THE UNIVERSITY OF CALGARY

# STUDY ON THE ELECTRIC POWER SECTOR FOR A THERMOELECTRIC PROJECT PLANT IN THE REPUBLIC OF ECUADOR

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**A MASTERS DEGREE PROJECT SUBMITTED TO THE FACULTY OF GRADUATE STUDIES IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN SUSTAINABLE ENERGY DEVELOPMENT**

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CERTIFICATE OF COMPLETION OF INDIVIDUAL PROJECT
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The undersigned certify that they have read, and recommended to the Faculty of Graduate Studies for acceptance, the Individual Project Report entitled "Study on the electric power sector for a thermoelectric project plant in the republic of Ecuador" submitted by Juan Pablo Moncayo in partial fulfillment of the requirements for the degree of Master of Science in Sustainable Energy Development.

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## DEDICATION

I want to dedicate all my effort to my beloved wife María Susana, who always encourages me to achieve my goals.

## ABSTRACT

Ecuador has experienced an energetic state of emergency for the past nine months. New demands cannot be covered by Ecuador's National Interconnected System at present, since Ecuador lacks of new infrastructure and energetic projects, although there are old and inefficient sub-transmission networks, with operating characteristics and conditions that make them unsuitable to be considered.

Accordingly, to the Ministry of Electrification and Renewable Energies (MEER), the Government requires all possible information about realistic alternatives for meeting its demand for next year´s dry season, including the possibility of investing in its own generating plant, or issuing special permits for the private sector, in order to ensure reliable supply to meet its demand.

To determine any project sustainability, it is very important to have clear, a complete knowledge about the current situation of the Ecuadorian electrical system and its short- and medium-term prospects.

On this basis, it is indispensable to examine the infrastructure, current and future, for both generation and transmission. Some research into plans and projects, both hydroelectric and thermoelectric, plus those proposed for renewable energies, will structure the likeliest scenario for expansion of generation. This task will be complemented by research into expansion plans for transmission, including expectations regarding electrical integration in the Andean Region.

Because it is especially important, the Transmission Expansion Plan for 2009-2020, currently being approved by the regulatory authority and expected to be in force shortly, which will be especially useful when analyzing alternatives to supply the load from the National Interconnected System, or to deliver surplus energy to the system.

Another fundamental aspect at present that cannot be ignored is the regulatory and financial issues. The electrical sector is being changed significantly pursuant to a Constitutional Mandate issued prior to the current Constitution and overriding laws and regulations. Some of these changes mean that expansion will no longer be funded by part of user rates but is now to be financed with treasury monies. These decisions, adopted at a time when high international oil market prices promised sufficient funds to cover public investment, seem difficult to apply under current circumstances.

It is also necessary to examine the regulatory, technical and economic context in which energy purchase and sale transactions take place. It is important, therefore, to explore market operation rules and fundamentally the prospects for the future, which is especially important at a time of changes and transformations.

Along this same line of action, to provide all information required for an implementation of new projects, the document summarizes the procedures for water use concession to generate electricity and the concession to set up and operate a generating plant, including a review of the environmental requirements.

The heart of the document identifies and analyzes in a conceptual stage a Thermo-electrical project of 10 MW, with the possibility of using in some percent Bio Fuels from jatropha vegetable oil.

The aim of this document, is to provide a wide picture of what is going on with the electrical sector in Ecuador, so this may help as a good guide or reference as base line for public or private incentives.

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## 1. STRUCTURE OF THE INDUSTRY AND PARTICIPANTS IN THE MARKET

The Electric Sector System Law (LRSE), enacted on 10 October 1996 (Official Gazette No. 43), reformed the electrical sector in the Republic of Ecuador, segmenting the industry horizontally and vertically, and creating a competitive market for producing electricity, opening up the option for incorporating private sector investments, with the intention of limiting the Government's participation to regulating, overseeing and indicative planning.

Introducing this new market-based model entailed major changes in concepts, structure and operations for the electrical sector, and gave rise to a profound transformation based on segmenting the industry into business units for generating, transporting and distributing electrical energy. This was a radical change from the model in effect from 1961 until the LRSE was issued, which revolved around the Government's now-disappeared National Institute of Electrification (INECEL) which covered all the industry's activities, including setting rates.

This new model went into effect in November 1997, when the National Electricity Council (CONELEC) was set up for regulation and oversight. The Wholesale Electric Market (MEM), also created by that Law, began operating partially on 1 April 1999 pursuant to CONELEC Board Resolution No. 0054/99 and has been consolidated over the last few years by the regulations issued by CONELEC.

The Law contemplates three fundamental theoretical principles, which constitute the foundation of the model:

1. Separating the functions of regulation and oversight from those involving implementation and operation;
2. Segmentation of the activities of generation, transmission and distribution (including marketing);
3. Independent coordination of the dispatch of generation, as a function of hourly marginal costs.

Accordingly, the electrical sector is structured as follows:

a) Ministry of Electricity and Renewable Energy (MEER)
b) National Electricity Council (CONELEC)
c) National Energy Oversight Center (CENACE)
d) Electric generating concessionaire companies
e) The electric transmission concessionaire company
f) Distribution and marketing concessionaire companies
g) Large consumers rated by CONELEC.
h) Regulated users

Starting in 2008 a new stakeholder joined in, the Ministry of Electricity and Renewable Energy.

## 1.1 MARKET DESIGN AND STRUCTURE

The Wholesale Electric Market of Ecuador (MEM) comprises the generators, distributors and large consumers incorporated into the National Interconnected System and involves all transactions to buy and sell power and energy, among generators; between generators and distributors; and between generators and large consumers, including additionally transactions to export or import.

The only transactions that can be done on this market are sales on the spot or short-term market, and term contracts. Market stakeholders and trade relationships among them.

Generators (G) can deliver their energy to the market, or commit delivery through contracts made directly with distributors and large consumers.

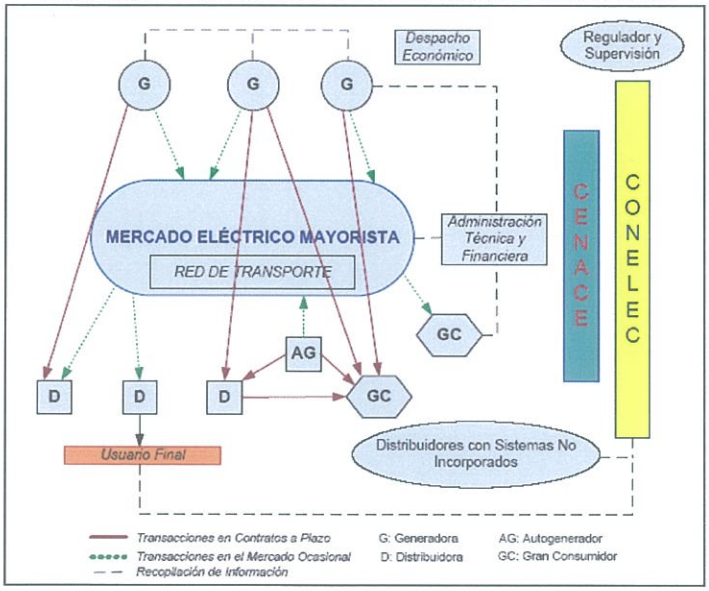
In turn, distributors (D) can purchase the energy they need to cover their demand on the spot market, or can sign contracts with the generators.

Large Consumers (GC) can get their energy on the spot market, or sign contracts directly with the generators. They can also sign contracts with distributors or remain as the regulated customers of a distributor subject to the rates set by the regulator.

The Law does not expressly mention the status of Self-Supplying Self-Generators (AG) with or without sale of surplus energy. However, their existence and market participation have been acknowledged through regulations.

Self-supplying generators can deliver their surplus energy to the market, or commit them through contracts made directly with distributors and large consumers.

**Illustration 1 WHOLESALE ELECTRIC MARKET STRUCTURE**




**Source**: CONELEC

Users who are not in a position to qualify as Large Consumers are customers of the distributor companies in their respective concession areas and their relations with distribution companies regarding pricing and quality indices are subject to regulations, so they are called "Regulated Customers". The Ecuadorian market does not provide for bulk energy sales.

The Market is technically and financial administered by the CENACE Corporation, which also operates the system. Market regulation and supervision and in general all sector activities are under the responsibility of CONELEC. A transmitter whose networks physically link energy buyers and sellers cannot take part in market activities and is obliged to grant free access to its networks to anyone who meets the technical requirements and pays the respective access fee.

CONELEC statistics show that, as of December 2008, the Wholesale Electric Market (MEM) comprised 18 generators (7 private capital and 11 with Government involvement), 1 transmitter, 20 distributors (18 incorporated into the National Interconnected System (SNI) and 2 not incorporated), 23 self-supplying generators and 85 Large Consumers.

In generation, there seems to be no great imbalance in the ratio of public versus private stakeholders. Nevertheless, in installed capacity, the situation is quite different. Out of a total of 3360 MW of installed capacity, 2847 MW (85%) belong to companies with Government ownership, and only 512 MW (15%) to private-capital companies.

Transmission was, up to December 2008, handled by the National Transmission Company, TRANSELECTRIC S.A., which belongs to the Solidarity Fund, with 100% government ownership.

As of December 2008, there were 20 distributors, out of which 19 were joint-stock corporations, the main shareholders being: the Solidarity Fund, municipalities, provincial councils, other public entities and private shareholders (but at a low percentage for the private players). The largest shareholder in most of these companies is the Solidarity Fund.

Distribution in Guayaquil, which is approximately 30% of total national demand, is under a Temporary Administration arrangement while its final status is defined. Its technical, administrative and commercial management is under the Corporation for Temporary Electrical Administration of Guayaquil (CATEG). Although CATEG is legally a private corporation, it is administered by the Government, through a Temporary Administrator and Supervisory Council whose members are appointed by CONELEC.

The Sucumbíos and Galapagos distribution companies are not incorporated into the SNI, although this is temporary in the case of the former, only until the transmission system's capacity is expanded to fully cover its demand through the national system. The Galapagos Provincial Electric Company, Inc. – whose concession area is the island province of Galapagos – will remain un-incorporated.

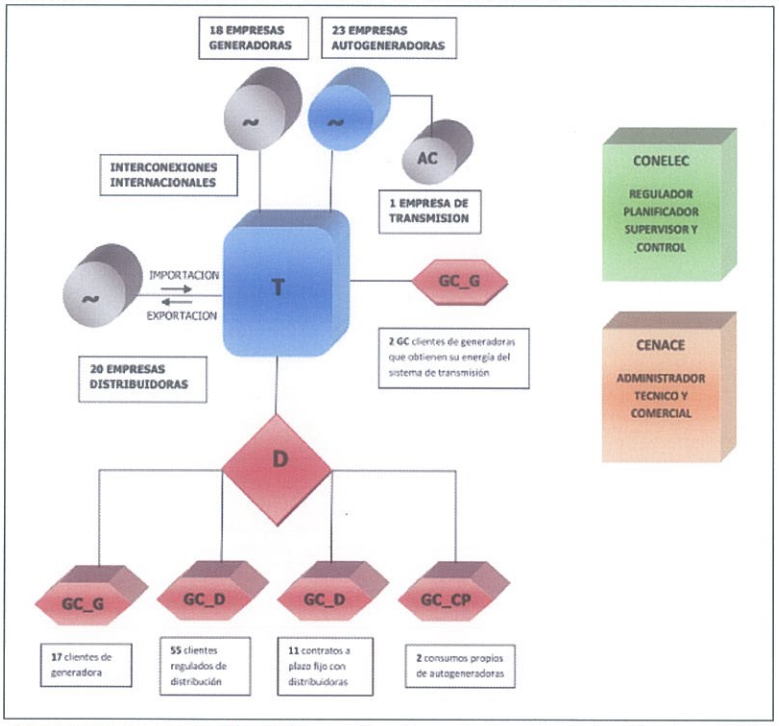
There are 85 stakeholders rated as Large Consumers, out of which 55 act as Regulated Customers of the distributors, 11 receive energy from their distributors through term contracts, 17 obtain energy from generators and 2 from self-supplying producers. Qualifying as a Large Consumer entails meeting a series of requirements set by the regulations.

Additionally, out of the 23 companies qualifying as self-supplying producers, 15 deliver their surplus energy to the market and 8 are operated by petroleum companies in Ecuador's Amazon region.

The creation of CNEL and CELEC has changed the number of market stakeholders. CNEL, as explained below, has merged 10 distributor companies, whereas CELEC has incorporated five generation companies and the transmitter, all government-owned.

With these changes, there are currently eleven distribution companies and seven generator companies, all government-owned. The structure of Ecuador's Electric Market as of December 2008 is shown in the following illustration:

**Illustration 2 CURRENT STRUCTURE OF ECUADOR'S ELECTRICAL SECTOR**




**Source**: CONELEC, Statistical Bulletin on the Ecuadorian Electrical Sector, 2007 Updated with 2008 data

Constitutional Mandate No. 15 issued by the Constitutional Assembly meant a change in the way the market is conceived and operates. CONELEC has issued Regulations No. 006/08 and 013/08, which set the new rules for this purpose, emphasizing long-term contracts, substantially reducing short-term energy market transactions, which will tend to disappear.

This model, which could be called a Regulated Contracting Model, has the premise of recognizing generation costs (fixed and variable), for both private-capital generators and those with public or governmental ownership. Contract prices are set on the basis of an individualized analysis of costs, which in the case of public generators will be regulated by CONELEC, whereas for contracts with private generators they will be subject to individualized negotiation with each stakeholder.

## 1.2 LEGAL AND INSTITUTIONAL ARRANGEMENTS OF THE MARKET

### 1.2.1 Basic Electrification Law (LBE) – Not currently in effect

Ecuador's electrical sector is in an initial stage of development, starting with the enactment of the Basic Electrification Law (LBE) on 10 September 1973, by which the Ecuadorian Government transferred to the "National Electrification Fund of INECEL" 47% of the income it received from royalties on petroleum extraction and fees for transporting crude oil via pipelines. These monies financed the studies and construction of generation projects and the transmission infrastructure that gave rise to the National Interconnected System (SNI), as well as major sub transmission projects in regional electrical systems.

This institutional arrangement yielded positive results as long as there were sufficient funds to finance electrical infrastructure, but also fostered the development of serious inefficiencies, mainly in distribution, which in a vertical structure were readily concealed by non-transparent transfer of costs among the different activities of the value chain.

When fiscal resources lagged, the system began to reveal its deficiencies. Major generation projects did not materialize and the energy supply began to fall short of demand, especially during the dry season, when less rainfall in the Amazon region affects Ecuador's largest hydropower stations. As a consequence, during the early 1990s there was rationing, leading to the adoption of unorthodox and seriously questioned measures, such as changing the time by one hour for all activities, which the public objected to and had to be suspended.

Under such circumstances the vertical system ran out and INECEL concluded its legal existence on 31 March 1999, when Executive Decree No. 773 of 14 April 1999 charged the Ministry of Energy and Mining with the process of accounting, budgetary, financial and technical closing-down of INECEL, which was done since March 1999 through INECEL's Liquidation Unit, created for that purpose.

Liquidation of INECEL, a governmental entity with a vertically integrated structure covering generation, transmission and distribution, was the end of a stage of direct governmental involvement, and gave way to a new model based on "deconcentration" of activities into independent business units open to private capital, with competition in generation, and regulated monopoly for transmission and distribution.

