offered by the new infrastructure and the market architecture that have been under development for over a decade.

179. The MER's general design provides a general framework that allows and promotes long-term firm power trade among Central American countries that would also facilitate the financing of regional generation plants. However, several barriers could arise for the achievement of such objectives. This section discusses the main barriers identified and proposes options to address them.

180. **Asymmetry in national markets.** The asymmetry in the national markets can lead to a lack of reciprocity in the treatment of market agents. There is a lack of reciprocity of the vertically integrated national electricity markets prevailing in two Central American countries (Costa Rica and Honduras) with the more open electricity markets already structured in the other four countries (El Salvador, Guatemala, Nicaragua and Panama). This is a source of asymmetry because regional generators (and national generators in the latter four countries) cannot directly contract electricity with potential distribution, commercialization and large consumers located in Honduras and Costa Rica. Moreover, potential regional generators located in these two countries would not have clear rules allowing them access to the national transmission grids. However, both ICE and ENEE will have the opportunity to sell to distribution and commercialization companies and large consumers in Panama, Nicaragua, El Salvador and Guatemala.

181. This could be a political issue because the national congress of each country is the ultimate body for decision making on power sector restructuring. In particular, the Costa Rican Legislative Assembly has not yet ratified the Second MER Protocol. Ratification has been difficult because the Costa Rican Government would remove some of ICE's authority as Costa Rica's sole agent in the MER, granting to MINAET the role of defining these responsibilities. ICE is working with MINAET to present a position of consensus.

182. To advance expeditiously in the solution of this lack of reciprocity and the asymmetry it entails, beyond the political factors, significant time and resources (technical and financial) would be required to implement the necessary electricity market reforms in Costa Rica and Honduras. In particular, these countries will have to develop clear rules for participation in the MER by agents other than ICE and ENEE (i.e., Independent Power Producers, IPPs), since they are, as of today, the sole agents in their respective national markets. In the case of Costa Rica, any new national market agents resulting from the structural reform of the system that may be introduced through the new Electricity Law should be able to participate in the MER. In the case of Honduras, ENEE is likely to remain the sole participating agent, at least in the medium term, since no significant reform of the sector is expected.

183. **Regulatory harmonization**. There is a lack of harmonization of national and regional regulations at the operational and commercial levels. National electricity regulations must be harmonized with regional regulations in order to facilitate market operations and regional long-term firm power contracts between qualified agents. This issue should be solved in order to implement the regulations and the appropriate interfaces so that MER regulations can work harmoniously with the corresponding regulations in each country.

184. The Executing Agency of the SIEPAC Project is currently working on the harmonization of regional and national regulations and on the strengthening of regional institutions (CRIE and EOR). The required tasks have been scheduled in two stages: a) the minimum regulatory harmonization necessary to allow the start-up of the RMER's operations instead of the transitional regulations (RTMER); and b) the remaining regulatory harmonization necessary to ensure full interaction between the MER and the national markets when the RMER is implemented in its final form.

185. In addition, CRIE is carrying out work in the following two specific areas: a) standardization of terms and clauses in long-term regional firm energy contracts, and b) institutionalization of regional competitive processes and mechanisms for the consolidation of regional coordinated contractual electricity purchases by multiple agents. These efforts would assist in advancing harmonization.

186. **Domestic demand has priority.** In most of the CA countries, domestic demand still has priority in the event of power shortages, which creates a risk for firm contracts in the regional market. In most of these countries, national laws, regulations and policies give priority to supply or establish wholesale price controls in electricity supply to the domestic markets. For example: a) Honduras, Nicaragua and Panama explicitly established power supply priority for the local market (E.D. 22-1998 Article 30 in the case of Panama), b) in Guatemala, a resolution in 2005 restricted energy exports, and c) in El Salvador and Nicaragua, significant government interventions aimed at lowering retail tariffs in their electricity markets manipulated the wholesale electricity prices, jeopardizing potential energy imports. In addition, the regulatory frameworks of all electricity markets foresee actions to guarantee local self-sufficiency in electricity supply, such as: a) generation–transmission expansion planning (centralized in Costa Rica and indicative in the other countries), and b) preferential treatment for the local markets of the long-term firm energy contracts for the regulated markets (in Honduras, Nicaragua and Panama).

187. The way in which the regional market was designed would allow all SIEPAC members to benefit from the surplus of one country to cover deficits in another country: a win-win

situation. However, to ensure that all countries benefit equally from the regional interconnection, the national supply priority in the case of power shortages will have to be adjusted in the national markets according to the Second MER Protocol in order provide for certainty of supply of the firm energy contracts in the MER. In this regard, the Framework Treaty, the Protocols and the associated regulations define the specific sanctions regime to be applied in cases of noncompliance with MER rules, as well as arbitration mechanisms for the resolution of disputes. In any case, countries could still decide unilaterally to restrict exports in the event of national shortages. However, it is expected that the pressure exerted by the rest of the countries in the market and the threat of sanctions would act as deterrents and minimize the risk of noncompliance with firm regional contracts.

188. **Price controls and price adjustments.** Price controls lead to misallocation of resources and can endanger the success of the regional market. During the reform processes in the power sector, the stated objective was to achieve a situation in which electricity would respond to market supply and demand signals (as in the case of oil products), rather than to managed criteria that either distort the wholesale price or institute unsustainable subsidies. However, political considerations and influences have affected regulatory decisions; for example, changing the rules of the game by setting ceilings for market prices, and otherwise impeding the establishment of true marginal cost schemes for power sector transactions in wholesale power markets. This issue can prove to be particularly problematic in interconnected spot markets during shortage situations if the exporting prices do not reflect the opportunity costs in the exporting country.

189. During the past four years, countries in the region, such as El Salvador and Nicaragua, have introduced price controls in the spot market and generalized subsidies to mitigate the impact of high fuel prices on electricity tariffs. These efforts have been at an enormous cost to the governments (as in Honduras and El Salvador) or to state power companies (as in Costa Rica and Guatemala). Moreover, the application of these practices in the future would reduce the opportunities for long-term contracts and short-term transactions in the regional market. Therefore, one of the challenges of interconnection and integration consists of agreeing on common rules to avoid the misallocation of resources through the unilateral rulings of individual regulators.

190. Avoiding these problems requires increased support from national regulatory institutions. Some specific courses of action can be identified: a) in Panama, the regulator has proved to be a solid and responsible agency that has recently been reorganized; this process is still ongoing and may have unforeseen consequences; b) in Costa Rica, the regulator has been at loggerheads with ICE, the major power company, with unfortunate consequences such as power blackouts; a redefinition of responsibilities should take place in order to ensure smoother institutional operation; c) in Nicaragua, the regulator has weak resources; this requires strengthening in order to effectively address numerous questions; d) El Salvador has an effective and well-organized agency that is, however, subject to political influence; this has led it to put in place unsustainable and costly subsidies, and its organization and mission should be revisited; e) Honduras has a weak and ineffective regulator with little influence over ENEE, the state power company; a thorough review of its functions should be undertaken; and f) Guatemala's regulator has been effective in overseeing the market but its rulings have proved to be ineffective in attracting investment for developing native resources.

191. Increasing prices of electricity in exporting countries and availability of cheaper electricity in importing countries can spur opposition, both from consumers in exporting countries and from existing generators in importing countries. If MER energy trading is included in national economic dispatches, prices may be higher in electricity exporting countries and lower than other alternatives in the importing countries. However, this may be viewed negatively by final consumers in the exporting countries and by generators in the importing countries.

192. CRIE should further analyze the effects of power exchanges on electricity prices in order to foresee appropriate mechanisms to address such effects, including congestion charges. These mechanisms should be designed so that, for the regional market to work successfully, individual countries have access to lower prices in other countries. In addition, governments of the interconnected countries should maintain a strong position to avoid yielding to the pressure of generation lobbies, which may have strong interests in preventing cheaper generation by neighboring countries from entering their national markets. If these lobbies were to succeed, consumers in the importing countries would not be able to benefit from cheaper electricity prices.

193. **Long-term transmission rights.** Lack of long-term transmission rights could hinder the signing of long-term contracts. Currently, transmission contracts are not signed for longer than one to two years. However, long-term energy contracts for the development of new regional power plants, for example, would likely have to be agreed for periods of 10 to15 years. The EOR will forecast nodal prices periodically for only two-year horizons, while transmission planning is expected to be done for ten-year horizons. The lack of long-term transmission contracts would have to be properly reconciled in order to support the regional long-term energy contracts associated with new regional power plants.

194. The RMER would have to be adjusted to provide longer terms for the transmission rights if, for example, the promoters and financiers of new regional power plants perceive that the term for the assignation of these rights is too short (i.e., permitting longer transmission rights to new regional power plants). However, if the transmission activity were perceived more as a common-carrier than as a contract-carrier type, such a requirement (i.e., short terms for the transmission rights) could be relaxed.

195. Furthermore, due to the considerable complexity of the regional transmission charges regulated in the RMER, the development of comprehensive methodologies to support clear forecasts of such charges would be required. These forecasts would be based on long-term generation–transmission expansion planning and would provide adequate information to agents on the expected prices of the transmission rights associated with the potential development of regional power plants. If such actions are not successful, future development of the MER would need to consider eventual simplifications in the scheme for regional transmission charges.

196. **Institutional capacity.** Limited capacity and resources in CRIE, the regional regulator, make it vulnerable to national interests. Addressing the more substantial harmonization problems would require additional analysis and the preparation of a strategy that also factors in political economy considerations. However, there is a lack of technical staff and computerized support in CRIE and the commissioners meet only about four times a year. Under these circumstances, CRIE's role could become very weak and the agency would risk a situation in

which national interests may prevail over regional ones. It is evident that CRIE requires urgent institutional strengthening to foster an adequate preparation of the platform for MER's initial operations.

197. Temporary financial resources would be needed until a more stabilized MER operation that provides stable financial resources to cover CRIE's operating budget is achieved. CRIE currently benefits from an IDB technical cooperation grant whose activities include direct support to the CRIE in the form of specialized consultants. However, it is estimated that additional support will be necessary to reinforce CRIE so that it can successfully carry out its regulatory activities.

198. Further activities might include: a) supporting CRIE to regulate in detail the concept of "firm energy" associated with power plants in a compatible manner with the concepts of "firm power" already established in the CA national markets, which is required to support reliability, certainty and predictability in regional long-term firm energy exchanges; b) supporting CRIE in the standardization of the terms and clauses of long-term regional firm energy contracts, taking into account the local regulations for firm power exchanges and the regional regulations and requirements of the MER's transmission rights, including the assessment of the adopted MER transmission regulations to foster regional electricity exchanges; and c) assisting CRIE and EOR to prepare a proposal for the institutionalization of regional competitive processes and of mechanisms aimed at the consolidation of regionally coordinated contractual electricity purchases by multiple agents.

199. **Bilateral agreements.** Bilateral agreements independent from the MER could limit the benefits of the interconnections with Mexico and Colombia. Guatemala and Mexico, as well as Panama and Colombia, are in the process of interconnecting their respective power systems, allowing for future bilateral international electricity exchanges. In both cases, bilateral agreements are being discussed and their implementation is moving forward. The Mexico–Guatemala link is being developed separately and independently from the MER. In the case of the Colombia–Panama interconnection, a regulatory harmonization study recommended the existence of a common carrier and of free access to the link. However, due to its relatively high investment cost, the governments of both countries have decided that its development would be at their promoters' own risk, implying a contract carrier-type of use for this link and consequently limiting free access to agents not involved in its development. This could mean that MER agents could face barriers to access this international link as part of the RTR.

200. The issue of trade through these interconnections with the MER would need to be analyzed in order to properly coordinate with MER regulations, which are interpreted as providing free access to those links, in order to avoid potential drawbacks in the development of the MER. In this sense, as mentioned previously, the SIEPAC Executing Unit has promoted the inclusion of a first phase of the MER–Mexico harmonization under a technical cooperation grant from IDB–CEAC; a similar exercise will be conducted for potential power exchanges with Colombia.

201. Higher demand volumes would be required for the development of high-capacity regional plants. Local demand by the distributors, traders, and large consumers and associated competitive processes to purchase electricity is for relatively small volumes. Under current market conditions, it is expected that individual long-term firm energy contracts would be for relatively minor volumes (i.e., associated with peak demands of 50 MW or lower). The MER's

development based on high-capacity regional plants (i.e., with 150 MW or more of installed capacity) would require higher contracting volumes with agents that might be located in different countries.

202. Rules and competitive processes for coordinating energy purchases with multiple agents (or a more formal long-term energy market) will need to be implemented. To increase the firm energy volumes to be contracted to supply demand in the MER, several buyers could participate jointly through public tenders. This would enable economies of scale because it would allow for the participation in such processes by producers that could develop larger-sized generation plants. Such procedures could be institutionalized to promote this type of competitive processes at the regional level. This would require CRIE to play an active role, including the creation of a centralized process to estimate the total demand to be tendered or auctioned. This is also one of the aspects that should be introduced in the regulatory harmonization of the RMER with national regulations.

7.2 Regulatory and Institutional Actions by Country and at the Regional Level

7.2.1 Recommendations at the country level

203. Central American governments and their respective national regulators need to make some relevant decisions and take actions to expedite and support the use of the interconnected system. Strong commitment by the national governments and their agencies would allow the set-up and operationalization of a general framework to facilitate long-term firm power trade in the region. This section has discussed in detail the main regulatory and institutional barriers to MER development that have been identified and has proposed several options to address them. Below is a list of some possible interventions presented country by country, as well as at the regional level. These actions are provided in summary form in Table 10.

Costa Rica

- Approve the MER Second Protocol at congressional level.
- Complete regulatory harmonization with the MER.
- Develop clear rules for participation in the MER by agents other than ICE.
- Avoid government interventions aimed at lowering retail tariffs below costs, because these jeopardize potential energy imports.
- Redefine responsibilities between the regulator (ARESEP) and ICE, in order to ensure smoother institutional operation.
- Ensure provision of adequate resources to strengthen CRIE.

El Salvador

- Complete regulatory harmonization with the MER.
- Reduce government interventions aimed at lowering retail tariffs below costs, because these jeopardize potential energy imports.
- Revisit the organization and mission of the regulator (SIGET) in order to avoid potential political influence that could lead, for example, to unsustainable and costly subsidies.
- Ensure provision of adequate resources to strengthen CRIE.

Guatemala

- Complete regulatory harmonization with the MER.
- Reduce government interventions aimed at lowering retail tariffs below costs, because these jeopardize potential energy imports.
- Ensure that the regulator (CNEE) maintains a strong independent position from political authorities.
- Bilateral agreements with Mexico should be coordinated with MER regulations so that the rest of the countries in the region can also benefit from the interconnection.
- Ensure provision of adequate resources to strengthen CRIE.

Honduras

- Complete regulatory harmonization with the MER.
- Develop clear rules for participation in the MER by agents other than ENEE.
- Introduce some flexibility to remove the power supply priority for local markets and remove the preferential treatment for local markets in power trading.
- Reduce government interventions aimed at lowering retail tariffs below costs, because these jeopardize potential energy imports.
- Empowerment of the regulator (CNE), which currently has little influence over the power utility, ENEE.
- Ensure the provision of adequate resources to strengthen CRIE.

Nicaragua

- Complete regulatory harmonization with the MER.
- Introduce some flexibility to remove the power supply priority for local markets and remove the preferential treatment for local markets in long-term energy contracts for regulated markets.
- Reduce government interventions aimed at lowering retail tariffs below costs, because these jeopardize potential energy imports.
- Strengthen the regulator (INE), which lacks resources.
- Ensure the provision of adequate resources to strengthen CRIE.

Panama

- Complete regulatory harmonization with the MER.
- Introduce some flexibility to remove the power supply priority for local markets and remove the preferential treatment for local markets in power trading.
- Closely monitor the reorganization of the regulator (ERSP), which has proved to be a solid and responsible agency.
- Bilateral agreements with Colombia should be coordinated with MER regulations, so that the rest of the countries in the region can also benefit from the interconnection.
- Ensure the provision of adequate resources to strengthen CRIE.

7.2.2 Recommendations at the regional level

204. Further work to be carried out by CRIE is concentrated on two specific areas: a) the standardization of terms and clauses for long-term regional firm energy contracts, and b) the institutionalization of regional competitive processes and mechanisms for the consolidation of regionally coordinated contractual electricity purchases by multiple agents. However, it is estimated that additional support will be necessary to reinforce CRIE so that it can successfully carry out its regulatory activities. Further activities might include:

- Development of appropriate regulations for "firm energy" associated with power plants in a manner compatible with the concepts of "firm power" already established in the CA national markets; this is required to support reliability and certainty in regional long-term firm energy exchanges.
- Standardization of the terms and clauses of long-term regional firm energy contracts, taking into account both a) the local regulations for firm power exchanges, and b) the regional regulations and requirements for the MER's transmission rights.
- Preparation of a proposal for the institutionalization of regional competitive processes and of mechanisms aimed at the consolidation of regionally coordinated contractual electricity purchases by multiple agents.