### 1.2.2 Electric Sector System Law (1996)

On 10 October 1996, the Supplement to Official Gazette No. 43 published the Electric Sector System Law (LRSE), which replaced the Basic Electrification Law and established a new model under the following precepts:

- Electrical energy supply is considered a public utility service in the national interest; the Government is responsible for satisfying, directly or indirectly, the country's electrical needs, by optimally using natural resources, pursuant to the National Electrification Plan.

- The Government can delegate activities of generation and public services of transmission, distribution and marketing electrical energy, as well as energy import and export activities, to the private sector.

- Private investment and development of the electrical sector are promoted.

- Payment to generators that sign contracts to purchase and sell power and energy, with distributor companies, is guaranteed during a transitional period.

- Jurisdiction for electrical sector policy-making falls to the corresponding ministry (currently the Ministry of Electricity and Renewable Energy) and CONELEC is responsible for electrical sector planning.

This Law has been amended several times (2 January, 19 February and 30 September 1998, 13 March and 18 August 2000, and September 2006), and is still in effect, although some of its provisions have been overridden by Constitutional Mandate No. 15 as explained below.

The LRSE established the following structure for the electrical sector:

- National Electricity Council (CONELEC)
- National Energy Oversight Center (CENACE)
- Electric generating concessionaire companies
- The electric transmission concessionaire company
- Distribution and marketing concessionaire companies

The LRSE created the National Electricity Council (CONELEC), as an autonomous public-law legal entity responsible for regulating and overseeing the electrical sector, and also the National Energy Oversight Center (CENACE), as a private-law civil corporation, responsible for technical operation of the electrical system and commercial administration of the market.

The Law also created COMOSEL (Council for Modernization of the Electrical Sector), charged with conducting the processes to promote private sector participation in generation and distribution companies. When the privatization process failed, COMOSEL ceased to exist for all practical purposes.

At the same time, the generation facilities belonging to the former INECEL were transferred to six (6) new generation companies: Hidropaute S.A., Hidroagoyán S.A., Hidropucará S.A., Termoesmeraldas S.A., Termopichincha S.A. and Electroguayas S.A.; whereas transmission facilities were turned over to a single transmission company, the National Transmission Company, TRANSELECTRIC S.A.

Subsequently in 2001 Hidroagoyán S.A. absorbed Hidropucará S.A.

The shares in these new companies became wholly owned by the Solidarity Fund, a government agency created to represent the Government in the stock of companies that are privatized, in order to channel profits toward social development projects.

Similarly, the stock of distribution companies that used to belong to the former INECEL became the property of the Solidarity Fund. The only exception was distribution in the ciudad of Guayaquil, which at that time was operated by the Electric Company of Ecuador Inc., a US company constituted in the state of Maine, which had been operating in Ecuador since 1925.

The privatizing program provided for sale of up to 51% of generator and distributor companies' stock, so it was understood that these businesses would be administered and operated by private stakeholders. As the privatization effort faltered and failed for the distribution sector, this blocked any possibility of privatizing generation, so the Solidarity Fund had to assume a responsibility it was never created for and was not prepared for, to administer practically every company in the electrical sector.

Among other aspects about the LRSE, we highlight the following:

- The Ecuadorian Government does not guarantee any generator production, price, profit on their investment and or a market for electrical energy. However, the State, through the Ministry of Economy and Finance, does guarantee payment to those generators who deliver their energy through contracts to distribution companies (this did not happen until 2008).
- Rates applicable to end consumers must cover reference prices for generation, the costs of the transmission system and value added for distribution (VAD) for all distribution companies.
- The rate structure for end consumers must reflect costs resulting from customers' modalities of consumption and voltage level.
- The Reference Price for Generation (PRG) for end users is calculated as the average of expected short-term marginal costs, plus the cost of the available power, whether dispatched or not.
- Transmission rates that MEM agents must pay to use the transmission system comprise an operational component and a component for expansion, which must be cleared by CONELEC.
- The Value Added for Distribution (VAD) is calculated for each distributor company, comparing their efficiency with a model (fictitious) company with similar operating characteristics. This calculation considers costs, investment,

operation and maintenance, plus a level of losses established by CONELEC regulations. It also includes marketing costs involving recording, reading, billing and collecting.

Some of these precepts were overridden by Constitutional Mandate No. 15, discussed below.

### 1.2.3 Constitutional Mandate No. 15 (2008)

The Constitutional Assembly meeting to public mandate as of 15 April 2007 assumed full power, pursuant to Article 1 of Constitutional Mandate N°1 of 29 November 2007, published in the Supplement to Official Gazette N° 223 on 30 November 2007.

Full Power means that their resolutions (expressed as Constitutional Mandates) override any contradictory norm, including the preceding Constitution.

Using such powers and authority, on 23 July 2008 Constitutional Mandate No.15 was approved and issued, making profound changes in the electrical sector, going beyond even the LRSE, summarized as follows:

- Establishing a single national rate for each type of consumption.
- Unlimited power for CONELEC to adjust the regulations as required for this purpose.
- Eliminating the item of marginal costs from calculating the generation component.
- Eliminating the components of investment for expansion from distribution and transmission costs.
- Financing expansion of generation, transmission and distribution with resources from the Nation's General Budget.
- Eliminating the 10% surcharge from the electric bills of commercial and industrial customers, which had been charged to finance rural electrification through the FERUM.
- Establishing a subsidy to cover the differences between costs and the single rate set for end consumers, to be paid by the Ministry of Finance.
- Canceling outstanding arrears for energy purchase, transmission fees, and fuel for generation, among companies owned by the State, and amounts outstanding payment by the Ministry of Finance for rate deficits.
- Transferring debts owed by State-owned enterprises as a result of the liquidation of INECEL to the Ministry of Finance.
- Recognizing the amounts of rate deficits, dignity rate and FERUM, which the Ministry of Finance must continue to pay.
- Far-reaching powers for the Solidarity Fund to amend by-laws, merge, set up new corporate bodies, dissolve companies and take any corporate action required to properly manage electric and telecommunications companies it holds stock in.

To make it viable to enforce Constitutional Mandate No. 15, CONELEC has issued (so far) Regulations 006/08 and 013/08, of which the latter is especially germane, as it sets the new market operation rules.

### 1.2.4 Rule No. CONELEC 013/08

The Board of CONELEC, through Resolution No. 0138/08 of 27 November 2008, passed Rule No. CONELEC 013/08, entitled "COMPLEMENTARY RULE No. 1 TO ENFORCE CONSTITUTIONAL MANDATE NO. 15", in order to:

- Set the commercial rules for market operation.
- Set norms for regulated contracts among market participants.
- Foster the market model transition.

Relevant articles, especially those involving the market, include the following:

*"7. Long-term Transactions:*

*The following kinds of contracts will be signed in the Electric Market:*

a. *Regulated term contracts resulting from public tenders and signed between private generators and distributors;*
b. *Regulated term contracts signed between private generators who are operating on the date this Rule is approved, and distributors;*
c. *Regulated term contracts signed between generators owned by the State, without any exception whatsoever, and distributors;*
d. *Term contracts freely agreed upon between those private generators and large consumers who are duly authorized to do so.*

*Public and private generators, to market their energy with distribution companies, are obliged to sign purchase and sale contracts with all of them, proportionally to those companies' demand.*

*8. Treatment of the Self-Supplying Generators.*

*Technical and commercial treatment of self-supplying generators shall be subject to the provisions established for this purpose in the specific Rule addressing these matters, issued by CONELEC. Only surplus generation will be considered for sale of energy produced by self-supplying generators on the market.*

*9. Contract Conditions*

*Regulated contracts signed by Generation or Self-Supplying Generation Companies with Distribution Companies must consider that net generation must be allocated proportionally to their regulated demand.*

*Regulated contracts must also clearly establish two components:*

a. *Fixed charge to be paid regardless of whether the generator is dispatched or not by CENACE, providing that it is kept available, considering maintenance periods duly authorized by CENACE.*

*To determine the fixed charge, the following costs will be considered: investment, administration, operation and maintenance. Regarding maintenance, only major overhauls are considered, as required to enhance units' power or prolong generator units' useful lifetime.*

*Monthly remuneration will be paid only when the generator is available; that is, during periods of unavailability due to equipment failures, maintenance or any other situation that forces that generator to be unavailable, no fixed charge will be paid.*

*For generators in which the State owns stock, fixed charges shall be set by CONELEC in the respective rate studies, which must be included in the respective regulated contracts, and notified to CENACE for the liquidation process.*

b. *Variable charge or variable production cost, to be determined under the specific norm and settled according to the electrical production measured. The Rule to be applied to declare this component will be No. CONELEC – 003/03 currently in effect or any that replaces it.*

*18.- Contracts with future generation by private capital*

*For this purpose, considering the criteria set in the preceding sub-sections, CONELEC will issue a specific Rule to set norms for the process of regulated contracts with future generation by private capital."*

### 1.2.5 New National Constitution of Ecuador (2008)

The new National Constitution of the Republic, in effect as of 22 October 2008 having been approved by national elections, contains a number of precepts to discuss:

Chapter five, on "Strategic sectors, services and public enterprises", states:

*"Article 313. The State reserves the right to administer, regulate, oversee and manage strategic sectors, pursuant to principles of environmental sustainability, precaution, prevention and efficiency.*

*Strategic sectors, subject to exclusive State decision-making and control, are those that, because of their transcendence and magnitude, have a decisive economic, social, political or environmental influence, and must be oriented toward fully developing societal rights and interests.*

*Strategic sectors are considered to include energy in all forms, telecommunications, non-renewable natural resources, transport and refining of*

*hydrocarbons, biodiversity and genetic heritage, the radio electrical spectrum, water, and others as determined by law.*

*Article 314. The State will be responsible for providing public services of drinking water and irrigation water, sanitation, electrical energy, telecommunications, roadways, port and airport infrastructure and others determined by Law.*

*The State will ensure that public services and their provision abide by the principles of mandatory, general, uniform, efficient, responsible, universal, accessible, regular, continuous and high quality coverage. The State will make sure that prices and rates for public services are equitable, and provide for oversight and regulation thereof.*

*Article 315. The State will constitute public enterprises to manage strategic sectors, public service provision, sustainable use of natural resources or of public goods and the pursuit of other economic activities.*

*Public enterprises will be subject to specific regulation and oversight by the relevant agencies, according to the Law; they will operate as public-law entities, with legal status and financial, economic, administrative and management autonomy, high parameters of quality and business, economic, social and environmental criteria.*

*Profits may be invested and reinvested in the enterprises themselves or their subsidiaries, related or associated companies of a public nature, at levels that will ensure their development. Profits not invested or reinvested shall be transferred to the Nation's General Budget.*

*The Law shall define participation by public enterprises in joint public-private companies in which the State will always be the majority shareholder, to take part in managing strategic sectors and providing public services."*

Pursuant to this last constitutional provision, the Solidarity Fund is preparing a draft Law on Public Enterprises, of unknown content but understood to be oriented toward setting up a single government enterprise for each sector considered strategic, namely: electricity, telecommunications, petroleum, water and mining.

Further, a package of amendments to the Electric Sector System Law is said to be in the works, to harmonize treatment of the market, rates and concessions, under the new Constitution and the provisions of Mandate No.15.

### 1.2.6 Water Law

The text is currently being discussed for a new Water Law to replace the one in effect, to incorporate the new precepts included in the Constitution that has been in effect since 22 October 2008.

The National Water Secretariat, the agency that has replaced the National Council on Water Resources, has published a third version of the proposed Sectoral Law on Water Resources, Use and Utilization.

The proposed law, containing the main issues regarding mining activity and using water to generate electricity. Anyway, several relevant articles are cited below:

> *Generating hydropower for public service is an economic utilization of water that will enjoy a special rate, according to the use of the energy generated (Article 58)*
>
> *Authorizations for economic use of water to generate electrical energy for industrial activities will be granted as a priority for projects that are a national priority, included in the National Development Plan. (Article 59).*
>
> *Authorizations will be granted for economic use of water for mining activities, with priority for those activities to be pursued in areas covered by the National Development Plan for the mining sector and its multi-year planning (Article 62).*
>
> *If no electrical energy can be obtained for mining activity from the national interconnected system, the project sponsor may generate their own energy, upon prior authorization to use water for hydroelectric generation (Article 65).*
>
> *For economic use of water to generate electrical energy not for public service, the corresponding fees must be paid, pursuant to this Law. Generating hydroelectricity for public service will also pay the water use rate. The overall water authority will have the power to collect these fees and the rate established in this Law and its Regulations using coercive legal force (Article 114).*
>
> *Using water to generate hydropower to use for public electrical service is an economic use of water that requires authorization; however, since it meets the people's basic needs, it is subject to a special rate, although it is governed by the applicable norms for priority and procedure applicable to any economic use of water (Article 178).*

## 1.3 KEY STAKEHOLDERS

This description of the legal and constitutional framework has identified the main stakeholders in the electrical sector, but it may be useful to describe them in somewhat greater detail.

### 1.3.1 Ministry of Electricity and Renewable Energy (MEER)

The MEER was created by Decree No. 475 of 9 July 2007, which divided the Ministry of Energy and Mining into the Ministries of Mining and Petroleum and of Electricity and Renewable Energies (MEER). Official letter No. DI-SENRES-002915, of 16 May 2007, approved the Organizational By-Laws for Management of Processes for the Ministry of Electricity and Renewable Energy, and the Technical Norm for Designing Regulations

was issued with Resolution SENRES-PROC-046, published in Official Gazette No. 251 of 17 April 2006.

According the Organizational By-Laws, the strategic objectives of the Ministry of Electricity and Renewable Energy are:

- To make the country into an exporter of electrical energy;
- to recover the role of the State in managing the electrical sector;
- to increase the use of renewable energies;
- to increase levels of electrical coverage and satisfaction of the citizens / users of electrical energy;
- to improve sectors' energy efficiency: industrial, commercial, residential and transportation;
- to define an energy matrix for the electrical sector;
- to represent the Ecuadorian Government nationally and internationally in regard to the electrical sector and the peaceful use of nuclear energy;
- to regulate and oversee the use of ionizing radiation nationwide;
- to enhance nuclear applications for the country's benefit;
- to oversee radioactive minerals.

Ministry Resolution No. 035, published in Official Gazette No. 518 of 30 January 2009, the Ministry of Electricity and Renewable Energy set new short-, medium- and long-term governmental policies in the energy sector, summarized below.

a) To recover the State's role of guidance and planning of the energy sector;

b) to strengthen relations between the State and communities;

c) to promote an energy development model with environmentally friendly technologies;

d) to formulate and implement a National Energy Plan to optimize the sector's expansion in a framework of sustainable development;

e) to promote strategic alliances between the national and foreign public and private sectors to develop energy projects in a setting of legal security;

f) to promote sustainable development of energy resources and promote projects with renewable generation sources (hydropower, geothermal, solar, wind) and new efficient electric generation, including nuclear, excluding generation based on the use of diesel;

g) to grant governmental guarantees of payment for energy generated and received by electric distribution companies or find the best payment mechanisms;

h) to strengthen expansion of the national interconnected system and technical development of the regional electrical sector, through the consequent increase in investments, reduction in generation costs and greater exchange of electricity among the countries of the region;

i) to strengthen the National Transmission System to access the energy from generation power plants and meet the requirements of electrical distribution companies, under conditions of quality, continuity and safety;

j) to strengthen governmental institutions in the energy sector:

k) to promote constitution of proactive, efficient, competitive electrical distribution companies, guided by the principles of solidary economics, maintaining the principle of public service;

l) to implement technologies for efficient use of energy, develop plans to reduce losses and promote rational, efficient use of energy among the public;

m) to promote creation and consolidation of energy service companies as a vehicle to reach consumers and get them to implement energy efficiency projects; and

n) to reduce fuel consumption in transport by substituting with compressed natural gas (CNG), electricity and introducing hybrid technologies.