Table 10: Actions at the national and regional levels to overcome regulatory and institutional barriers to MER development	Guatemala	El Salvador	Honduras	Nicaragua
Asymmetry in the structure of national markets				
Development of clear rules and remove obstacles for participation in the MER of agents other than ICE and ENEE			x	
Incomplete regulatory harmonization				
Provision of additional financial and technical support to strengthen CRIE and EOR	x	x	x	x
Standardization of terms and clauses in long term regional firm energy contracts				
Institutionalization of regional competitive processes and mechanisms for the consolidation of regional coordinated contractual electricity purchases by multiple agents				
Priority of domestic demand				
Eliminate provisions that give supply priority to domestic markets			x	x
Avoid enactment of restrictions to electricity exports	x			
Price controls				
Avoid price controls in electricity supply to the domestic markets		x	x	x
Oposition from consumers in exporting countries and from generators in importing countries				
Guarantee non-discrimination among the national markets	x	x	x	x
Hold strong positions against potential pressure from generation lobbies	x	x		x
Analysis of the effects of power exchanges in electricity prices				
Design appropriate and transparent mechanisms to address effect of power exchanges in domestic prices				
Lack of long-term transmission rights				
Adjust the RMER to provide longer terms for SIEPAC's transmission rights				
Development of comprehensive methodologies to support clear forecasts of transmission charges				
Consider eventual simplifications in the scheme for regional transmission charges				
Weak national markets				
Strengthen national markets while maintaining an integration vision	x	x	x	x
Ensure financial sustainability of the electricity sector (through more efficient tariffs and better targeted and transparent subsidies)	x	x	x	x
Strengthen planning capabilities in power-policy making entities	x	x	x	x
Design effective and transparent power auctions for the existing capacity or to attract new investors	x	x	x	x
Vulnerability of CRIE to national interests				
Provision of adequate resources to strengthen CRIE	x	x	x	x
Strong political commitment to the success of the regional market regulatory and institutional architecture	x	x	x	x
Bilateral agreements that restrict the potential regional benefits of the interconnections with Mexico and Colombia				
Avoid the signature of bilateral agreements totally independent from the MER	x			
Coordinate MER regulations with bilateral agreements				
Need for higher demand volumes for development of high capacity regional plants				
Implementation of rules and competitive processes coordinating energy purchases with multiple agents				

CHAPTER EIGHT
CONCLUSIONS

205. The major challenge faced by the regional market is how to exploit the potential offered by the transmission line and the MER regulatory and institutional framework by attracting energy projects at a regional scale (i.e., projects designed to serve the international market using the SIEPAC infrastructure). For this to happen, the regulatory framework and the regional institutions must demonstrate their credibility to investors. In this sense, the early use and performance of the line, which will begin operation in 2010, will serve as a pilot in this process of trust building.[28]

206. Development of the Central American regional market's architecture has been slow but has advanced considerably; however, its success will not be evident until the market has been operational for some time. The SIEPAC initiative illustrates that it is possible to create a relatively advanced regional electricity trading arrangement between countries that are at differing stages of internal market development and that have different types of electricity industry and institutional schemes. However, while the regional electricity market is in a transition stage, the Central American governments and national regulators need to make some relevant decisions and take actions to expedite the use of the transmission line and ensure that the region fully benefits from the potential offered by the new infrastructure and by the market architecture, which have been under development for over a decade. As integration progresses, competitive pressures in the electricity market are likely to lead "naturally," as in the case of Northern Europe's Nord Pool (see below), to ownership and structural changes in the sector, including some cross-ownership between countries and the entry of some foreign power companies.[29]

207. The regional market's performance will also depend on the decisions made by governments to strengthen their own national markets. The region has been facing some difficulties in implementing the regional market, with a reduction in the volume of electricity exchanges in recent years. This regional market performance reflects, to some extent, the state of crisis within some of the national power systems that have implemented short-lived measures, such as the governments' imposition of restrictions on international energy transfers in an attempt to control internal tariffs. This was done in a context where generation reserves were low or nonexistent, and available national thermal generation was highly dependent on volatile oil prices. These factors can jeopardize the overall consolidation of the regional electricity market by further eroding national electricity markets.[30]

208. The pursuit of self-sufficiency in an attempt to build stronger national markets is not necessarily detrimental to the development of a regional market. Many governments have long viewed electricity as a strategic asset, which has traditionally led them to favor self-sufficiency, often through vertically integrated, state-controlled companies.[31] In Central America, national expansion plans prepared for the 2008–2020 period share a common characteristic: reliance on

[28] Economic Consulting Associates, 2009.
[29] Carlson, 1999.
[30] USAID, 2008.
[31] Charpentier and Schenk, 1995.

local energy resources. Nevertheless, self-sufficiency need not impede the development of the regional market. Countries could be self-sufficient but always have opportunities to obtain cheaper power from imports, for example. For instance, NORDEL[32] was based on the principle that each country would build enough generating capacity to be self-sufficient. Trading was meant to achieve the optimal dispatch of a larger system, and investment in interconnection was generally based not on net exports but on expected savings from pooling available generating capacity.[33]

209. The consolidation of the MER's regulatory framework could benefit from additional short- to medium-term support to the regional institutions in the form of technical assistance. Further activities might include: a) support to CRIE for regulating in detail the concept of "firm energy" for power plants in a manner that is compatible with the concepts of "firm power" already established in the CA national markets, which is required to support reliability and certainty in regional long-term firm energy exchanges; b) support to CRIE for standardizing the terms and clauses of long-term regional firm energy contracts, taking into account the local regulations for firm power exchanges and the regional regulations regarding MER transmission rights; and c) assistance to CRIE and EOR for preparing a proposal to institutionalize regional competitive processes and mechanisms aimed at coordinated regional electricity purchases by multiple agents.

210. The development of a regional generating plant could create the necessary incentives to overcome some of the existing regulatory barriers. Successful development of regional generation in MER could follow two different paths. The first would entail waiting for the complete definition of market rules and the full implementation of institutional arrangements before large investments in generation are undertaken. The second alternative would consist of the development, in the short term, of a medium-sized regional generation plant with the participation of private investors and national governments and with potential support from international financial institutions. Such an initiative would generate strong incentives for the different players in the market to find workable solutions to overcome the barriers arising from the incomplete regulatory harmonization and underdeveloped MER rules.

211. The interconnections with Mexico and Colombia could also prove critical in overcoming the supply/demand imbalances in the region. The Mexico–Guatemala and Colombia–Panama interconnections, if integrated with the regional transmission backbone, have the potential to provide enough power to address the precarious balance of supply and demand affecting the countries in the Central American region. These interconnections could eventually deliver the greatest benefits of power integration to the region. For this and other reasons, a commonly agreed and carefully designed regional expansion strategy that factors in potential imports from Mexico and Colombia is urgently needed, so that existing human, technical and financial resources are used in the most efficient manner. This would also be a test of the regional market's rules, which need to be flexible in order to accommodate an evolving reality and to benefit more fully from the opportunities offered by an enlarged market.

[32] This multicountry organization was founded in 1963 to promote cooperation among all power utilities of the Nordic countries (Denmark, Finland, Norway, and Sweden). NORDEL's original goal was to create and maintain conditions for efficient utilization of the interconnected national power grids of the Nordic countries to exchange hydro and thermal power. Nord Pool, the regional power pool, began to develop in 1992.

[33] Carlson, 1999.

ANNEX 1: THEORY OF POWER INTEGRATION

The complexities of the electricity market

The physical properties of electricity production, transmission and distribution make the challenge of matching supply and demand at every moment especially difficult. Because storing electricity is virtually impossible (at least in economic terms) and capacity constraints on production from a plant cannot be breached for significant periods without incurring extreme risks, the amount of energy that can be delivered at any particular moment is essentially fixed. Any failure to equate demand and supply endangers the stability, not only of the market participants that caused the imbalance, but of the system as a whole. Moreover, an action that could be profitable to one market participant and that simultaneously degrades system reliability, can negatively affect the ability of other buyers or suppliers to fulfill their contractual obligations (i.e., there are important externalities as a result of being interconnected). For this reason, modern electricity markets usually have a system operator that controls the operation of the generation flows (dispatch) in order to preserve adequate functioning, thus avoiding major oscillations in tension, throughout the transmission network.