Action by the MEER is not limited to just establishing the sectoral policy pursuant to the Law, but in practical terms it has become the governing agency for the electrical sector, above all other institutions, including CONELEC, which is chaired by the Minister of Electricity.

### 1.3.2 Ministry of the Environment

The Ministry of the Environment is the national environmental authority, responsible for sustainable development and the country's environmental quality and is the top body for coordination, issuing policies, norms and regulations at the national level, to develop the basic guidelines to organize and operate environmental management.

It is the Ecuadorian Government agency responsible for designing environmental policies and coordinating strategies, projects and programs to care for ecosystems and sustainably use natural resources. It proposes and defines norms to attain adequate environmental quality, with development based on conservation and appropriate use of biodiversity and of our country's resources.

The Ministry of the Environment pursues its mission on a decentralized basis, through Regional Districts that implement policies in their local jurisdictions and coordinate directly with Under-Secretariats, also providing legal advisory assistance, and forestry, biodiversity, environmental quality and organizational development. The Regional

Districts were declared Deconcentrated Financial Units by Ministry Resolution 017 of 21 June 2001.

In regard to electrical sector activities, the Ministry of the Environment, on 11 February 2005, accredited CONELEC as the "Environmental Authority Responsible for Enforcement" which empowered it to issue environmental licenses for electrical sector projects unless they are located in or pass through protected zones.

Decree No. 1630 signed on 20 March 2009 transferred to the Ministry of the Environment all jurisdiction, powers and delegations in environmental matters from the Under-Secretariat for Environmental Protection of the Ministry of Mining and Petroleum, the National Directorate of Mining Protection (DINAPAM) and the National Directorate of Hydrocarbons Environmental Protection (DINAPAH).

So, all environmental issues to be addressed regarding mining and hydrocarbons come under the Ministry of the Environment, whereas for electrical sector issues, CONELEC maintains its jurisdiction as the Environmental Authority Responsible for Enforcement.

### 1.3.3 National Electricity Council (CONELEC)

The LRSE created the National Electricity Council (CONELEC) as an autonomous, public-law legal entity responsible for regulating, setting rates and overseeing the electrical sector, also charged with indicative planning for the sector empowered to grant concessions by delegation from the national Government, for the activities of generation, transmission and distribution, and is forbidden to engage in business activities in the electrical sector.

CONELEC began operating early in 1998, once the General Regulations in Substitution for the LRSE were promulgated on 20 November 1997.

Its Board comprises three representatives of the President of Ecuador, one of whom chairs it, one delegate of the National Planning Secretariat (SENPLADES), one delegate of the armed forces, one delegate of the Chambers of Production and a delegate of electrical sector workers. The last amendment of the LRSE established a new structure and the appointment of its members by competitive selection under an Evaluating Committee. This reform, among others, was disputed through lawsuits before the Constitutional Tribunal which ruled it un-constitutional so it was not enforced.

In real terms, the Government has at least four of the Board's seven members, which is currently – for the first time in the history of CONELEC – chaired by the Ministry of Electricity and Renewable Energy, which ensures that the regulator's decisions will not necessarily be independent and will in general follow the policy line imposed by the series of governments, especially in regard to setting rates.

The budget for CONELEC's operation is funded by contributions, which must be paid in advance during the first quarter of each year, by all generators, the transmitter and distributors, proportionally to their gross revenues. Nevertheless, as of January 2009,

all resources of CONELEC became part of the single account of the National Treasury, which practically eliminated its financial autonomy.

Moreover, CONELEC has had to follow the norms regarding human resource administration, salary setting, and public contracts, which are applied across the board for the entire State sector, which has also seriously reduced the administrative autonomy granted by the LRSE.

Therefore, the regulator's autonomy established in the Law remains purely formal and does not exist in practice.

According to the structure that is being designed for the strategic sectors of the economy, the electrical sector should have a structure very similar to the one set forth in the Mining Law, and comprising a Ministry, a Regulatory Agency and a single State Enterprise. If this same pattern is kept for the electrical sector, CONELEC will become a Regulatory Agency reporting to the Ministry of Electricity.

### 1.3.4 National Energy Oversight Center (CENACE)

The LRSE also created the National Energy Oversight Center (CENACE) as a private-law civil entity responsible for technical operation of the electrical system and commercial administration of the market. It began operating in this new status on 1st February 1999.

The National Energy Oversight Center (CENACE) is an eminently technical, non-profit, entity whose membership is from all the generation, transmission, distribution companies and major consumers. This agency is responsible for technical and economic management of bulk energy, and must ensure at all times that demand will be met with conditions of quality and safety as established in the norms.

Its main tasks include the following:

- Administer the technical and financial transactions of the Wholesale Electric Market.
- Protect the conditions for safe operation of the National Interconnected System.
- Take responsibility for supplying the market with energy, at the lowest possible cost.
- Preserve the sector's overall efficiency.
- Create market conditions for electrical energy marketing by generator companies, granting them transmission system access.
- Report to CONELEC when required.

CENACE has a Board with seven (7) members delegated by generation companies (2), transmission companies (1), distribution companies (2) and large consumers (1) and the Chair is appointed by the President of Ecuador.

It has been a common practice for one of the generators' delegates to be from the private sector, so along with the large consumers' delegate they are the only private sector representatives, versus five representatives who directly or indirectly come from the public sector.

Nevertheless, with its private-law status, CENACE has managed to maintain its administrative, financial and operational autonomy. CENACE's budget is contributed by all agents of the Wholesale Electric Market.

Discussions of how to reorganize the sectoral structure, the prevailing criterion is to keep the CENACE as an autonomous technical agency, although it would change to a public-law entity, thereby losing its financial and administrative autonomy, as happened with CONELEC.

The actions of CENACE as system operator and market administrator are taken on the basis of the regulations issued for this purpose by CONELEC.

### 1.3.5 Solidarity Fund

The Solidarity Fund was created by a Law published in Official Gazette No.661 on 24 March 1995 and it was included in the Constitution in 1998.

The Solidarity Fund is a public agency, created by law, constitutionally autonomous, representing the State as owner of the shares in electric companies (generation, transmission and distribution) and in telecommunications companies in Ecuador.

With profits and yield on its investments, the Solidarity Fund finances human development programs in the sectors of education, health, environmental sanitation and remediation of the effects caused by natural disasters.

Additionally, on the basis of Ecuador's electrical sector norms, it administers the resources of the Rural and Urban–Marginal Electrification Fund (FERUM) and uses them to fund electrification projects in zones traditionally not served, attempting to grant most citizens access to electricity.

On the basis of current legal provisions, the assets in the Solidarity Fund can only grow over time and the yield may be used only to cover investments.

According to the new Constitution, the Solidarity Fund should disappear in approximately a year. Electrical sector enterprise management will then become the responsibility of the Ministry of Electricity and Renewable Energy.

### 1.3.6 National Electricity Corporation (CNEL)

The Solidarity Fund, which is the main shareholder in Ecuador's electrical Generation, Transmission and Distribution enterprises, was empowered by Constitutional Mandate No. 15, Transitional Provision Three, to take all corporate actions required to

restructure the electric companies of which it is the main shareholder, so among other actions it can amend corporate by-laws, merge, form new entities, decide to dissolve companies, etc.

On this legal basis, the Fund resolved to create the National Electricity Corporation (CNEL) y merging ten distributor companies (El Oro, Guayas – Los Ríos, Esmeraldas, Los Ríos, Manabí, Milagro, Santa Elena, Santo Domingo, Sucumbíos and Bolívar) which according to the new corporation's structure become Regional Offices. On 16 January year 2009 the deed of constitution of the CNEL was filed with the Mercantile Register of Guayaquil. The other electrical distributor companies will continue to operate autonomously.

The Corporation was created with a corporate stock of USD 108 million dollars and assets of USD 1.1 billion. This merger was to improve business management, since the merged companies had accrued losses totaling about USD 100 million.

The National Electricity Council (CONELEC), using its powers and pursuant to Mandate No.15, authorized on 10 March 2009, the assignment of these ten distributor companies' rights and obligations to CNEL, and its operation in Ecuador's electrical sector as an electricity distributor company. So, customers in the concession areas of the companies merged are now served by CNEL.

### 1.3.7 Electrical Corporation of Ecuador (CELEC)

On the same legal basis, the Solidarity Fund resolved to form the complementary Electrical Corporation of Ecuador (CELEC), which regularized its operation with the Superintendence of Companies as of 13 February 2009. The newborn company was created by merging several generator companies (Hidropaute S.A., Electroguayas S.A., Termoesmeraldas S.A., Termopichincha S.A., Hidroagoyán S.A. and the transmitter TRANSELECTRIC S.A.) which according to the structure established become Business Units.

The Hidropastaza S.A., which had as its only shareholder the merged company Hidroagoyán S.A., was left out of this merger. This exceptional treatment has led to lawsuits internationally between this company and Norberto Odebrecht Constructions, over the building of the San Francisco hydropower station, which encountered serious construction problems less than one year after beginning operations. The legal situation of those lawsuits could have been affected by the merger.

The formalization of its operations in the electrical sector is being arranged in CONELEC.

### 1.3.8 National Water Secretariat

The National Water Secretariat (SENAGUA) has the purpose of conducting and governing Ecuador's water resource management in a integrated, sustainable manner

on a watershed basis. It was created by Decree Executive 1088 on 15 May 2008, which went into effect on 27 May, with its publication in Official Gazette Nº 346.

For the first time in Ecuador's history, the Government has recognized the intrinsic value and nature of water, placing water management at the highest institutional level, to enable integrated coordination of this natural heritage to help conserve it.

This National Secretariat, created at the ministry level, replaces the former National Council of Water Resources, and works to establish systems to set up discrete policy-making and oversight, separately from research and social participation.

The main powers of SENAGUA include:

- National water resource management and administration.
- Setting policies to govern water management and determine the norms and regulations needed to enforce them.
- Formulate the National Water Management Plan.
- Establish policies to recover water costs by charging user rates.
- Issue norms on management of watersheds

According to the Decree Executive that created SENAGUA, all watershed-based water management entities must adapt their policies and structure to SENAGUA's, including the National Institute of Meteorology (INAMHI).

## 1.4 KEY ASPECTS TO BE CONSIDERED FOR DECISION-MAKING ON INVESTMENT IN THE ELECTRICAL SECTOR.

The electrical sector's development and future prospects in the short and medium term features some key factors that the different stakeholders must consider, as should those who would like to have enough information to make decisions about possible investment in the electrical sector.

At present, profound changes are under way in State governance and strategic sectors, including the electrical sector. This leads to some uncertainties, but there are also clear signals to indicate at least the general essence and direction of such changes.

The key aspects to be considered in this analysis involve the sector's institutions, policy advocacy regarding decisions, the financial situation and its impact on infrastructure projects that are required. This all attempts to set up a scenario that will be as close as possible to the expected new reality of the electrical sector.

### 1.4.1 New structure and new Law for the electrical sector

Although the structure of the electrical sector established in the Electric Sector System Law of 1996 and amendments thereto remains in effect to this day, there are clear signs of a transformation toward a new institutional model.

Research and public statements by electric sector authorities show that the Government has decided on a basic structure to be applied to the areas considered strategic for the nation's economy, including the electrical sector.

This structure is tripartite, with a Ministry, a Regulatory Agency, and a Single, State-owned Enterprise.

For the electrical sector this structure would be represented by the Ministry of Electricity and Renewable Energy (MEER), the Agency – now CONELEC, and the Single Company yet to be formed. The recent merger of several enterprises to create CNEL and CELEC clearly shows that the transformation is under way, and is moving toward the formation of a single company.

CENACE would remain as an independent technical body, although turned in to a public-law entity, subject to human resource administration and contract norms set for the public sector. This way CENACE would no longer be a private entity, which has so far enabled it to attain a high level of development technologically.

The future single company will incorporate generation, transmission and distribution in a vertical structure, although the intention would be to maintain independent business units for each activity, to avoid mixing all the inefficiencies together, as happened with the former INECEL.

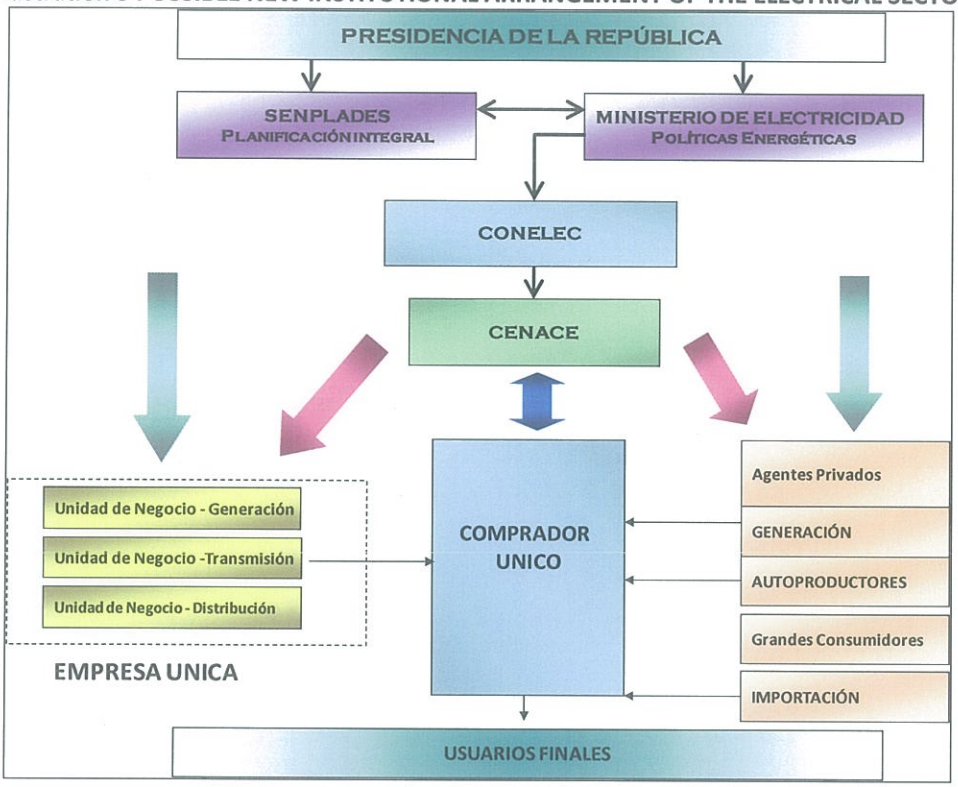
Further, the new rule issued by CONELEC reveals the intention to migrate toward a single buyer model, although the body that would act as such has not yet been chosen. CENACE might play this role, or a new entity may be set up.

To make all these changes, two bodies of law are being prepared: a new Electric Sector System Law and a Law on Public Enterprises. The latter would create a new corporate status in Ecuador, through public enterprises, that would be treated differently from present-day corporations, in such sensitive areas as labor relations and taxes.

This is partly because the current Government finds it bothersome that enterprises currently providing public services that are State-owned are set up as private companies and are therefore obliged to pay taxes and to share 15% of their profits with their workers.

The intention of forming single enterprises for each strategic sector contradicts Government announcements of the intention to implement anti-monopoly legislation, while creating large State monopolies, which private stakeholders would have difficulty competing and negotiating with.

Illustration 3 POSSIBLE NEW INSTITUTIONAL ARRANGEMENT OF THE ELECTRICAL SECTOR




**Source**: MEER with some adjustments.

### 1.4.2 Political Dependence of these Agencies

Under the sector's new structure, political influence in the different bodies will be much more evident, despite their apparent independence. The experience of what has happened during the current model's ten years of operation shows this. This will become even more evident in the immediate future when the policy implemented by the Government further concentrates power in the different sectors, through the respective ministries.

CONELEC, according to the LRSE, has administrative and financial autonomy, in practical terms has lost that autonomy and must follow the human resource administration and financial management norms set for the entire public sector.

Further, with its Board membership of mostly representatives of the Nation's President, and chaired by the Minister of Electricity, its resolutions will not be totally independent; on the contrary, it is assumed that its resolutions will enforce government policies, particularly in such sensitive aspects as rates and market rules.

Moreover, the intention of the new Electric Law is expected to be to eliminate the Board's corporate spirit, by eliminating participation by workers, chambers of production and the armed forces, with membership limited to government representatives. If that happens, the regulator will have completely lost its autonomy.

CENACE has so far managed to maintain a certain degree of autonomy, although its board comprises mostly representatives of government generation, transmission and

distribution companies, will lose much of its management capacity by becoming a public entity, subject to this sector's norms, which are generally more oriented toward oversight than toward management.

When it becomes a public agency, it will surely change the membership of its Board, with more stakeholders linked to the government. This could also result in political influence in CENACE's decisions. Nevertheless, some defend the CENACE's autonomy since its responsibility for system operation is so weighty and the quality and safety of supply depend on its decisions.

It is to be hoped that this way of thinking gathers momentum and CENACE remains as it is at present.

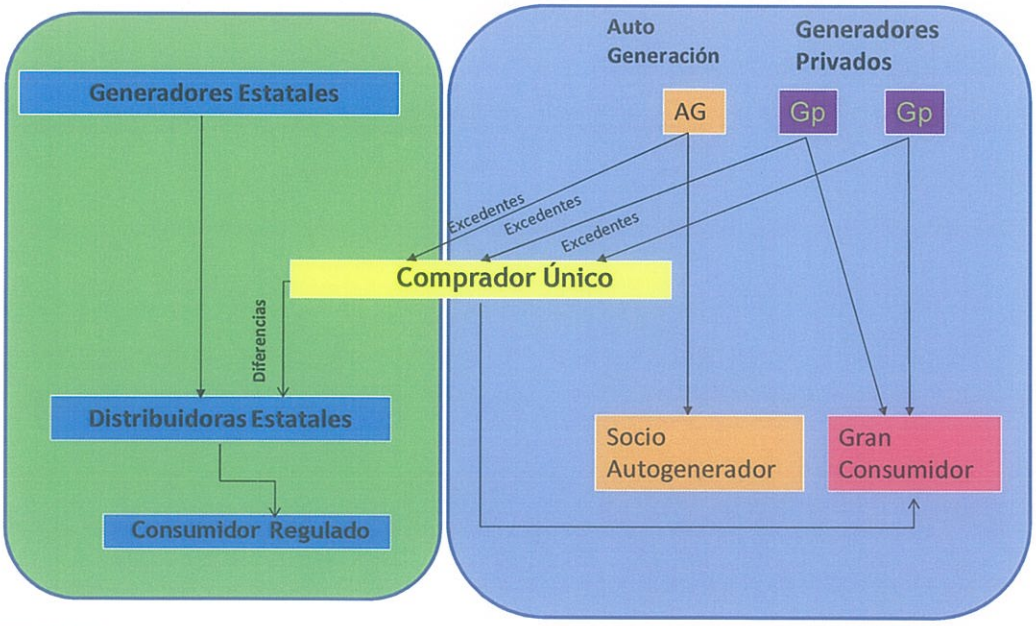
### 1.4.3 Future behavior of the market

Regulatory signs are tending toward the structuring of a market of regulated contracts, with majority shareholding by the State, although there is room for private involvement under arrangements that have not yet been wholly defined.

Rule No. 013/08 issued by CONELEC in November 2008, containing new guidelines for market operation, states that, according to those guidelines, CONELEC will issue a specific regulation governing the contract process for future generation by private capital.

Available information suggests a trend toward establishing an arrangement similar to the Brazilian market, in which the planning authority establishes the generation needed to meet future demand and, on that basis, identifies projects to implement, holding tenders for concessions to construct and operate those projects, under a pricing by auction system.

**Illustration 4 POSSIBLE NEW OPERATION OF THE ELECTRIC MARKET**




**Source**: MEER

The involvement of self-supplying producers selling surplus energy is not clearly defined, but it may be assumed that they will be completely free to sell their surplus through contracts with private large consumers. It seems unlikely for a self-supplier to negotiate contracts with distribution companies, which are expected to be integrated into one big company. Although in legal and regulatory terms it would be allowed, a self-supplier's negotiating capacity would be very small regarding a single large State company.

The spot or short-term market will play a minor role and will be used only to cover shortfalls that arise between contracted power and dispatch, although if the contract uses an ex post liquidation arrangement for all power generated, such differences will be practically nonexistent.

In any event, the regulated contract model features some advantages for private stakeholders, because auctions to hire energy capacity and production that the country will need in the future will entail payment guarantees from the agency conducting such processes.

The lack of a guarantee of payment has been one of the factors that has most prevented new generation stakeholders from emerging during the ten years that the current LRSE has been in force. A guarantee that investors can rely on will reverse this situation.

However, there are other factors that significantly influence decisions to invest private capital, such as legal and regulatory security. If the country maintains its image of disregard for legal norms, political influence in judicial affairs and unstable regulations, private investors can hardly be expected, despite payment guarantees and other regulatory improvements in this direction.

### 1.4.4 The Electrical Sector's Financial Situation

One key issue to consider when analyzing the electrical sector is its financial situation, discussed below.

The sector has experienced progressive deterioration of its finances, with an increasing financial gap resulting from a series of serious deficiencies such as:

- Applying rates lower than real levels determined by studies.
- Rate calculation methodology that does not allow users to pay the actual costs of energy.
- High losses and low collection rates in distributor companies.
- Non-payment culture among some distributor companies.

This all results in a "vicious circle" of debts among the State, distributors, generators, transmitter and the fuel supplier, PETROCOMERCIAL. A large part of the debts, totaling over USD 1 billion, begin and end in the State, so they cancel out and the actual balances are much lower.

This mechanism has narrowed the fiscal gap created by almost ten years of operating under an arrangement that has been unsuited to the local reality and has failed to give good results.

However, many causes of this deficit remain in force. Adjustments in the rate schedule have reduced the gap between the actual rate and the rate charged for end users, but State presence (subsidies and financing expansion) is quite evident.

This system could work adequately, at least for a while, with a financially robust State, but reveals serious weaknesses when State resources are limited. Unfortunately, the country's economic reality changed before all these changes could be implemented, much less yield their first results.
It would be difficult to forecast the sector's future, in view of the great array of uncertainties. Many changes are being made at once, in electric sector structure, institutions, norms, rate schedule and market operation. All these changes, which result in an almost hegemonic State control, within an economic environment that looks complicated if oil prices stay low, make the scenario very complex and difficult.

However, the government is pressing to continue generation projects, seeking international financing. This is not the case for transmission or distribution, which have a harder time getting financing and are the weakest, especially distribution.

Returning to a system of vertical integration – the first steps have been to set up CNEL and CELEC – does not solve the fundamental problems, but tends to increasingly concentrate power with the central government. The inexperience of the staff administering the new companies casts doubt on their outcomes, which must be awaited in order to judge them fairly.

The electrical sector's financial situation, building up a huge debt burden up until a few months ago, is now looking different, with much lower indebtedness. However, this is not because the sector is in a healthier position, but the canceling of debts the State owed itself at different stages of the electric business.

There are expectations regarding the results of implementing the new contract-based market arrangement, and vertical integration of generation, transmission and distribution activities.

## 2. REGULATORY FRAMEWORK

### 2.1 EVOLUTION

The normative structure of Ecuador's electrical sector is based on the National Constitution and the Electric Sector System Law, which have already been broadly described.

On the basis of constitutional precepts and the provisions of the LRSE, an extensive body of norms has been created, comprising:

- Regulations: to apply the Law, prepared by CONELEC, submitted to a process of public consultation and approved by the President of Ecuador through Executive Decrees.

- Rules: norms at a lower level than regulations to implement regulations. They are approved by CONELEC's Board. A system of prior public consultation has recently been implemented, though it is not wholly consolidated yet.

- Resolutions: norms below rules, approved by the Executive Director of CONELEC. They generally involve details of processes to implement rules.

All this normative structure and its hierarchical ordering is known as Kelsen's pyramid.

At this writing, the following regulations are in force, many of them amended repeatedly.

- Regulations on Concessions, Permits and Licenses
- Regulations on Rates
- Regulations for Operation of the Wholesale Electric Market
- Regulations for Dispatch and Operation of the National Interconnected System
- Regulations for Free Access to Transmission and Distribution Systems
- Regulations on Controlling Abuse of Monopolistic Positions in electrical sector activities.
- Regulations on guarantees of payment for contracts to purchase and sell power and energy
- Environmental Regulations for Electrical Activities
- Regulations on Electrical Service Supply
- Regulations for International Electricity Transactions
- Regulations to Administer the Rural and Urban Marginal Electrification Fund (FERUM)

There are a series of complementary rules on specific issues covered by the regulations.

The National Constitutional Assembly, a full-powered body operating in Ecuador during 2008, changed this hierarchy by establishing a series of Mandates that override even the Constitution previously in effect, and many complementary laws and norms.

Mandate No. 15 also introduced amendments in the Electric Sector System Law and in certain regulations, especially the Regulations on Rates and on the Market.

## 2.2 RECENT CHANGES

The most recent changes in norms were made by issuing Rules No.06/08 and 013/08 which introduced changes in the way of calculating rates and the way the market operates, pursuant to Mandate No.15:

The main regulatory changes are as follows:

**Rule No. 06/08 (12 August 2008)**

- Eliminating the marginal costs of generation from rate calculations.
- Setting the Reference Price for Generation on the basis of contract prices.
- Eliminating the component of expansion from transmission and distribution rates.
- Eliminating the item of New Replacement Value for assets in service from rate calculations.
- Establishing a single national rate.
- Government subsidy to cover the differences produced by applying the single rate.
- Regulated contracts to be settled for all the actual production of electrical energy by public generators, to be allocated to all distributor companies in proportion to their actual measured demand.
- Contract prices with a fixed charge relating to availability and a variable charge as a function of production.
- Contracts with a minimum duration of one year; except for generators who use non-conventional renewable energies, for whom the duration must be at least ten years.

**Rule No. 013/08 (27 November 2008)**

- The following types of contracts are defined:
- Regulated term contracts resulting from public tenders and signed between private generators and distributors.
- Regulated term contracts signed between private generators who are operating on the date this Rule is approved, and distributors.
- Regulated term contracts signed between generators owned by the State and distributors.
- Term contracts freely agreed upon between those private generators and large consumers.

- The short-term or secondary market will settle only remnant production by generators that is not committed to the demand through contracts for purchase and sale.
- Regulated contracts must establish two components:
- Fixed charge, for availability regardless of dispatch, calculated on the basis of the investment and fixed costs of administration, operation and maintenance.
- Variable charge or variable production cost, to be determined according to the specific rule, applied to the energy produced.
- Need to renegotiate contracts with existing private generators.
- A specific rule is announced for contracts involving future generation by private capital.

## 2.3 PROSPECTS FOR THE FUTURE

A new Electrical Sector Law is being prepared, which is assumed to include the following changes:

- A new structure for the sector with a Ministry, a Regulatory Agency, a single vertically-integrated Public Enterprise and CENACE.
- Reallocation of responsibilities between the Ministry and CONELEC.
- The Ministry will be responsible for planning and concessions.
- CONELEC will handle regulation and oversight.
- CENACE will become a public agency.
- Rates set on the basis of average costs.
- Expansion financed by the State.
- The Single Buyer is created.
- Private capital participates only in generation.
- Market based on contracts.
- Public tenders for contracts regarding future generation.
- New rules for generation concessions.

Additionally, the Law will establish all changes made through Mandate No.15 and Rules 06/08 and 013/08.

With these changes in the Law, the regulations must be amended or new regulations issued regarding:

- Concessions
- Operation of the Market
- Rate setting
- Environmental Protection
- Anti-monopoly rules
- International Transactions

All the rules must be changed to adjust to this new set of norms. According to information from the CONELEC Directorate of Regulation, regardless of whether a new law is enacted, the following regulatory progress will soon be made:

- A new rule for public processes to purchase future energy.
- A new rule governing energy contracts with self-supplying producers.
- A new rule updating prices for non-conventional renewable energies.
- A new rule to keep independent accounting in each business unit of the companies comprising various activities or resulting from the merger of companies.

The norms and rule will consolidate almost hegemonic State control, in which private stakeholders will have opportunities subject to the conditions established for their involvement. This could be viewed as a negative situation, but may offer better conditions for investors than during the past decade. Of course investment will also depend on the country's political, economic and legal conditions.

## 3. CURRENT AND FUTURE MARKET CONDITIONS

Wanting to make decisions about possible participation as an electrical sector stakeholder, through generation or self-supplying generation, selling surplus, it is fundamental to analyze the environment of Ecuador's electricity market.

### 3.1 HISTORICAL BEHAVIOR OF THE ELECTRIC MARKET

The Wholesale Electric Market in Ecuador resulted from the enactment of the Electric Sector System Law in October 1996 and began implementation in April 1999 as an essential part of the reform, characterized by separating the activities of generation, transmission and distribution, which up to the reform had been concentrated in a single government agency called INECEL.

This reform fit into a worldwide trend, as part of commercial, economic and financial globalization during the 1990s, focusing on opening up public services, including electricity, to private capital.

This market model, implemented in many countries of Latin America and worldwide, abandoned the idea of planning according to the State's strategic aims, moving toward indicative planning, in which the market's "invisible hand" would have the force to foster the appearance of new stakeholders and lead to expansion of efficient, low-cost generation, optimally utilizing energy resources.

The results of this model have not been satisfactory: electric markets in general have not operated as expected and have not yielded the foreseen fruits regarding incorporation of new stakeholders and the massive presence of capital to invest in expansion. This has forced States to take action, implementing reforms to guarantee that the demand is met.

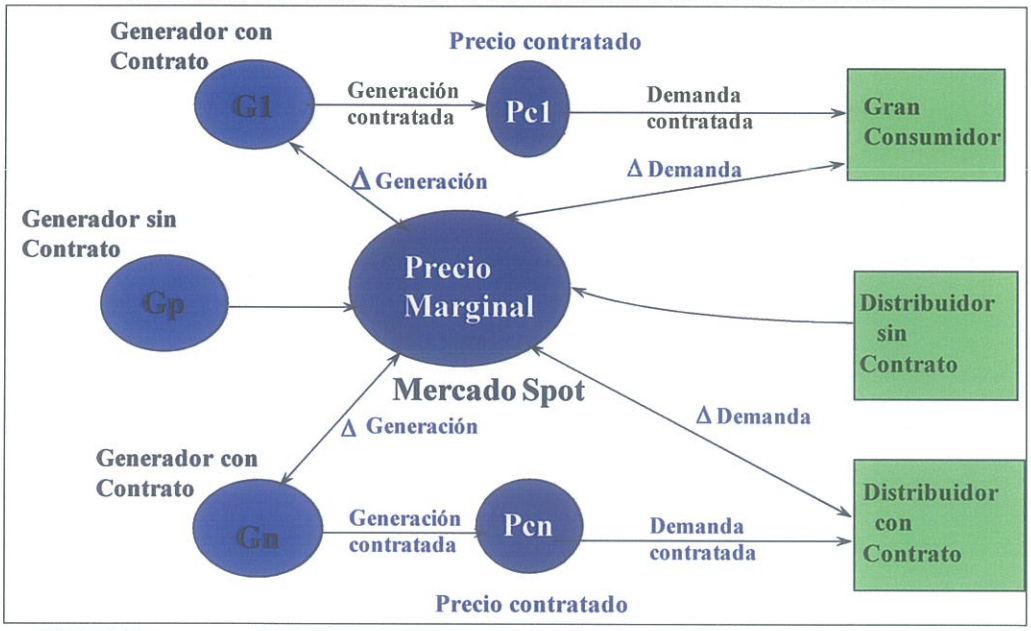
These results have been even more negative for Ecuador, where the failure of privatization has superimposed legislation designed for a scenario of mass private participation, on a reality in which the State has the majority presence in all activities in the sector, for the last decade. The market model never worked in Ecuador because it never had favorable conditions for development, with a financial gap practically from the outset, caused by a rate deficit that soared to unsustainable levels, on top of a longtime legacy of deficient management in most distributor companies.