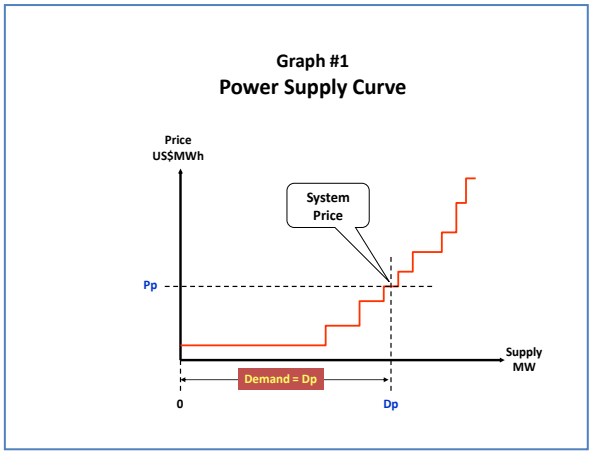
> *"Contrary to common perception, a buyer of electricity is not purchasing megawatt-hours (MWh) of energy produced by a specific generation unit. A buyer is only purchasing the right to withdraw that quantity of MWhs from a specific location in the network and a seller is paid for injecting a certain quantity of MWhs into the grid at a specified location in network." (Wolak, Lessons from Electricity Market Monitoring, UCEI, 2004).*

One major feature of modern electricity markets is that while electrons flow according to the laws of physics, energy payments flow according to the terms of financial contracts.[34] It means that the laws governing the flows of energy are totally independent from the financial flows. When consumer A signs a contract to purchase energy from generator B, it does not necessarily mean that energy consumer A is going to receive what was physically produced by generator B. On the contrary, this generally would not be case. As Wolak (2004) clearly states:

In the spot or wholesale market, generators can buy or sell energy among them as long as the system is ultimately balanced. For example, if the system operator that administers system dispatch instructs one generator to generate less energy than the amount agreed in its contracts, it will become a "deficit generator" and will have to buy the rest of energy needed to complete its contracts in the spot market. On the contrary, if a generator is made to generate more energy than its contracted energy, it becomes a "surplus generator" and thus has to sell surplus energy in the spot market. The spot market price is given by the marginal cost of the system; in other words, by the variable cost of the most expensive generator which is dispatched.

[34] Once produced, electricity travels along the transmission grid according to Kirchoff's law, i.e., following the path of least resistance, and at the speed of light.

The supply curve of the industry is, as usual, the aggregation of all of the marginal cost curves, represented with a stairway profile because the marginal cost of the system jumps up every time a new power plant enters the dispatch order. Graph #1 shows that the market price (Pp) is determined by the marginal cost of the last plant that is generating to meet the demand of that precise moment (Dp) in the very short term. In peak hours (typically in the evenings) when demand increases, the spot price jumps because the more expensive plants are required to generate.



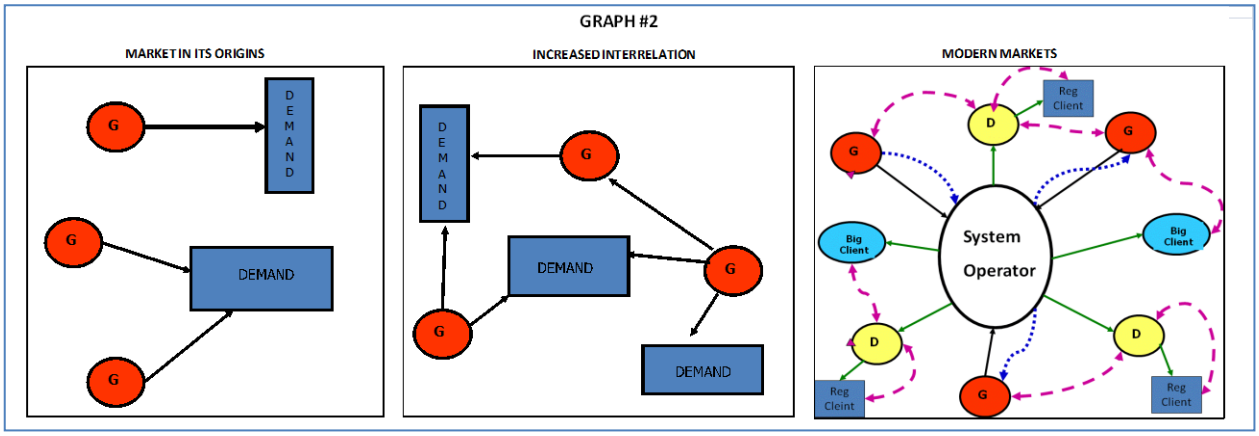
Originally, electric power systems were developed as small isolated monopolies with a few generating units under central control. These isolated systems were gradually interconnected to allow power trading and reserve sharing. As interconnections grew, so did the scope and complexity of the control system. No real-time pricing of grid interactions was established. However, there was little reason to do so because neighboring generators (monopolies) essentially bartered energy and reserves and cooperated to maintain system reliability (see Graph #2).

Eventually, simple contract trading developed among neighboring monopolies, but this trading did not include any actual pricing of network interactions. When asked to do so, the selling monopolist would agree to deliver a certain amount of energy to the buying monopolist for an agreed price, and the buyer would simply integrate this demand source into his unpriced central dispatch process. Pressure for competitive generation developed only in the 1970s and 1980s, when independent power producers (IPPs) could also be paid for delivering energy to the local monopoly utility. But real competition, in which a generator could compete to sell directly to a consumer or to a distributor not affiliated with the local monopoly utility, did not develop until the 1990s (see Hunt 2002).[35]

In modern electricity markets there are multiple participants: a large number of generators (G), a large number of consumers, whether regulated (i.e., the small household and commercial consumers attended by distribution utilities [D]) or non-regulated (i.e., large industrial plants, mines, etc. that can purchase energy directly from suppliers at negotiated prices). As previously mentioned, the control of this complex system relies on a centralized system operator that manages the dispatch of several power plants according to their marginal costs, either "real" costs or "bid prices" depending on the regulatory framework, in the best possible manner to ensure the stability and proper functioning of the transmission grid (see Graph #2).

[35] The exception is Chile which reformed its electricity market in 1982, introducing competition in generation even before the United Kingdom's reform in 1990.

The financial flows linked to contracts among the different participants in the market are independent from the physical flows. Thus, there is a need for a market administrator to work as a clearinghouse for all net physical energy flows so that the clearing of payments can occur accordingly.[36]



Interconnection is not equal to integration

There are many examples of electricity interconnections between or among two or more national power systems in LAC. For example, the Colombia–Ecuador interconnection began operating in late-1998, but due to the physical configuration of the transmission line it is merely a "radial" interconnection, meaning that it is impossible to achieve a synchronized operation of both systems.[37] Under these circumstances, it would be difficult to assert that Colombia and Ecuador have an integrated power system; they merely trade power.

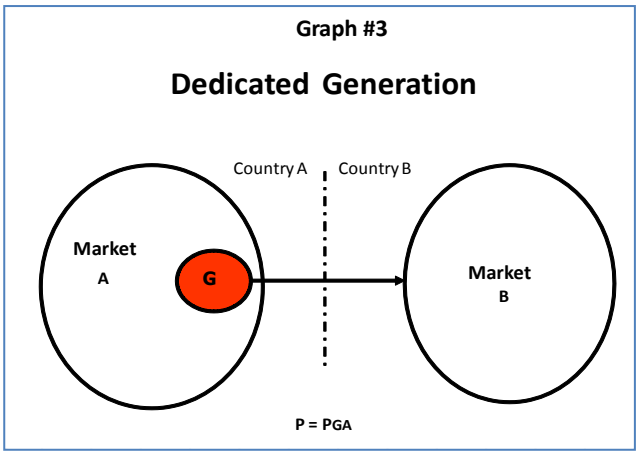
Another example is the interconnection of Brazil and Paraguay through the co-owned Itaipu power plant. Itaipu is owned on a 50–50 basis by Brazil and Paraguay, but 90 percent of its production goes to Brazil and only 10 percent to Paraguay. The Paraguayan energy surplus, i.e., the difference between its right to access 50 percent of the plant's energy and the domestic consumption, must be sold to Brazil through the Brazilian electricity monopoly that acts as a single buyer.[38] Again, it would be fair to say that the Paraguayan power system is linked to Itaipu (almost 90 percent of Paraguay's domestic demand is provided by this plant) but not necessarily to the Brazilian power system. The reverse is even truer: the Brazilian power system is not really integrated with the Paraguayan system; it simply shares a common power plant. Therefore, the difference between interconnection and integration is analogous to the difference between trading goods and having a common economic market.

[36] In many markets, the system operator is the same as the market administrator. However, some market regulations have preferred to separate both entities.

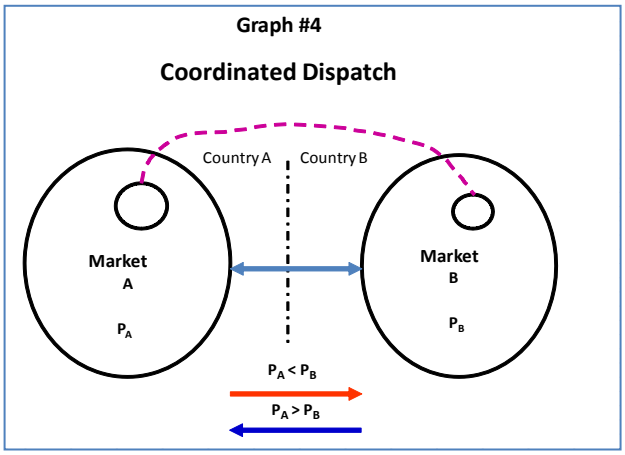
[37] In a "radial" interconnection, the demand physically disconnects from its national system and is met from the export country as if it were part of its own system. But there is not really an interconnection of both systems at the same time.