Ecuador's political instability over the past decade, with a series of government turnovers prior to completing their terms in office, plus unwise appointments of administrators in State-owned enterprises, geared more toward short-term results than sustainable long-term planning, with rates set lower than realistic levels, without any effective compensation by the State – this all drove the electrical sector into a serious crisis that began with finances but spread progressively through quality of service.

This resulted in what the Master Electrification Plan for 2007-2016 called a "vicious circle", with rates too low, debts unpaid, investment programs incomplete and serious inefficiencies affecting users and the sector's stability.

This condition was the cause, among others, for little involvement by any new stakeholders in expanding generation, the only segment left open for private capital, which therefore did not grow to keep up with demand, progressively losing reserves, with fuel prices remaining high despite governmental fuel subsidies.
The following figure shows how the Market operates, to this day:

**Illustration 5 TRANSACTIONS IN THE ELECTRICAL WHOLESALE MARKET**




**Source:** CONELEC

During its period of operation, the MEM built up a major financial deficit, due to poor payment by distributors, since the rates applied were lower than recommended by studies, and due to inefficient, low-productivity administration and management in some of them. This situation has required the sector's agencies as a whole and the national Government to adopt a series of actions, including:

- Distributor companies setting up trusts to ensure equitable flow of funds available among MEM stakeholders;
- Signing term contracts to buy and sell energy, among the Solidarity Fund's generation companies and all distributors incorporated into the SNI.;
- Some distributor companies that had been generating discontinued generation;
- Allocations in the General National Budget recognized the current rate deficit; and
- Several electrical state of emergency declarations nationwide, to ensure continuity in electrical supply, to enable PETROCOMERCIAL to sell fuels on credit to thermoelectric generators operating legally in the country.

This whole situation made it urgently necessary to establish a mechanism to cancel out the many debts that the State owed itself, while implementing profound changes in electrical sector operation, administration and management.

The following figures reflect MEM behavior in 2008:

Total energy purchased in the MEM during 2008 was 15,571.54 GWh, comprising:

- 3,144.32 GWh (20.19%) on the spot market
- 12,427.22 GWh (79.81%) on the contract market.

Billing for energy sale transactions in the MEM totaled USD 897.87 million, comprising:

- 434.14 million dollars (49.71%) for energy purchased on the spot market
- 439.25 million dollars (50.29%) for energy purchased under term contracts.

Billing on the spot market includes: Amounts for sale of energy, power, transmission, market services and distribution fees.

If the total billing is divided by the total billed for energy, the average total price for selling energy on the MEM was USD 0.0561 (5.61 cents) / kWh. And the average price by market type, calculated the same way, yields the following results:

- USD 0.1381 (13.81 cents) / kWh on the spot market (including power); and
- USD 0.0353 (3.53 cents) / kWh on the contract market.

These figures must be handled carefully, because they are really not comparable, since the spot market price includes, in addition to energy, the other charges mentioned above, whereas the price reported for the contract market is exclusively for energy.

Market behavior concerning energy prices exclusively is discussed below in the chapter on Costs and Rates.

Total MEM income for energy exports was USD 2.29 million for 37.53 GWh, and the amount billed for energy imports from Colombia totaled USD 33.90 million dollars for 500.16 GWh.

Energy sales totaled 815.69 million dollars, broken down as follows:

- 393.16 million dollars (48.20%) on the spot market;
- 419.38 million dollars (51.41%) in contracts;
- 3.16 million dollars (0.39%) for exports and in-house consumption.

The average energy sale price in 2008 was USD 0.0495 (4.95 cents) / kWh, comprising:

- USD 0.0937 (9.37 cents) / kWh on the spot market; and
- USD 0.035 (3.5 cents) / kWh in term contracts.

In 2008, maximum National Interconnected System demand at the generation connections (without considering unincorporated systems) happened on Wednesday 17 December at 7:30 p.m. – 2,785.2 MW, representing an increase of 78.9 MW (2.9%) over 2007.

The National Transmission System (S.N.T.) received 14,290.43 GWh and had losses of 4.3%, expressed in terms of energy received. The transmitter billed USD 75.07 million dollars.

The distributor in Guayaquil (CATEG) represented in 2008 26.50% of total energy billing in Ecuador.

Thermoelectric generators used fuels as outlined below:

**Table 1 FUEL CONSUMPTION TO GENERATE ELECTRICITY, 2008**

| COMBUSTIBLE | CANTIDAD | UNIDAD |
|---|---|---|
| Fuel Oil | 191,90 | millones de galones |
| Diesel | 124,63 | millones de galones |
| Nafta | 7,94 | millones de galones |
| Gas Natural | 16.080,31 | millones de pies$^3$ |
| Residuo | 30,75 | millones de galones |
| Crudo | 54,99 | millones de galones |
| Bagazo de Caña. | 0,99 | millones de ton. |
| Gas Licuado de Petróleo | 8,58 | millones de galones |

Incluye los combustibles usados por los Autogeneradores

**Source**: Data, CONELEC, organized by the authors

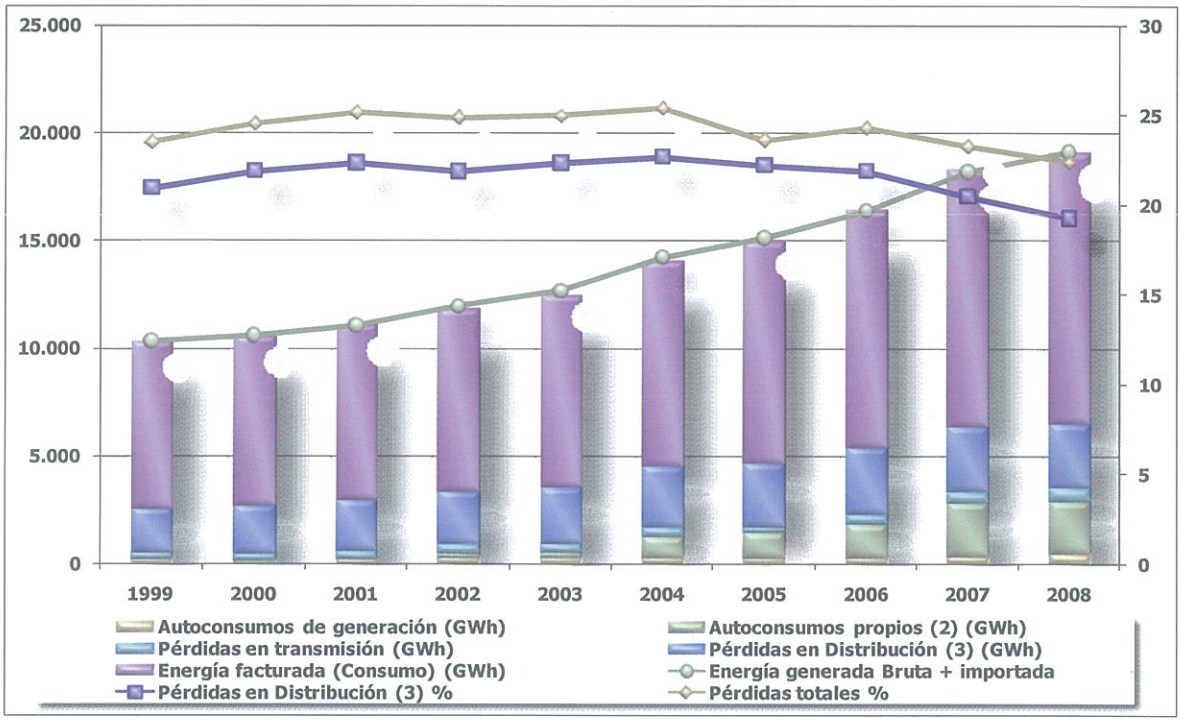
Gross energy in 1999 was 10,332 GWh, but had reached 19,108.69 GWh, that is, an 84.95 % in the last ten years. This is the equivalent of an annual average growth rate 8.5 %.
For 2008 the following figures may be highlighted:

- Gross energy produced and imported, measured at the generation connectors (S.N.I. + Non- Incorporated + Self-supplying producers who reported) was 19,108.69 GWh;
- Self-supplier generation totaled 311.17 GWh;
- Total energy losses have remained very high, but lower than the previous year, reaching 23.03% of net energy generated;
- Transmission losses were 624.54 GWh;
- Energy available at distribution substations (for Regulated Customers and non-regulated) was 15,562.69 GWh;
- Distribution losses versus energy available at delivery terminals were 2,993.95 GWh (19.24%), 1,421.06 GWh (9.13%) technical and 1,572.89 GWh (10.11%) non-technical or commercial; and

- Energy billed to users, both Regulated (customers of distributor companies with rates approved by CONELEC), and Non-Regulated, totaled 12,568.74 GWh, considering in-house consumption by self-supplying producers.

Illustration 6 shows the evolution of energy produced and imported, as well as losses, in the last 10 years.

**Illustration 6 BALANCE OF ELECTRICAL ENERGY PRODUCTION, TRANSMISSION, DISTRIBUTION AND LOSSES DURING THE 1999 - 2008 PERIOD**




**Source**: CONELEC

## 3.2 CURRENT SITUATION OF THE ELECTRIC MARKET

When the clearly socialistic government presided by economist Rafael Correa took office (January 2007), new, far-reaching changes in State management began to emerge, and the electrical sector has been no exception.

The electrical sector is undergoing major changes to return to a vertically integrated model, with much more direct State participation. In addition to the ideological essence underlying decisions, the failure of the market model (a reality that would be hard to conceal), provides excellent justification for those driving such changes.

Implementing a new role for the State called for a new Constitution, so a Constitutional Assembly was elected and drafted a new Constitution, which went into effect on 20 October 2008. This Assembly, legitimized by national elections, granted itself the power to legislate in major aspects of governance, through Mandates.

So, on 23 July 2008, the Constitutional Assembly gathered in the "Ciudad Alfaro" Civic Center in the canton of Montecristi, approved Constitutional Mandate No. 15,

establishing great changes in electrical sector management, particularly rates, ordering CONELEC to approve new rate schedules with a single blanket rate nationwide for each type of consumption, setting certain guidelines, including: eliminating the item of marginal costs and eliminating the component of investment in expansion from distribution and transmission costs, determining that the resources required to cover investments in generation, transmission and distribution will be provided by the State and must be included in the General National Budget.
At this time, the market remains practically in the same conditions as last year, with a major presence of contracts and with transactions on the spot market. Nevertheless, the process has begun to negotiate new contracts between State-owned generators and distributor companies. According to Rule 013/08 issued by CONELEC, generators are obliged to sign contracts with all distributor companies, under the same pricing conditions for each, allocating all its production according to each company's demand. Each generator will set the price as a function of its cost structure.

Prices of contracts will be set with a fixed component, calculated on the basis of investment plus fixed operating and maintenance costs, which will be paid for availability, regardless of dispatch. A charge will be added equivalent to the variable production cost, and paid as a function of the energy generated.

Negotiations are about to begin for new contracts between distributor companies and private generators, according to the same arrangement.

It has been heard that there are other opinions within the government, with a different idea regarding the price structure for contracts, to try to encourage efficiency for future generation. However, no documentary evidence has been found in this regard. Until such ideas take shape in a rule, they cannot be put into practice.

For the purpose of negotiating contracts with private generators at this time, according to research conducted, it is calculated that the Weighted Average Cost of Capital (WACC) is about 12%, judging by the following criteria:

- Equity / debt ratio of 30/70
- Fiscal shield t = 36.25%
- Beta = 1
- Cost of own capital = on the order of 24%
- Cost of debt = on the order of 9%

In this regard, the discount rate established for the electrical sector since 1999 is 11.2%, which was calculated as the WACC by a consultancy responsible for designing rates. For the purposes of rate calculation, this rate has been used only to calculate remuneration for power to generators. For transmission and distribution, lower rates have been used, on the order of 7%.

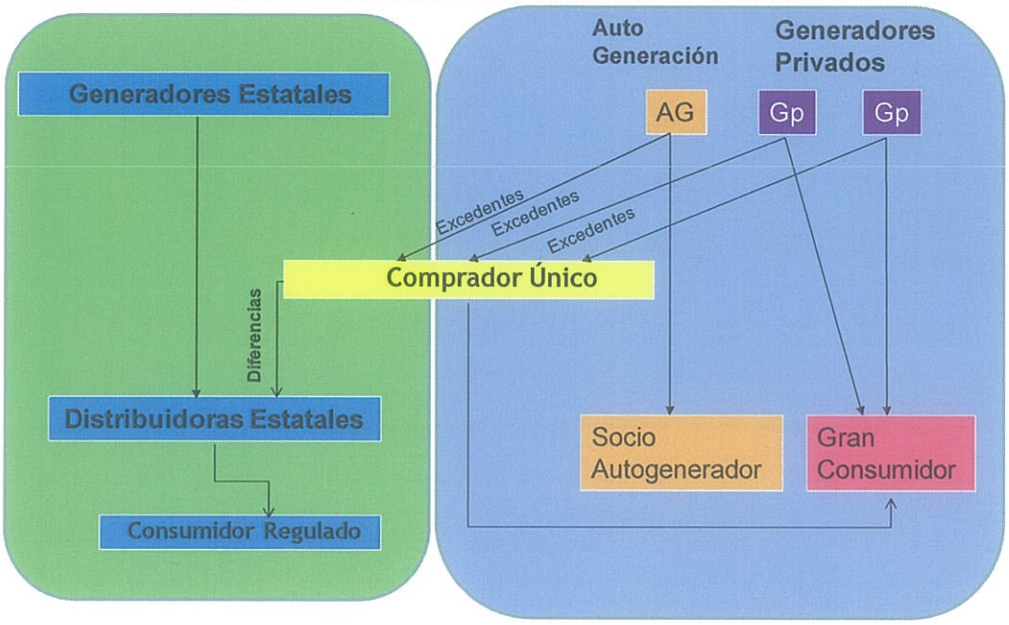
As a result of contract processes that have begun, it is expected that over 90% of the energy will be committed through contracts, leaving only a few leftovers to be liquidated at spot market prices, resulting from dispatch at minimum cost.

## 3.3 FUTURE PROSPECTS

Constitutional Mandate No. 15 issued by the Constitutional Assembly meant a change in market operational guidelines. CONELEC has issued Regulations No. 006/08 and 013/08, which set the new rules for this purpose, emphasizing long-term contracts, substantially reducing short-term energy market transactions, which will tend to disappear.

The following figure shows how the new Market model may be structured:

**Illustration 7 POSSIBLE FUTURE OPERATION OF THE MARKET**




This model, which could be called a Regulated Contracting Model, is based on the premise of recognizing generating costs (fixed and variable), for both private-capital generators and those with public or governmental ownership. Contract prices are set on the basis of an individualized analysis of costs, which in the case of public generators will be regulated by CONELEC, whereas for contracts with private generators they will be subject to individualized negotiation with each stakeholder.

It is assumed that the contract arrangement currently being put in place will remain in effect and will be formalized in the future through the new Law of the Electrical Sector. Prices for new contracts signed as a result of public processes will be maintained, with two components:

- A fixed component, regardless of dispatch, payable as a function of the capacity available, which will be audited by the operator.
- A variable component, payable as a function of variable production costs and the energy generated and delivered to the market.

The fixed component will be calculated as the sum of:

- Annual investment calculated on the basis of the following parameters:

- Investment: according to the type of technology (pass-through hydroelectric, hydroelectric with a dam, turbo steam, gas-fired turbine, etc.).
- Useful lifetime: according to the amounts set by CONELEC in rate studies.
- Discount Rate, from calculating the Weighted Average Cost of Capital (WACC)

- Fixed costs of administration, operation and maintenance: calculated in USD / kW installed, for each type of technology.

In practice, and according to the information provided by stakeholders involved in the process, new contracts are being negotiated on the basis of two basic parameters:

- Investment
- Discount Rate

Other parameters in the economic equation are defined and will not be subject to negotiation or at least to a lesser degree.

A quick analysis of this new model reveals a number of aspects that are highly favorable for new investment in generation. On the one hand, setting energy prices to make it possible to recover the investment, and on the other hand, the existence of a guarantee of payment by the State. If these two basic aspects are fulfilled according to the rule, this will give positive signals for investment.

Under the conditions prevailing in Ecuador when the reforms were made, this issue was not too important, because there was the expectation of sufficient State resources to finance the entire expansion plan, especially for generation. Now this situation has shifted, and State resources are insufficient, public contracts to attract private capital wanting to invest in generation, is very important.

Moreover, the creation of CELEC and CNEL changes the distribution of market forces, because CELEC concentrates practically all State-owned generation, with the exception of Hidropastaza and Hidronación, and because CNEL – which merged 10 distributor companies, is also a significant new player, with great negotiating capacity in dealing with private generators.

To date, no norms have been issued regarding mechanisms to be used for public tenders for new generation contracts in the future. It is known that CONELEC is preparing the respective rule to start these processes.

A new rule is also being prepared to deal with surplus energy, to be delivered to the market by self-supplying producers. Regarding this issue, no decisions have been made yet.

In conclusion, although changes will become evident with a new Law and a new underlying rule, the direction the market is going through the latest rules clearly suggests future trends, at least in the short and medium term.

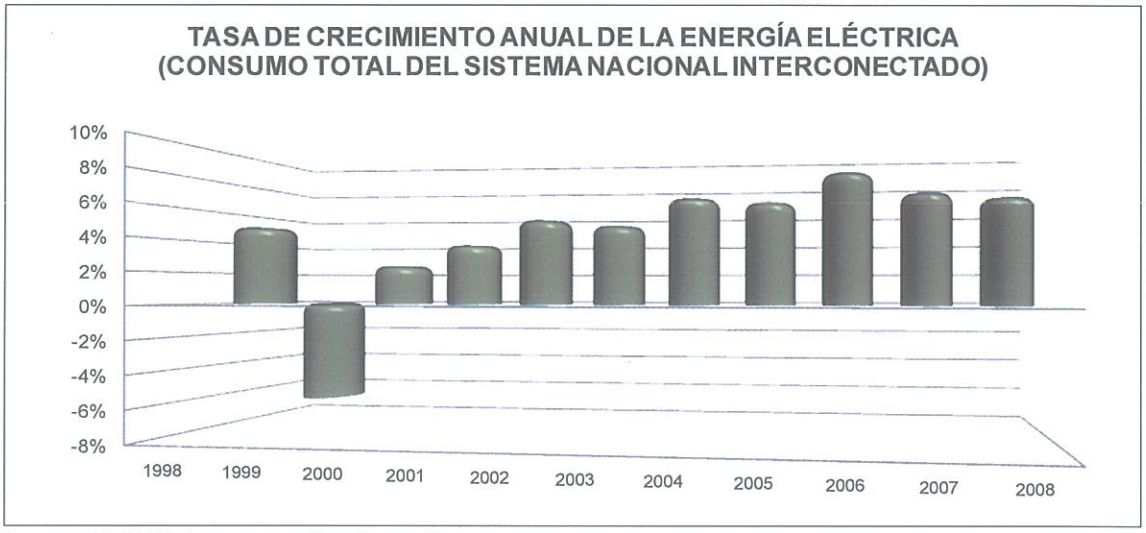
## 4. BEHAVIOR OF DEMAND

### 4.1 HISTORICAL EVOLUTION (10 YEARS)

Ecuador's electrical market has evolved in terms of demand for energy and power, with sustained growth over the last seven years.

The percentages at the delivery substation terminals have been as follows:

**Illustration 8 ANNUAL GROWTH RATE OF ELECTRIC POWER**




**Source:** CONELEC, organized by the authors

The country's stable macro-economic situation in the last few years has made it easier methodologically to forecast electric demand. Still, the information provided to the regulatory body by electric companies is important, since the realities faced by each of them varies significantly and since their closeness to and knowledge of the market in their concession area makes them better prepared (or at least they should be) to foresee their future needs for electrical energy and power, both overall and geographically.

In 1999 the country's economic difficulties caused uncertainty in forecasting demand, and it was judged necessary to more closely monitor the patterns of behavior in macroeconomic variables and their respective indicators, to introduce, through demand studies, the corresponding adjustments in forecasts.

The evolution of national macroeconomic indicators published by the Central Bank of Ecuador shows annual growth in the GDP at the following percentage rates.

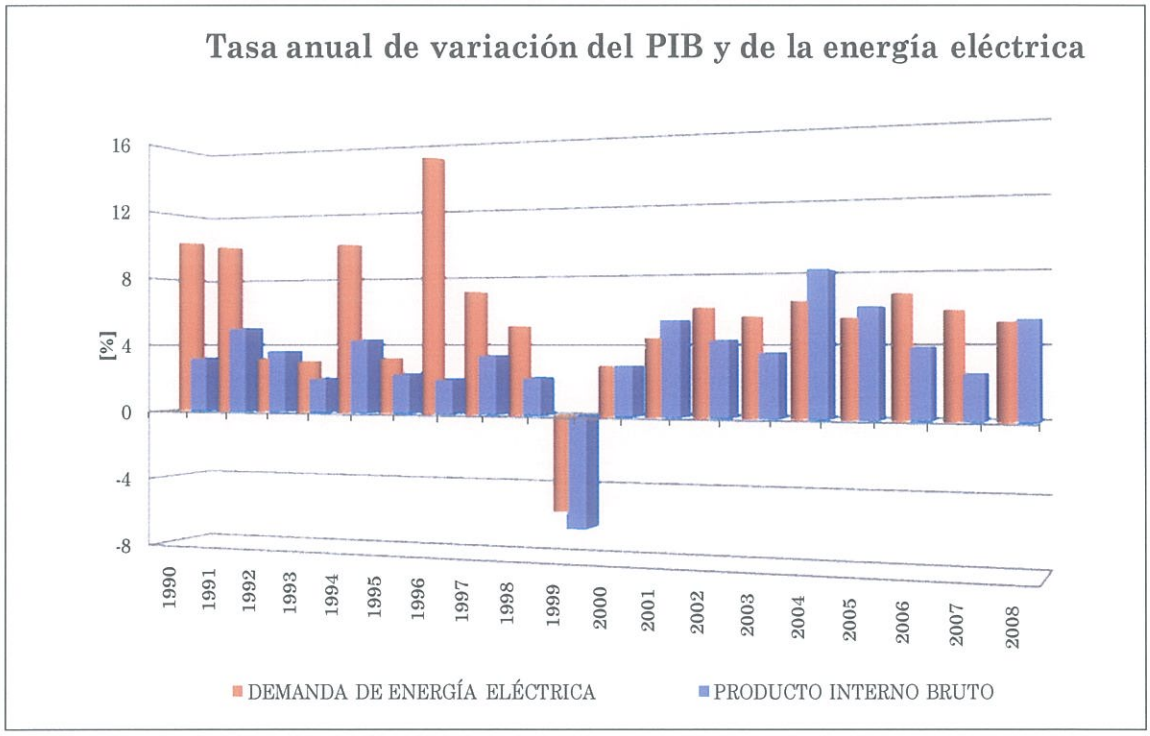
Table 2 Annual variation in GDP

| AÑO | Porcentaje |
|---|---|
| 1998 | 2,10% |
| 1999 | -6,30% |
| 2000 | 2,80% |
| 2001 | 5,30% |
| 2002 | 4,20% |
| 2003 | 3,60% |
| 2004 | 8,00% |
| 2005 | 6,00% |
| 2006 | 3,90% |
| 2007 | 2,50% |
| 2008 | 5,30% |

Primarily due to variations in electricity pricing, the prosperity of electrical demand in Ecuador has behaved differently during the past decade than growth in the GDP. Above all from 1994 to 1997, the decreasing rate, in terms of constant currency values, caused a high growth in demand, apparently distorting the correlation between evolution of electrical energy and the country's economy.

A comparison of these growth percentages, since 1990, is shown in Illustration 9:

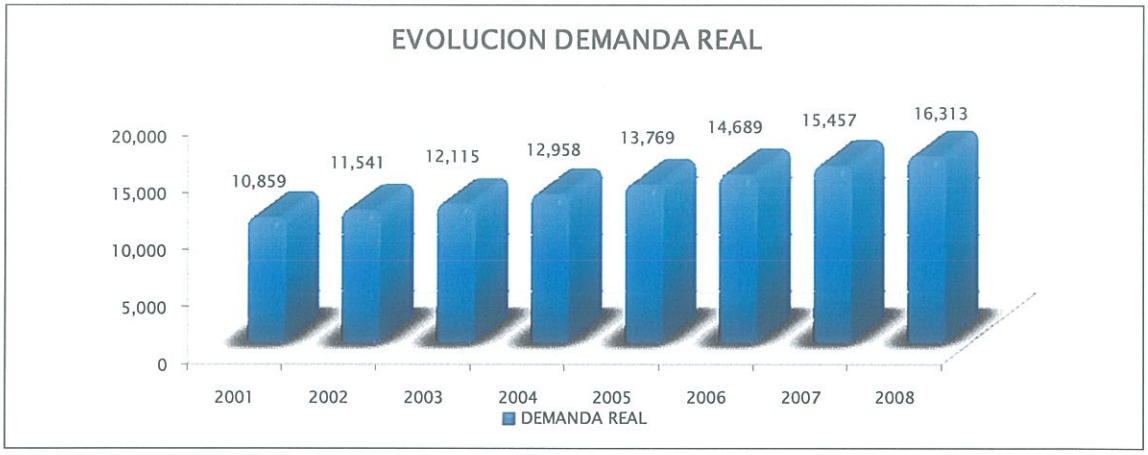
Illustration 9 ANNUAL RATE OF CHANGE IN GDP AND ELECTRICITY




**Source**: Data, CONELEC, organized by the authors

Clearly, although electricity and the economy have grown through most annual periods, the years when electrical demand grows substantially faster than the GDP are the years when electric prices have been lowest.

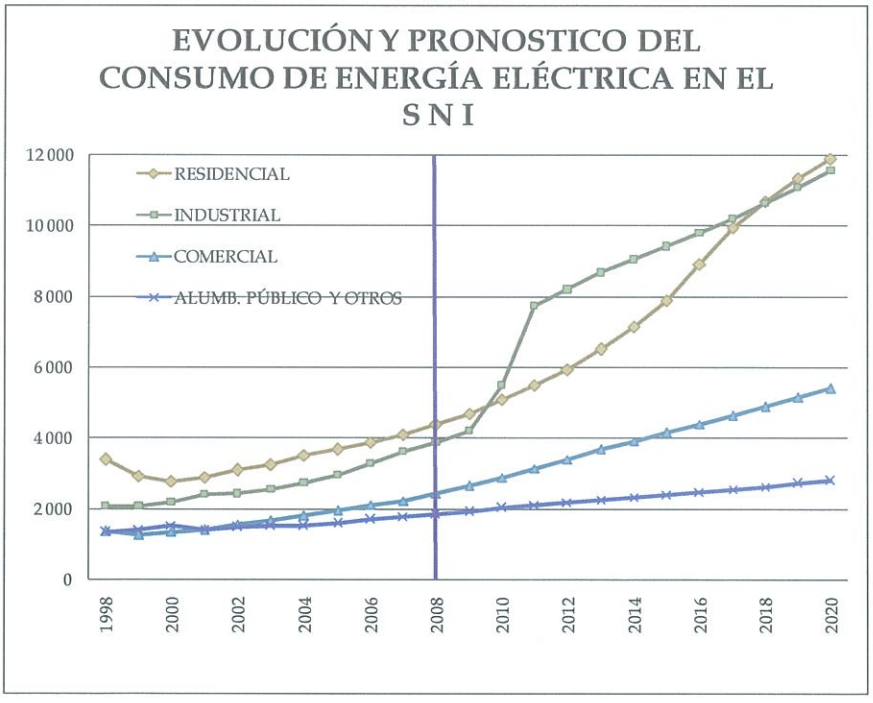
**Illustration 10 REAL DEMAND DEVELOPMENTS**




## 4.2 DEMAND BY TYPES OF USERS

Demand by all user types has grown since 1998. An analysis of the data forecast this behavior to continue until 2020. Historical and forecast trends are shown below:

**Illustration 11 EVOLUTION AND PROGNOSIS OF ELECTRIC ENERGY CONSUMPTION IN THE SNI**




2001:

During 2001, the country's economy grew faster than electrical energy. This lower growth of demand is primary due to low growth in consumption of commercial and industrial electricity. The residential sector reversed its decreasing trend from the two previous years, 1999 and 2000.

2002:

This year, the trend from the previous year in residential sector consumption was reaffirmed in a high annual growth (7%), just as commercial consumption increased even more by 11.2% over the previous year. Industrial consumption grew by 5.1%. This behavior of the load justified a 5.9% total annual growth.

2003:

This year had a significant decrease in industrial consumption, which grew only 2.9%, unlike the residential and commercial segments, which increased by 5.5% and 6.6%, respectively. The increase in total energy consumption was 4.6%, without considering energy exports to Colombia.

2004:

Commercial consumption rose to 9% growth, while residential grew at 8.3%. That year electrical consumption and the economy grew at about the same rates, 6.6% and 6.9% respectively. The March 2003 decree reducing electricity rates by 5% may have encouraged greater consumption.

2005:

The overall behavior of electrical energy consumption stayed about the same, at 6.5%; however, the economy grew at 3.3%, increasing the percentage difference between these two variables.

2006:

This year SIN demand grew (at substation terminals that deliver to distribution systems) by about 6.7% over the previous year, compared to a forecast of 6.2%. This growth does not include exports to Colombia, namely 35 GWh in 2004, 16 GWh in 2005 and 1.1 GWh in 2006.