[38] In 2009, Brazil agreed to a fairer payment of electricity to Paraguay and also allowed Paraguay to sell excess power directly to Brazilian companies instead of solely through Eletrobras.

One important feature of power integration is that it is a very lengthy process with multiple, different stages. The first step is, of course, to create the physical interconnection through a transmission line across the border. But from that point onward, power integration can take various, different modalities or degrees of "integration." In its most basic form, a generator in one country can provide electricity to consumers in another country at a contract price (see Graph #3). Itaipu is an example of this basic form of trade, which would not be referred to as "integration." Neither system is working in coordination nor does the dispatch of different plants on either side of the border affect the energy flows of this plant.



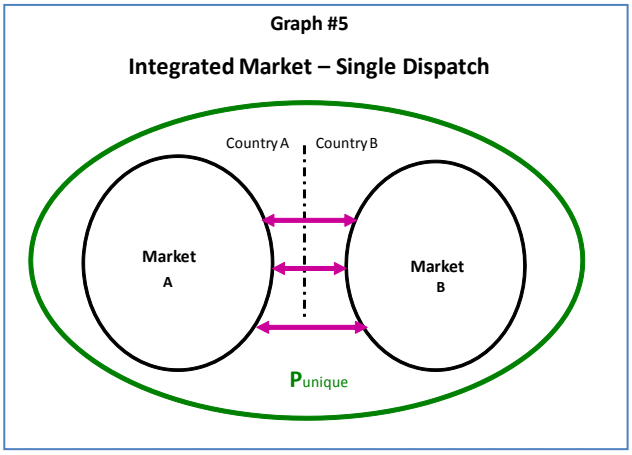
The next step toward a greater degree of integration is when the two systems are working with a coordinated dispatch that allows participants in both markets to know the spot prices in each market at every moment.[39] The higher-price country will always import from the lower-price country and vice versa. As illustrated below, when the price in country A (P_A) is higher than the price in country B (P_B), the flow will go from country B exporting energy to country A and vice versa. These are the so-called short-term international transactions; there are no contracts between specific suppliers or consumers but between the two wholesale markets (the Colombia–Ecuador trade operates through this modality). In the case of the existence of long-term contracts between a supplier in country A and a consumer in country B (for instance, a distribution company), the fact that a contract exists does not mean that the supplier would necessarily generate its own energy to comply with the energy delivery. It may well buy energy in the domestic spot market (if $P_A < P_B$) or in the foreign spot market (if $P_A > P_B$) to honor its contract. (See Graph #4.)



One important feature of this level of integration is that whenever the low-price country is exporting, the domestic spot price will rise as a consequence of having additional demand to meet with its installed capacity. As a result of export activity, higher-cost plants would be ordered to dispatch as the new demand (from the import country) exerts pressure on the domestic system. Conversely, the spot market price in the import country will diminish as the new supply (coming from across the border) partially meets the domestic demand, thereby displacing high-cost plants in the local market. This is a basic idea that is important to keep in mind when promoting power trade: prices will rise in the export country as consequence of the power trade. This is why some countries find it politically difficult to convince domestic consumers that

[39] These markets are known as "loose pools."

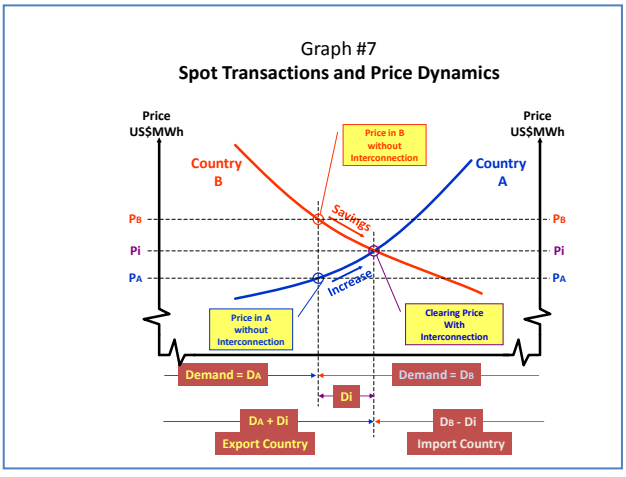
exporting power is beneficial. By analogy, power generators in the import country are prone to lobby the government because imports of cheap energy from abroad can erode their profits.



The third stage of integration is the integrated market, or power pool, in which the two systems behave as one, with a single centralized dispatch and in which there is no difference between market participants, whether nationals or foreigners. In this integrated market there is a unique supply curve determined by the marginal costs of all the power plants in both systems[40] and the aggregate power demand is the sum of all consumption on both sides of the border (see Graph #5). Consequently, there is only one price in the spot market for this integrated system. This is the last stage and what most people have in mind when they talk about "integration". Of course, this level of integration (achieved, for example, in the Nord Pool system of the Nordic countries) requires an impressive amount of political will, substantial investments for IT systems and an advanced level of regulatory harmonization.

Power trade: contracts versus spot transactions

When two electricity systems are interconnected, energy will be transmitted from the low-price country (zone) to the high-price country (zone). As stated above, in the exporting country, prices increase because additional, more expensive generators are required to dispatch whereas in the importing zone prices decrease because expensive plants are no longer required to generate. In equilibrium and assuming infinite transmission capacity, price equalizes between the two zones.



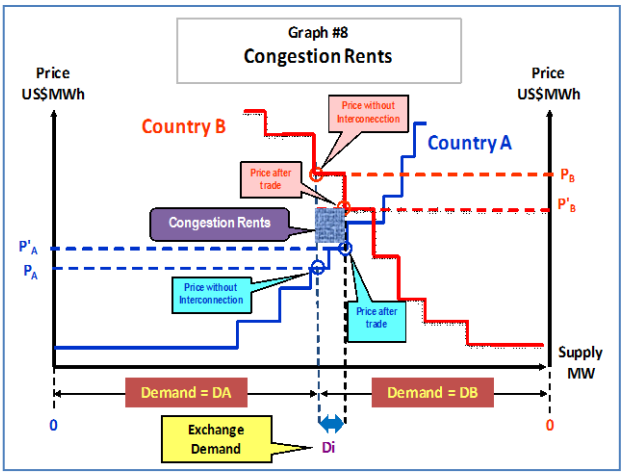
Graph #7 shows how the price gap between the two trading zones (P_B-P_A) present before trading goes down to zero after increasing power generation in the export country (A) and diminishing domestic generation in the import country (B). In theory, there are important savings in the import country equal to [(D_B-Di) x (P_B-Pi)] while important costs in the export country are equal to [(D_A + Di) x (Pi-P_A)].

However, in practice, most of the transmission interconnections are subject to capacity constraints, so there are no conditions for price equalization because the demand for exchange (Di) is only a relatively small portion of the total demand in the import zone system. As a result, the price gap between the two power

[40] Sometimes power pools are divided into *"tight pools,"* in which a centralized least-cost merit order dispatch is put in place, and *"new pools,"* in which dispatching is not based on costs, but rather on the bid price of each generator (i.e., on a competitive basis).

zones does not vanish. As Graph #8 shows, the import country will pay a price P_B while the generators in the export country will receive P_A, so a price differential appears. This price differencial multiplied by the total energy traded [(P_B-P_A) x Di] generates a amount of money known as the "*congestion rents.*"

There has been considerable debate on how to share these congestion rents between the two zones. In the case of Colombia–Ecuador power exchanges, the rents go to the export country to compensate for the additional costs incurred by the export country's consumers.[41] In other international power exchanges, these rents have been equally shared between both countries. In fact, the lack of agreement about how to share these congestion rents has been the main obstacle to starting the operation of the Peru–Ecuador interconnection.[42] In the case of Central America, the sharing of congestion rents has not posed an issue because the 50–50 formula has been the prevalent rule in the region's power trade during the past few years.



In markets that show high price volatility—such as the power spot markets—it is common for buyers and sellers to smooth out their transaction prices through long-term contracts. Under forward power purchase contracts, the buyer is obliged to purchase a certain amount of power from the seller under a predefined price and for a sufficiently long-term tenure (typically 10 to 15 years). International experience has shown that the main supply-side benefit of industry restructuring is the competitive procurement of long-term power purchase contracts that have sufficient magnitude and duration to allow suppliers to fund the construction of new generation facilities. These power purchase agreements (PPAs) are very important to make the construction of new power facilities "bankable." This fact will be of paramount importance in discussions of the feasibility of regional power plants in Central America.[43]

[41] In Colombia, 80 percent of the congestion rents are allocated to the *Fondo de Energía Social* (FOES), which finances rural electrification infrastructure, while the remaining 20 percent are used to alleviate the higher prices that Colombian consumers would have to pay due to the electricity export.