2007 and 2008:

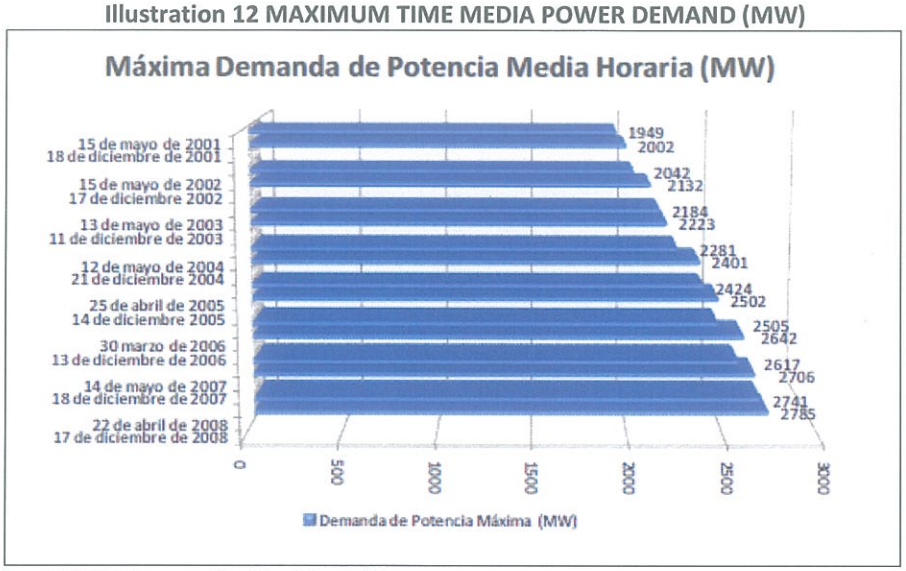
Growth of demand for electricity has remained high, over 5%, although with a decreasing trend, partly due to replacement of incandescent light bulbs by energy-saving compact fluorescents, implemented by distributors under programming and leadership by the Ministry of Electricity and Renewable Energy. As for the relationship with growth of the economy, this has stayed lower than electricity's growth.

### 4.3 PEAK DEMAND

The figures show behavior since 2001 of peak power recorded in the first and second halves of each year, with the second six months showing a higher peak recurrently.

The peak hourly power demand regularly occurs in May and December, but there are different years, e.g., 2005, 2006 and 2008, which had some months different for this indicator in the first half of the year.

Illustration 12 MAXIMUM TIME MEDIA POWER DEMAND (MW)




**Source**: Data, CONELEC, organized by the authors

Annual energy growth rates, according to the updated forecast by CONELEC, vary especially in 2007 and 2008 compared to the previous forecast, as a consequence of the country's economic assumptions for those years and an appraisal of this economic growth, primarily.

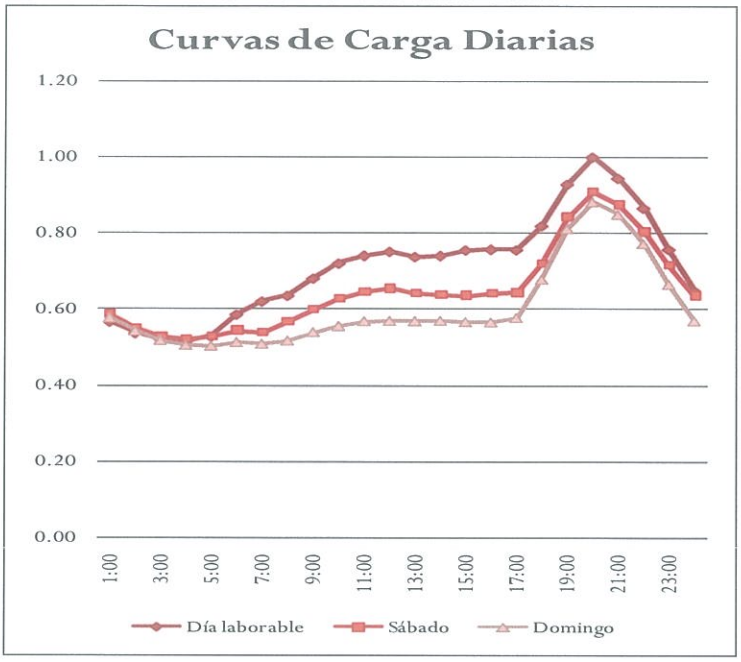
Concretely, the trends shown are expected to continue with an economic and social reactivation of the country during 2008 - 2009 so growth in demand for both power and energy must also follow that growth.

One rate policy promoted to encourage industrial use of electrical energy is to incorporate an hourly differentiation in consumption so that users can reduce their bills by improving their utilization factor.

To restore trust in the new economic situation, slow contraction of economic activity and lay the foundations for renewed growth with a social face, the national Government is carrying out a broad reform program for the electrical sector, among other mechanisms by encouraging long-term investments in hydroelectric generation to supplant inefficient thermoelectric generation, which has increased end user rates, and decrease the costs of inputs for construction and operation of new hydropower plants, such as import duties on capital goods, value-added tax (VAT) and income tax on new investments, so these costs will not be transferred to end users' bills.

The load curves are shown below for the SNI on a work day, a semi-workday (Saturday) and a holiday (Sunday). Power is expressed per unit (p.u.) of the workday peak.

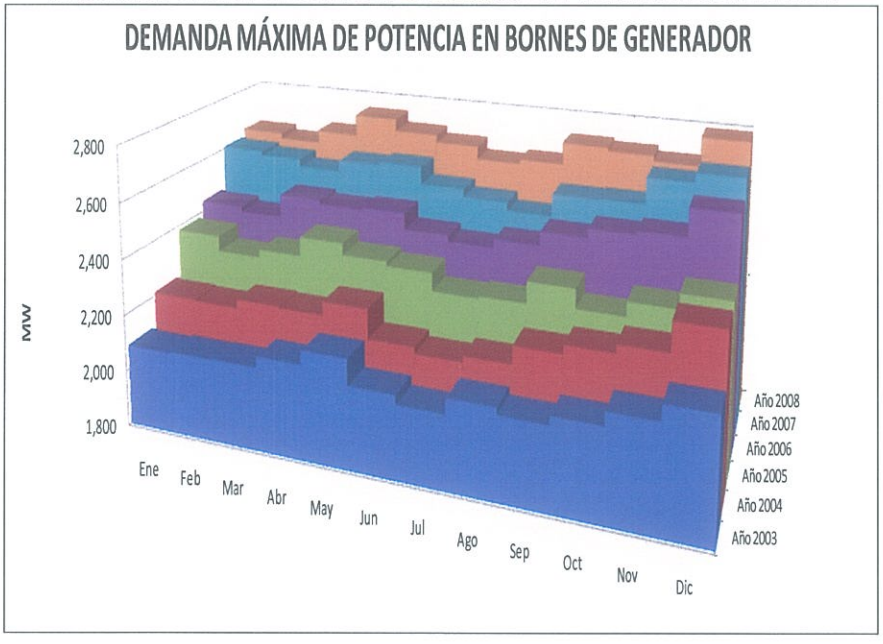
Illustration 13 DAILY LOAD CURVE




## 4.4 PROJECTING THE DEMAND

CONELEC determines demand at generator terminals by adding the amounts at the terminal level in the main substation, the in-house consumption of generator plants, and losses in the transmission system.

Illustration 14 MAXIMUM POWER DEMAND IN TERMINAL GENERATOR

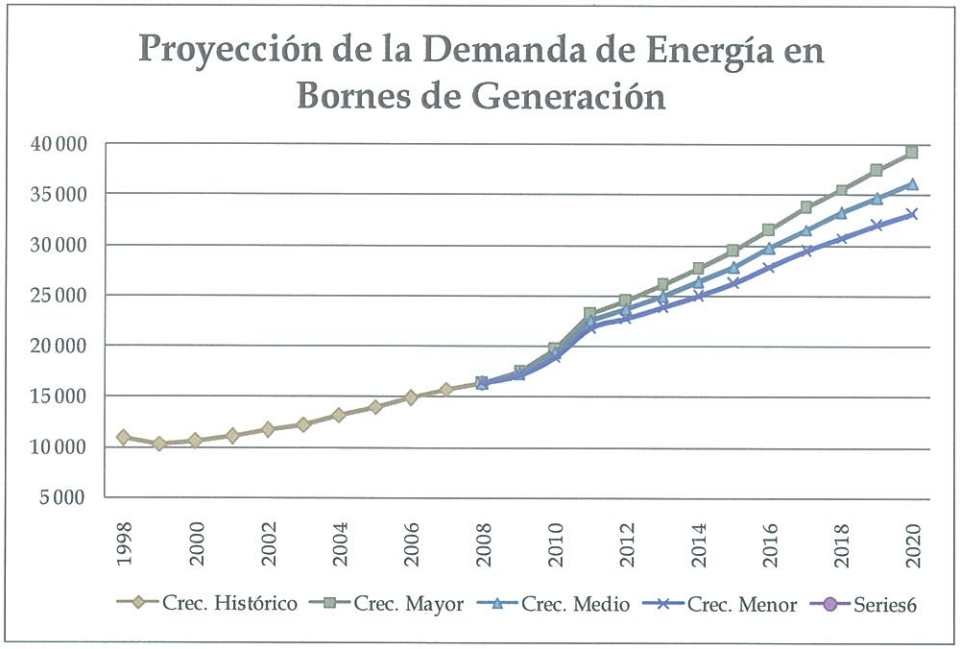



Forecasts of peak active power and active energy at the generation delivery terminals for the National Interconnected System, for the three growth scenarios analyzed and for ten years, used for the Electrification Master Plan, are shown in the following chart:

Table 3PROJECTION OF DEMAND GENERATOR IN TERMINALS

| PROYECCIÓN DE DEMANDA EN BORNES DE GENERADOR | | | | | | |
|---|---|---|---|---|---|---|
| AÑO | DEMANDA DE POTENCIA (MW) | | | DEMANDA DE ENERGÍA (GWh) | | |
| | MENOR | MEDIO | MAYOR | MENOR | MEDIO | MAYOR |
| 2009 | 2 897 | 2 923 | 2 946 | 17 074 | 17 234 | 17 392 |
| 2010 | 3 160 | 3 206 | 3 253 | 18 901 | 19 321 | 19 696 |
| 2011 | 3 567 | 3 659 | 3 751 | 21 795 | 22 550 | 23 246 |
| 2012 | 3 706 | 3 830 | 3 952 | 22 698 | 23 647 | 24 531 |
| 2013 | 3 885 | 4 041 | 4 196 | 23 840 | 24 991 | 26 079 |
| 2014 | 4 069 | 4 260 | 4 451 | 25 008 | 26 378 | 27 689 |
| 2015 | 4 268 | 4 497 | 4 726 | 26 264 | 27 870 | 29 422 |
| 2016 | 4 531 | 4 800 | 5 071 | 27 900 | 29 760 | 31 572 |
| 2017 | 4 787 | 5 100 | 5 415 | 29 498 | 31 633 | 33 725 |
| 2018 | 4 995 | 5 355 | 5 718 | 30 811 | 33 241 | 35 634 |
| 2019 | 5 182 | 5 591 | 6 006 | 31 997 | 34 745 | 37 462 |
| 2020 | 5 356 | 5 819 | 6 289 | 33 110 | 36 197 | 39 262 |
| Crecimiento 2009-2020 | 5.7% | 6.5% | 7.1% | 6.2% | 7.0% | 7.7% |

Illustration 15 PROJECTION OF ENERGY DEMAND GENERATOR TERMINALS




## 5. ANALYSIS OF THE ENERGY SUPPLY

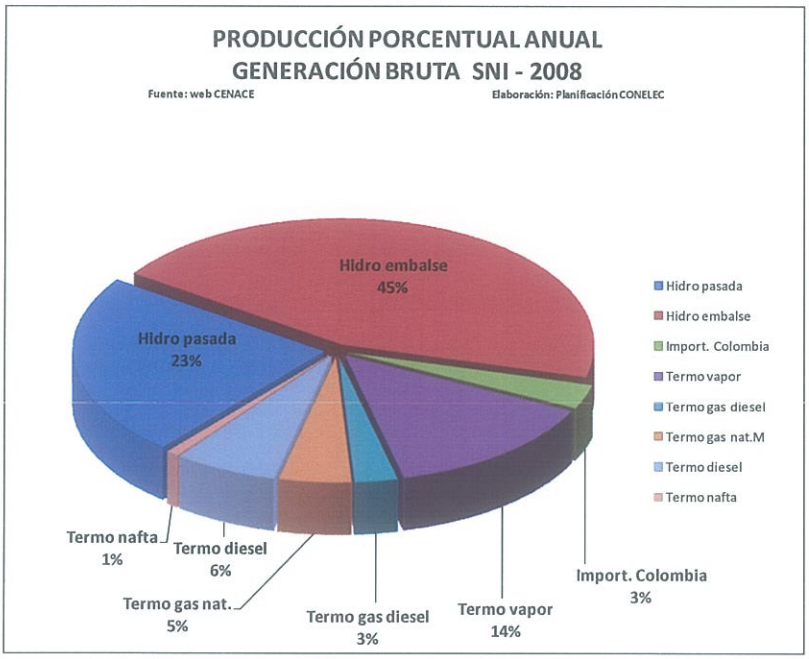
The energy supply to date has been 4500 MW of installed power and on the basis of analyses to expand generation projects have been classed as candidates and fixed, understanding that the fixed projects are those promoted by the government.

### 5.1 CURRENT SITUATION

Ecuador's situation regarding electrical supply calls for careful analysis, because despite the country's high availability of hydropower, over the past decade

hydroelectric generation has waned, from covering 55% of the demand, to 48%, maintaining a high component of thermoelectric generation (about 40%) and dependence on energy imported from Colombia (about 12%).

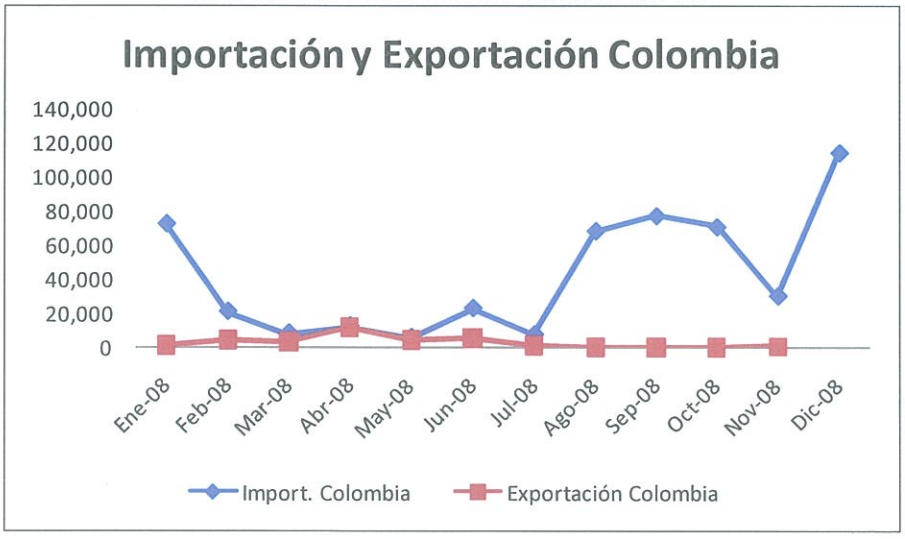
**Illustration 16 COMPOSITION OF GENERATION**




2008 was a good year for hydropower, taking full advantage of hydropower plants. Additionally the operation of the San Francisco power station contributed to hydro generation.