[42] The Peru–Ecuador interconnection was physically finished in 2004 and since then it has only been used in two instances, both in response to emergencies in Ecuador. The sharing of congestion rents has been the main obstacle to reaching commercial accords. Peru pushed for the same treatment as the Colombia example (100 percent to the export country) while Ecuador insisted on the 50–50 scheme.

[43] Wolak (2003) points out that the spread of wholesale forward contract markets throughout the United States during the early 1980s led to new generation capacity investment decisions.

ANNEX 2: ELECTRICITY INTERCONNECTIONS AND POWER POOLS

Objectives of a power pool

The search for more reliable and secure electricity supply has been the determining factor in the decision to build power system interconnections and to enter into inter-utility electricity exchange agreements among neighboring countries around the world. Development experience and operation of power pools in Europe and the United States indicate that the power-pooling arrangements have, for the most part, evolved from simple interconnections between neighboring utilities to support each other in case of emergencies into more sophisticated formal legal entities with differing responsibilities in system operation and power market regulation.[44]

Five main types of exchanges can take place between interconnected partners: a) firm energy sales (i.e., a continuous exchange of base load energy, which may include slight variations provided for in the contract, as well as interruptible power); b) backup exchanges for emergency support; c) marginal exchanges of spinning reserves; d) occasional exchanges, in which no guarantee of capacity is given; and e) compensation exchanges made in kind.[45]

Once deployed, the operation of cross-border interconnection facilities opens up numerous opportunities for national power utilities to exchange a range of energy services that are germane to the delivery of reliable electricity supply at minimum cost, including the following: a) lowering of generation capacity reserve requirements; b) ability to achieve economies of scale; c) opportunity to exchange economic energy; d) increased load and fuel diversity; e) opportunities for sale of surplus firm energy; and f) emergency support in major breakdowns.[46]

The objectives of power pooling can differ between developed and developing countries. In developed countries, where power systems cover almost the entire population, a recent objective of most power pools is to reduce capital and operating costs by capturing the benefits of competition in generation and in fuel supply, as well as to reduce costs, plan regionally, and enhance the reliability of service and security of supply. Under competition, generators typically have the option of entering their supply units into a competitive "pool" that establishes a dispatch merit order based on the bids they have received. In developing countries, the early strategic emphasis of the power pool's institutional design is on enhancing the region's power sector investment environment, rather than necessarily unleashing competition in those power markets from the start. With an appropriate and flexible institutional design at the outset, a regional power pool can gradually develop its governance, regulatory structures and technical rules as competition becomes more desirable and feasible.[47]

In a developing country context, as is the case of the Central America Regional Electricity Market (MER), the creation of a regional power pool by a group of smaller market economies can reduce risks and help the pool match supply and demand more efficiently. The existence of a pool enhances a project developer's ability to finance and construct power generating facilities that are closer to available energy sources situated in smaller market

[44] ECA, 2004.
[45] Charpentier and Schenk, 1995.
[46] World Bank, 2008.
[47] USAID, 2008.

economies, and utilizing cleaner and more sustainable energy resources. A pool can make the development of a country's or subregion's capital-intensive power projects more attractive to domestic and international investors and lenders, reducing risks by creating a broader demand pool of utilities/off-takers for the production of proposed generating facilities.

Benefits of power pools

General benefits derived from power pooling include: a) increasing efficient supply to meet the regional demand; b) increased opportunities for development of larger-scale projects; c) enhanced competition; d) increased market liquidity; and e) reduced power supply risks. The result would benefit all consumers in the region by lowering prices and improving power supply quality and safety and would eventually result in a reduced environmental impact due to power development.[48]

Benefits of power pools would be gradually realized by the member countries as the regional market evolves (see Figure below). In the short to medium term, the two main benefits of power pools are:

a) *Increased security and reliability of electricity supply by*:
- providing mutual support during emergencies through short-term, non-firm power exchanges,
- sharing spinning reserve capacity in the interconnected system, and
- seeking a balanced generation mix involving hydro;

b) *Improved electricity sector investment environment thanks to:*
- aggregation of individual power off-take markets and improved access to multiple off-takers, which allow project developers to access multiple markets using more efficient technologies,
- diversification of individual country risks, and
- improved creditworthiness of individual projects.[49]

In the medium to long term, the main benefits would be:

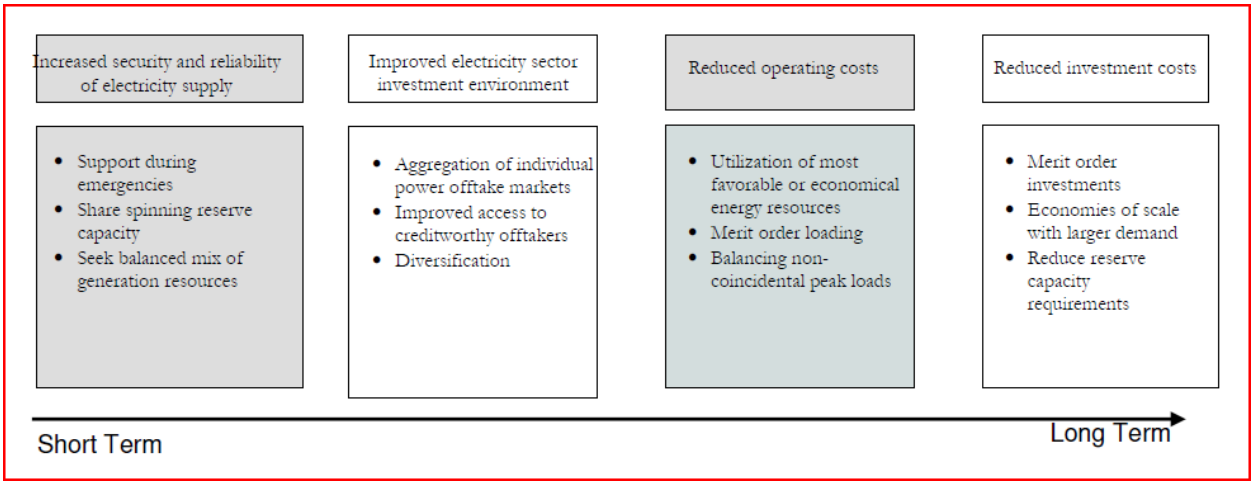
a) *Reduced operating costs from:*
- using the most favorable or economic energy resources, particularly through the integration and coordination of hydropower and thermal systems, which reduce operating costs through increased hydropower generation in off-peak periods,
- merit order loading to obtain operational benefits in the case of central dispatching,
- balancing non-coincidental peak loads; and

b) *Reduced investment costs in the long term through integrated planning on a multi-system basis from:*
- economies of scale,
- reduced total reserve requirements,
- reduced or postponed investments in new peak power capacity in thermal systems,

[48] ESMAP, 2001.
[49] USAID, 2008.

- reduced investment in the hydro system due to the possibility of importing electricity from neighboring systems during a dry year.[50]

Figure: Core benefits of power pools



Source: USAID 2008

Benefits derive from the multiplication of energy exchanges. The benefits accruing from cross-border interconnection facilities, once built and put into operation, derive primarily from the multiplication of energy exchanges among national power utilities. In economic terms, such growth in cross-border energy exchanges should increase until the marginal benefits from displacing more expensive capacity and/or from additional sales equal the marginal cost of transmission across the interconnected networks. The same applies to expansion of an interconnection, for which costs of new generation and transmission must be taken into account.[51]

Main requirements for the creation of a successful power pool

Common and flexible legal regulatory framework. A critical success factor in creating regional power pools is the extent to which governments and the operators of their respective national power grids are able to define a common legal and regulatory framework to facilitate the achievement of regional objectives. Once consensus is reached on putting in place a common legal and regulatory framework, another critical success factor is to maintain flexibility in setting up a viable, multicountry, organizational structure to leverage the individual and collective capabilities of the system operators to a) plan for and implement cross-border interconnection facilities; b) harmonize the operational rules of practice for their interconnected national power grids; and c) put in place a transparent, fair and viable commercial framework for cross-border trading in energy services.[52]

Harmonized commercial rules. Regardless of whether cross-border trade takes place on the basis of cooperative or competitive frameworks, it is important for a clear, transparent and harmonized set of "Commercial Rules of Practice" to be put in place and adhered to by the

[50] USAID, 2008.
[51] World Bank, 2008.
[52] World Bank, 2008.

interconnected national power utilities, with the following aims: a) setting the commercial framework within which energy exchanges will be conducted; b) agreeing on pricing principles; c) overseeing and settling transactions; d) agreeing on and enforcing technical standards for metering; and e) arbitrating between and among power utilities. Deployment of such commercial rules of practice also requires the introduction of measures to enhance the system operators' capabilities.[53]

Types of power pools

Power pools evolve over time. Power pools worldwide have evolved over time from simple interconnections between neighboring utilities that support each other in emergencies to more sophisticated formal legal entities with differing responsibilities in system operation and power market regulation. In fact, many power pools have arrangements that are designed to evolve over time from pure bilateral agreements between neighboring countries to more competitive pools as integrated power systems develop.[54]

An example of such evolution is Nord Pool.[55] Before the move to the international pool, the power sectors of Norway, Sweden and Finland all had an oligopolistic structure, with dominant state-owned enterprises that also controlled the national grids and with differences in structure, ownership and regulation. The smooth transition to the world's first international power market happened thanks in large part to the long tradition of cross-border bilateral trade and cooperation and the existence of cross-border transmission structures.[56]

The four main models of power pools could be regarded as four phases in a continuum: a) interconnection of electricity systems, an arrangement in which participants must meet fairly simple requirements such as building an interconnection and must define an arrangement by which they agree to support the neighboring country, region or utility during emergencies; b) loose pools, in which power exchanges are defined contractually through bilateral power purchase agreements that occur continuously, requiring coordinated dispatch between the countries, regions or utilities involved; c) tight pools, in which a centralized least-cost merit order dispatch takes the place of the coordinated dispatch, leading to a high level of complexity that requires substantial investment for IT systems and an advanced level of harmonization of regulatory frameworks; and d) new pools, in which dispatching is not based on costs, but rather on the bid price of each generator (i.e., on a competitive basis), which means "open access"[57] of the market, at least at the wholesale level.[58]

[53] World Bank, 2008.
[54] USAID, 2008.
[55] The Nord Pool power pool began to develop in 1992 when a power exchange was established in Norway. When Sweden opened its electricity market in January 1996, Nord Pool became the world's first international power exchange.
[56] Carlson, 1999.
[57] One the most successful open access pools in operation today is right next to the Central American region, in Colombia. Colombia exchanges electricity on a daily auction basis with Venezuela and Ecuador. The Colombian regulator has implemented a scheme that does not interfere with or considerably distort domestic prices and benefits nationals of both exchanging countries (i.e., importer and exporter), taking advantage of the complementary seasonal hydrological and weather conditions.
[58] ECA, 2004.

ANNEX 3: SDDP MODEL DESCRIPTION AND BASIS USED FOR THE CA MARKET SIMULATIONS

In Chapter 2, Section 1.5 of this document, the results of SDDP simulations are presented to illustrate MER power exchanges, national demand and supply balances, and the impact of power exchanges on national marginal costs for various countries in Central America. The SDDP model is an optimization model for hydrothermal power system operation that is extensively used in the Central American countries. This Annex includes a brief description of the SDDP model and provides a synthesis of the database used for the simulations presented in Chapter 2.

A. Summarized description of SDDP model

SDDP is a hydrothermal dispatch model with representation of the transmission network used for short-, medium- and long-term operation studies. It uses the stochastic dual dynamic programming, developed by PSR, to estimate the future opportunity cost function of stored water in hydroelectric power plants. Because of this feature, it is not necessary to list the combinations of reservoir levels, thus allowing the determination of the stochastic optimal solution for systems with a large number of hydro plants, such as the Central American interconnected power systems.

The model calculates the least-cost stochastic operating policy of a hydrothermal system, taking into account the following aspects: a) operational details of hydro plants (water balance, limits on storage and turbined outflow, spillage, filtration, etc.); b) detailed thermal plant modeling (unit commitment, "take-or-pay" fuel contracts, concave and convex efficiency curves, fuel consumption constraints, multiple fuels, etc.); c) representation of spot markets and supply contracts; d) hydrological uncertainty: it is possible to use stochastic inflow models that represent the system's hydrological characteristics (seasonality, time and space dependence, severe droughts, etc.) and the effect of specific climatic phenomena such as El Niño; e) detailed transmission network: Kirchhoff laws, limits on power flows in each circuit, losses, security constraints, export and import limits for electrical areas, etc; f) load variation per load level and per bus, with monthly or weekly stages (medium- or long-term studies) or hourly levels (short-term studies).

Besides the least-cost operating policy, the SDDP model calculates several economic indexes and operational results, including: a) operational statistics: hydro and thermal generation, thermal operation costs, energy exchanges, fuel consumption, deficit risks and energy not supplied; b) short-run marginal costs (spot prices) for each interconnected market; c) marginal capacity benefits (i.e., measurement of the operational benefit of reinforcing the installed capacity of a thermal plant, the turbine limit of a hydro plant or the storage capacity of a reservoir). All detailed results of the SDDP model are written to *. csv format files. These files are managed by a graphic interface (the GRAF program) which produces Excel files with the desired results.

B. Main data used

The main data used in the simulations were obtained from XM Company, included in the *Documento de Supuestos para los Análisis Energéticos de Febrero 2009. Gerencia Centro Nacional de Despacho. Dirección Planeación de la Operación*. February 10, 2009. XM. Colombia.

B.1 Demand forecasts

The following table summarizes the demand forecasts used in the simulations.

CENTRAL AMERICAN COUNTRIES: POWER DEMAND FORECASTS

	PANAMA		COSTA RICA		HONDURAS	
Año	TWh/año	%	TWh/año	%	TWh/año	%
2008	6.6951		9.5621		6.7467	
2009	7.3421	9.7	10.0430	5.0	7.1626	6.2
2010	7.7289	5.3	10.5559	5.1	7.5355	5.2
2011	8.2007	6.1	11.0828	5.0	7.9375	5.3
2012	8.6697	5.7	11.6357	5.0	8.3335	5.0
2013	9.1397	5.4	12.2186	5.0	8.7895	5.5
2014	9.6117	5.2	12.8345	5.0	9.2574	5.3
2015	10.0917	5.0	13.4843	5.1	9.7373	5.2
2016	10.6007	5.0	14.1762	5.1	10.2303	5.1
2017	11.1368	5.1	14.9091	5.2	10.7332	4.9
2018	11.6998	5.1	15.6819	5.2	11.2482	4.8
2019	12.2888	5.0	16.4998	5.2	11.7751	4.7

	NICARAGUA		EL SALVADOR		GUATEMALA	
Año	TWh/año	%	TWh/año	%	TWh/año	%
2008	3.1776		5.5991		8.3558	
2009	3.3496	5.4	5.8401	4.3	8.8978	6.5
2010	3.5226	5.2	6.0911	4.3	9.1926	3.3
2011	3.6795	4.5	6.3531	4.3	9.7496	6.1
2012	3.8435	4.5	6.6261	4.3	10.3116	5.8
2013	4.0165	4.5	6.9111	4.3	10.8786	5.5
2014	4.2014	4.6	7.2081	4.3	11.4505	5.3
2015	4.3974	4.7	7.5181	4.3	12.0125	4.9
2016	4.5964	4.5	7.8411	4.3	12.5795	4.7
2017	4.8104	4.7	8.1781	4.3	13.1686	4.7
2018	5.0403	4.8	8.5301	4.3	13.7796	4.6
2019	5.2753	4.7	8.8971	4.3	14.4146	4.6

Source: XM (ETESA, October, 2008. Mean scenario)

B.2 Generation expansion programs

Generation expansion programs used for each country are presented below.

CENTRAL AMERICAN COUNTRIES: GENERATION EXPANSION PROGRAMS

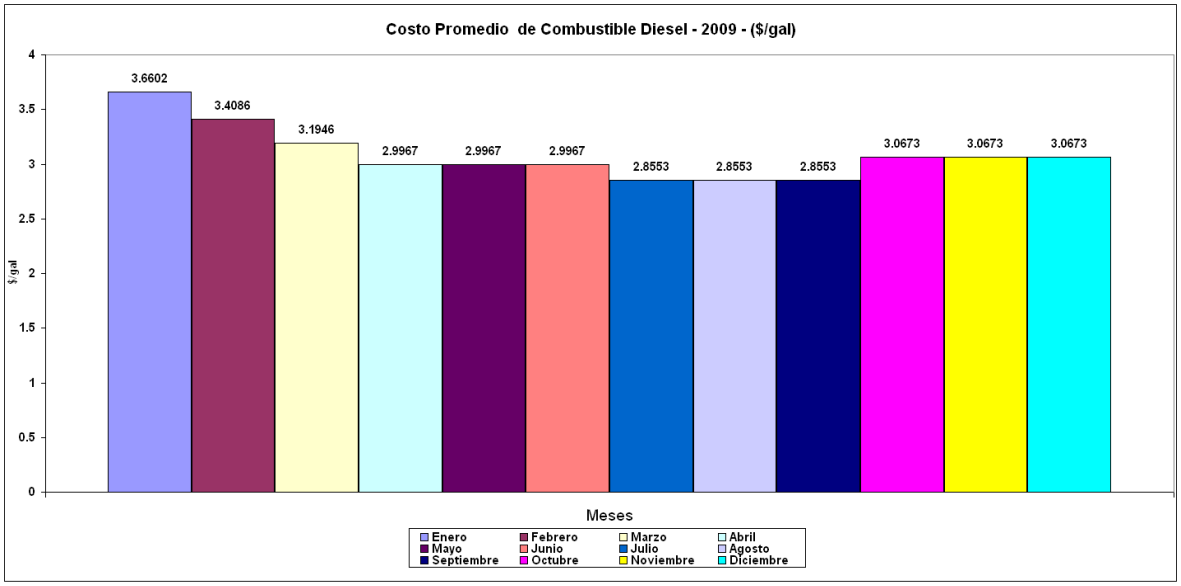
	PANAMA		COSTA RICA		NICARAGUA	
	PLANTA	MW	PLANTA	MW	NICARAGUA	MW
2009	Tcativa(Ene)	43.5	EolBOT(Ene)	25	E AMAYO(ene)	40
			Pocosol(ene)	26	ALBANISA4(mar)	80
	CC_tcol(Jun)	130	INGEN_BUN(Abr)	38	PMANAG_U3(Jul)	-43
			El_Encant(oct)	8	MMV 44 (ago)	44
			INGENIOS(Dic)	42		
2010	Blmcarbon(Ene)	120	EolBOT(Ene)	25		
	BLM123(Ret-Ene)	-120	Pirris(Ago)	128		
	Mendre(Ene)	20	MMV GARAB(Sep)	200	PTIZATE1(dic)	-10
	Bjo Mina(Ene)	52	ALQUILER(Sep)	-200	PTIZATE2 (dic)	33
					PTIZATE3(dic)	33
2011	Chan I (Abr)	213	GEO PAILA(May)	70		
		10			LARREYNAG (sep)	17
	Baitun(Abr)	86	Toro3(Ago)	50	PANTASMA(sep	17
	Gulaca(Nov)	26				
2012	Los Anile(Mar)	36	COLIMA(Ene)	-14		
	Chiriquí(Sep)	56	MOIN_MT(Ene)	-26		
	Pando(Sep)	32	EolProy1(Ene)	20	CB100(dic)	100
	Mon Lirio(Sep)	52	COL NEW(Ene)	30	PGEHOYOl(dic)	40
2013	El Alto(Ene)	60	EolProy1(ene)	30	BOBOKE(ene)	70
	Bonyic(Ene)	30	EolProy2(Ene)	100	PBRISA_U1	-24
			EolProy3(Ene)	100	PBRISA_U2	-38
			Bot-Proy(ene)	150	SALTO Y-Y(sep)	25
2014			Reventazo(ene)	300		
					TUMARIN(may)	160
2015	Tab II(ene)	35	S ANT NEW (Ene)	34	MMV100a(ene)	100
			S ANT(ene)	-34	MMV100b(ene)	100
2016	Sindigo(ene)	10	BARRANC(ene)	-36	VALENTIN(ene)	28
			BARR NEW(ene)	36		
			Diquis(ene)	622		
2017					CORRIE LI(ene)	40
					MMV100c(ene)	100
					MMV100d(ene)	100
2018	CB250a(ene)	250			PIED FINA	42
2019	B. Blanco(Ene)	20	CCLNG500a	500	EL CARMEN(ene)	60
2020					CCDS150a(ene)	150
					CB150(ene)	150
2021	CB250b(ene)	250				
2022			CCLNG500b	500		

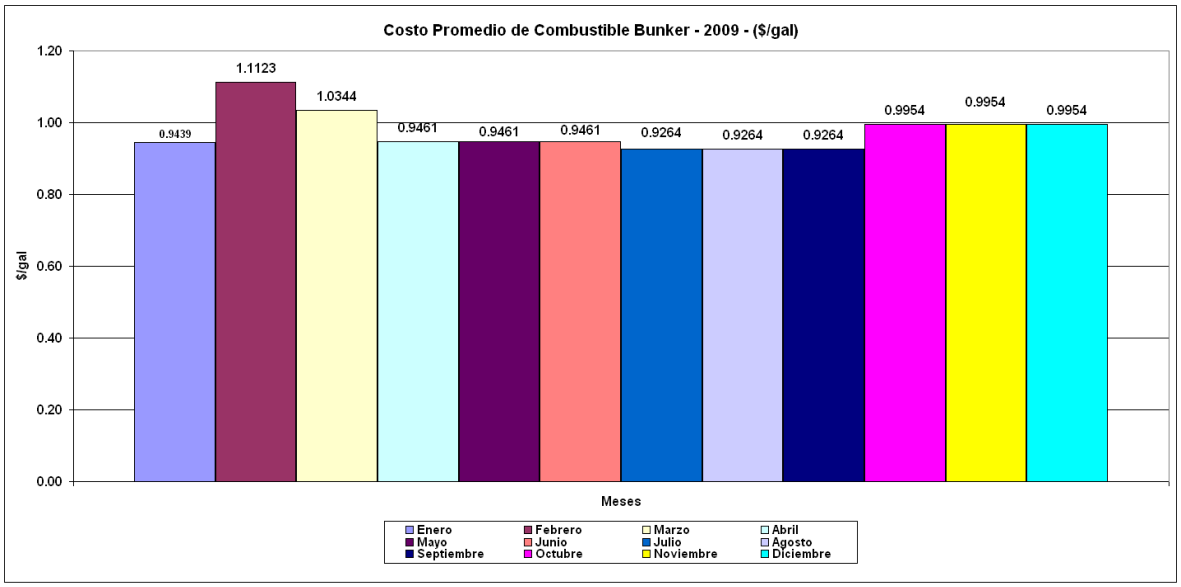
	HONDURAS		EL SALVADOR		GUATEMALA	
	PLANTA	MW	PLANTA	MW	PLANTA	MW
2009	Biomasa(ene)	93	TALNIQUE(may)	50	CALD3b-B(ene)	22
	Alsthom (mar)	27			CALD3c-B(ene)	11
	Sulzer(may)	30			GESSA-B (ene)	35
	Ceiba(sep)	-24				
	ENVAS MOT(oct)	33	TERMOPUER(nov)	75		
	CECSA MOT(oct)	50				
2010	Biomasa(ene)	11	SONSONATE(ene)	20	ESC2-V(ene)	-24
	Elcosa(jun)	-80	OZATLAN(ene)	50	ESC3_V(ene)	200
	Lufussa1(dic)	-40			DUKE-C(ene)	80
					TECUAMBU(ene)	44
					STAROSA-C(ene)	100
2011	CECSA(ene)	150	CHAPARRAL(ene)	66	XACBAL(ene)	94
	ENVASA(ene	100	05-Nov(ene)	64	RENACE(ene)	163
	Biomasa(ene)	100	AES F(ene)	250		
	CECSA MOT (oct)	-33				
	ENVAS MOT(oct)	-50				
2012	CB60(ene)	60	CERRON GD(ene)	86	CB275(ene)	275
	Alsthom(ene)	-27				
	Sulzer(ene)	-30				
2013			CUTUCO(ene)	525		
2014					SERCHIL(ene)	145
2015	Patuca2A(ene)	150	CIMARRON(ene)	261		
	Tornillit(ene)	160				
	Llanitos(ene)	98				
	Puert ENE(ene)	-10				
	Puert MEX(ene)	-16				
2016	Tablon(ene)	20				
	Jicatuyo(ene)	173				
2017					CB250a(ene)	250
	Lufu3-210(dic)	-210				
	CB100(dic)	100				
2018	Enersa(ene)	-15	MMV100a(ene)	100		
	MDMV 2(ene)	500				
2019	CB300a(ene)	300			CB500(ene)	500
	Emce2(abr)	-55				
	Lufussa2(may)	-77				
2020			MMV100b(ene)	100		
2021	Amp-ENERS(ene)	-15			CB250c(ene)	250
	Enersa(ene)	-200				
	CB200(ene)	200				

Source: XM (ETESA, October 2008)

B.3 Fuel prices

Fuel Oil #2 (Diesel) and Fuel Oil #6 (Bunker) prices, the main drivers of marginal costs and electricity prices in Central America, were updated according to forecasts made by CND (ETESA) in Panama for the last three quarters of 2009 (based on EIA short-term forecasts). These price levels (US$2.97/gal for Diesel and US$0.97/gal for Bunker C) were assumed to remain stable for 2010–2016. The following graphs illustrate the monthly fuel oil and diesel price forecasts used by ETESA in the Panamanian market for 2009.





Source: Informe Mensual de Operaciones. ETESA, CND. March 2009

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Energy Unit
Sustainable Development Department
Latin America and Caribbean Region
The World Bank