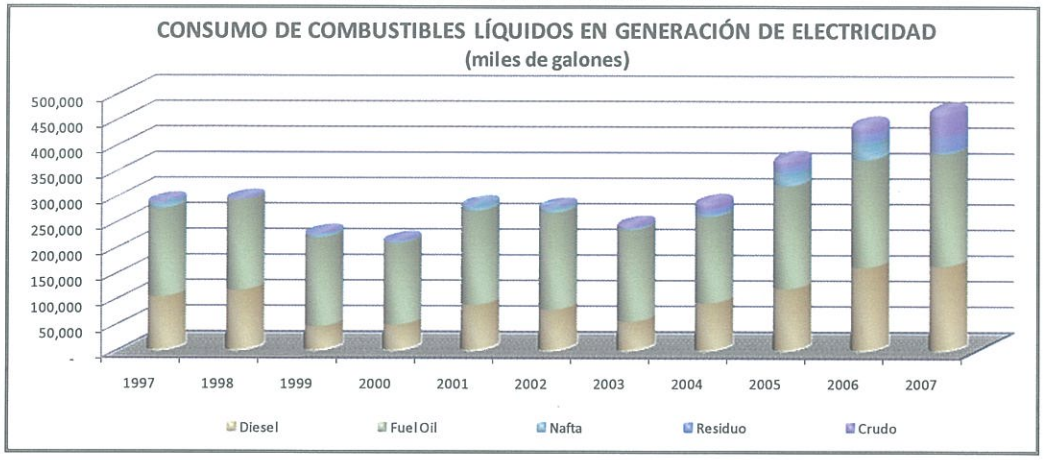
This reduced energy imports from Colombia although they have picked back up in the last few months.

**Illustration 17 COLOMBIA IMPORT AND EXPORT**




Consumption of liquid fuels continues to rise, especially for diesel and fuel oil.

Illustration 18 FUEL CONSUMPTION




With this panorama the government has attempted to address generation capacity by structuring and implementing a short-, medium- and long-term plan to build large, medium and small hydropower projects, and to install efficient thermoelectric generation, and use renewable energy sources, which will cover overall future demand.

Developing all this infrastructure will result in a market of free competition, naturally reducing energy prices, providing better living conditions for the people by the development that drives rates down and by supporting production sector competitiveness nationally and internationally by cutting costs.

To achieve these goals, reforms have been implemented, starting with Mandate No.15 issued by the Constitutional Assembly on 23 July 2008.

This Mandate sets the guidelines for several substantial changes in electrical sector management, starting with rates by instructing CONELEC to approve new rate schedules with a single blanket rate nationwide for each type of consumption, and eliminating the item of marginal costs, eliminating the 10% charge for FERUM, and eliminating the component for investment in structural expansion from distribution and transmission costs, also determining that resources required to cover investments in generation, transmission and distribution, will be covered by the State and making it mandatory to include them in the General State Budget.

However, the world economic situation has affected Ecuador's economy and the implementation of these changes, since our trade balance is highly dependent on petroleum.

Despite this situation the Government has taken a series of measures to counteract this worldwide effect, reinforced by the importance of these projects and the development they will mean for the country, seeking alternative funding sources to make them viable.

Just overcoming financing barriers will not solve short- and medium-term generation needs driven by economic growth, and hydropower projects take quite a long time, so

a short- and medium-term thermoelectric generation plan is needed, to cover a sustained growth in demand and the need to ensure domestic supply without depending on imports that may not be stable enough.

## 5.2 PROJECTS BEING DEVELOPED

### 5.2.1 Hydropower stations

- MAZAR (160 MW)

This project will provide average energy of approximately 800 GWh / year, reinforcing the generation by the 1100 MW Paute–Molino Plant downriver, and will catch much of the sediment currently reaching that plant's reservoir.

Status: The project is in its final stage of construction, with 88% progress in physical facilities.
Estimated Operation Date: April 2010
Financing: Public Funds.

- BABA (42 MW)

The average energy that this project will deliver is approximately 161 GWh / year. Through a transfer to the Daule Peripa dam, it will increase generation by the Marcel Laniado de Wind plant, currently in operation, by 441 GWh / year.

Status: In construction with 60% completed.
Estimated Operation Date: October 2010
Financing: Public Funds.

- OCAÑA (26 MW)

The average energy that this project will provide is approximately 208 GWh / year.

Status: Preliminary facilities under construction, with 2.4% done so far.
Estimated Operation Date: 2012.
Financing: Public Funds.

- TOACHI PILATÓN (228 MW)

The project comes under the government policy of reducing thermoelectric generation fired by fossil fuels subsidized by the State. Being on the western slope, the project has the advantage of being able to produce peak energy during the months when the Paute and Agoyán hydropower plants, on the eastern slopes, have their dry season.

Status: construction of access roads and preliminary facilities.
Estimated Operation Date: The first units by October 2013
Financing: Public Funds.

- SOPLADORA (487 MW)

This project is currently in the study phase to prepare a final design, to decide on a power increase between 400 and 580 MW, possibly 487 MW.

Status: construction of access roads and preliminary facilities.
Estimated Operation Date: 2014
Financing: Public Funds.

- COCA-CODO SINCLAIR (1500 MW)

This project is considered a priority for the nation's interests, to cover the demand for power and energy in coming years and even generate for export.

Status: Studies being arranged for. Construction of access roads and preliminary facilities.
Estimated Operation Date: 2015
Financing: Public Funds.

- CHORRILLOS (4 MW)

It will deliver approximately 21 GWh / year, with a contractual deadline to operate by July 2007.

Status: Construction is currently at a standstill due to lack of resources.
Estimated Operation Date: Not definite.
Financing: Public Funds.

- SAN JOSÉ DE MINAS (6 MW)

The San José de Minas S.A. company has signed a contract with CONELEC to be a self-supplying generator.

Status: The project is under construction.
Estimated Operation Date: 2011
Financing: Private Funding.

- APAQUÍ

The Current Energy of Ecuador S.A. company signed a contract in January 2007 to implement the Apaquí 36 MW (2 Pelton units) hydropower project, which had been studied by the former INECEL. It will increase power by 45 MW.
Status: Construction of preliminary facilities has begun (3.5% progress) but is currently at a standstill.
Estimated Operation Date: Not definite.
Financing: Private Funding.

- HIDROTAMBO (7.6 MW)

This project could produce an average of 50 GWh / year of energy.

Status: Currently 25% progress in construction. Not advancing due to opposition from the community of San Pablo de Amagalí.
Estimated Operation Date: 2012 (unsure)
Financing: Private Funding

- SIGCHOS (17.4 MW)

Annual average production 125 GWh.

Status: Preliminary facilities have been built. Construction suspended.
Estimated Operation Date: 2012.
Financing: Private Funding.

- PILALÓ (9.3 MW).

Status: Preliminary facilities have begun construction but work is now suspended due to the opposition of the communities of Pujilí and La Maná.
Estimated Operation Date: 2013
Financing: Private Funding.

- ANGAMARCA (75 MW).

Status: Preliminary facilities (camp and improvement of access roads) under construction. Construction suspended, to redesign the project to avoid affecting the archaeological zone.
Estimated Operation Date: 2014
Financing: Private Funding.

- MINAS (273 MW) and LA UNIÓN (80 MW).

The Enerjubones S.A. company (Shareholders: Provincial Government of Azuay and Autonomous Government of El Oro). The Minas and La Unión hydropower projects are located on the Pacific slopes, with hydrology that is relatively complementary regarding the generation plants in the Amazon basin; this makes them very attractive.

The projects were originally approved for funding from the Ecuadorian Fund for Investment in the Energy and Hydrocarbon Sectors (FEISEH).

Status: processing contracts for studies to make the final design.
Estimated Operation Date: 2014
Financing: Public Funds for design. Not defined for construction.

- CHESPÍ (250 MW).

Hidro Equinoccio HEQ S.A. Company (Shareholder: Honorable Provincial Council of Pichincha).
The project, originally planned to generate 167 MW of power and an annual average energy of 979 GWh, belongs to the Hydrographic System of the Esmeraldas River, sub-basin of the Guayllabamba River. The facilities are located in the province of Pichincha, canton of Quito, some 40 km from the capital, between the towns of Calacalí and San José de Minas. The updated study forecasts a generating capacity of 250 MW of power.

Status: Hidro Equinoccio HEQ S.A. is arranging for studies up to final design.
Estimated Operation Date: Not definite.
Financing: Public Funds for studies. Not defined for construction.

- VILLADORA (350 MW) and CHONTAL (150 MW).

Hidro Equinoccio HEQ S.A. Company (Shareholder: Honorable Provincial Council of Pichincha).
Originally conceived with 270 MW for Villadora and 72 MW for Chontal.

Status: Studies being arranged for.
Estimated Operation Date: Not definite
Financing: Public Funds for studies. Not defined for construction.

- TOPO (22.8 MW).

The Pemaf S.A. company must get the 22.8 MW Topo power plant into operation, which will generate an annual average of 164 GWh.

Status: completing the documentation required prior to beginning construction.
Estimated Operation Date: 2013
Financing: Private Funding.

- VICTORIA (10 MW).

Hidrovictoria S.A. signed a permit contract to build a 10 MW hydropower plant in Quijos, which can generate some 64 GWh / year. This self-supplying generator expects to sell all its production to its shareholders.

Status: Construction has not begun yet due to lack of financing.
Estimated Operation Date: 2013.
Financing: Private Funding.

- Río Luis (15.5 MW)

Status: With certificate provided to ENERGYHDINE- Self-supplying generation
Observation: Application for extension of deadline pending.
Financing: Private Funding.

- Jondachi Sardinas (12.6 MW)

Status: With certificate provided to ERDESU - Generation
Observation: Revoked on 6 February 2009.
Financing: Private Funding.

- Palanda (16.8 MW)

Status: With certificate provided to HIDROCHINCHIPE - Generation
Observation: Application for extension of deadline pending in CDCPL.
Financing: Private Funding.

- Angamarca Sinde (29.1 MW)

Status: With certificate provided to HIDRONACION - Generation
Observation: Application for extension of deadline pending.
Financing: Public Funds.

- Sabanilla (30 MW)

Status: With certificate provided to HIDRELGEN - Generation
Observation: Certificate to be revoked, because the contract has not been signed.
Financing: Private Funding.

- Palmira (10 MW)

Status: With certificate provided to HIDRONANEGAL - Self-supplying generation
Observation: Application for extension of deadline pending before the Board.
Financing: Private.

- Fátima (20 MW)

Status: With certificate provided to HIDROSUR - Generation
Observation: Application for extension of deadline pending. Soon to sign contract.
Financing: Private.

- Hidrogen (31.4 MW)

Status: With certificate provided to HIDROGEN - Self-supplying generation
Observation: Application for extension of deadline pending.
Financing: Private.

- Río Verde Chico (10 MW)

Status: With certificate provided to HIDROSIERRA - Generation
Observation: Application for extension of deadline pending.
Financing: Private.

- Delsitanisagua (115 MW)

Status: With certificate provided to HIDRONOVA - Self-supplying generation
Observation: Application for extension of deadline pending. Company has been asked to submit additional documents.
Financing: Private.

- San Jerónimo 4 (7 MW)

Status: With certificate provided to HIDROIMBABURA - Generation
Observation: Within timeframe.
Financing: Private.

- Salto del Bimbe (4.2 MW)

Status: With certificate provided to REYSAHIWAL - Self-supplying generation
Observation: Application for extension of deadline pending. Soon to sign contract.
Financing: Private.

### 5.2.2 Thermoelectric Projects

- POWER BARGE II (50 MW)

This generator barge in Guayaquil has not yet begun operation commercially, claiming Force Majeure.

Status: Out of operation due to Force Majeure
Estimated Operation Date: Not definite.
Financing: Private Funding.

- MACHALA II (95 MW) and III (87 MW).

Machala Power Cía. Ltda. signed a concession contract to build and operate in three stages a 312 MW generating plant in Bajo Alto, using the gas from the Gulf of Guayaquil, concessioned to the EDC company. Due to legal and economic contingencies, the contractual timetable is suspended indefinitely.

### 5.2.3 Wind Projects

- E.E. Galapagos (5.7 MW).

The Galapagos Electric Company signed a contract in August 2003 with CONELEC to provide renewable energy (wind and photovoltaic) to four islands, with a power of 5.7 MW. A wind farm is planned for Baltra Island, with a power of 3 MW in the first phase and then building a transmission line from Baltra to Port Ayora, 45 km long. A photovoltaic system (500 kW peak) will be installed on Isabela Island to connect to the Port Villamil distribution network.

- VILLONACO (15 MW).

The Villonaco Wind Power S.A. company signed a contract in July 2006 to set up a 15 MW wind power facility on a mountain named Villonaco, in the province of Loja. The wind facility would comprise 14 aero generators. The contractual operating date is December 2008, but for the purposes of planning and considering the delay to date, commercial operation is expected to begin in 2013.

The above information would indicate that, despite having quite an extensive list of projects, especially hydroelectric projects, in the pipeline, in actual practice only Mazar has public funding and is proceeding. There are many public initiative projects that are in the study phase but there is no clear expectation that they will be built.

## 5.3 FUTURE PROSPECTS

### 5.3.1 In Hydropower

In the short term, the 160 MW Mazar power plant is expected to start operating the first quarter of 2010. The dam will be ready and will begin filling in July 2009. This is the only hydropower project that will be commissioned in the short term.

There are also a series of large hydropower projects that have been promoted by the Government of Ecuador, some under construction and most in the study stage, with varying states of progress, as shown in the following table:

**Table 4 CHARACTERISTICS OF HYDROELECTRIC PROJECTS**

| Nombre | Potencia MW | Energía GWh | Costo Inversión (MM$) | Entrada en Operación | Situación |
|---|---|---|---|---|---|
| MAZAR | 160 | 690 | 527 | 2010 | Construcción por concluir |
| BABA | 42 | 180 | 310 | 2010 | En construcción |
| BAEZA | 50 | 377 | 93 | 2012 | Por contratar construcción |
| QUIJOS | 50 | 370 | 102 | 2012 | Por contratar construcción |
| OCAÑA | 26 | 212 | 60 | 2012 | Por iniciar construcción |
| SOPLADORA | 466 | 2803 | 467 | 2013 | En estudios |
| TOACHI - PILATON | 228 | 1068 | 471 | 2014 | En estudios |
| COCA-CODO SINCLAIR | 1500 | 9472 | 2000 | 2015 | Por contratar construcción |
| CHESPÍ | 250 | 1200 | 380 | 2014 | Por contratar estudios |
| VILLADORA | 350 | 1700 | 460 | 2019 | Por contratar estudios |
| CHONTAL | 150 | 700 | 184 | 2013 | Por contratar estudios |

Data: MEER and CONELEC, organized by the authors

### 5.3.2 In Thermoelectric Generation

Under thermoelectric generation, the 144 MW Esmeraldas II project is fully underway, to be installed alongside the current Esmeraldas thermoelectric power plant. The project will install internal combustion engines (ICE) fired by petroleum wastes (slops) from the refinery located at the site, very near the power plant.

To distribute this energy, the Santo Domingo – Esmeraldas 230 KV transmission system will be built, at a cost of USD 43 million. The Government has allocated USD 20 million for the project's initial stages, which will be completed in 2009.

The Shushufindi project studies are underway. This power plant to be built in Ecuador's Amazon region in the zone of the same name would use the slops from the refinery located there. However, no resources have been allocated to continue with the project, so its future is uncertain.

A topic of great uncertainty is the natural gas from the Gulf of Guayaquil, concessioned to the EDC company and used by Machala Power to operate its 140 MW power plant. Gas reserves are reported to be sufficient to install another 400 additional MW of generation. However, it is unlikely for Machala Power to expand its generating capacity, in view of the growing debt the State owes them, which has been acknowledged and validated, but has not been paid yet.

Some private generators are interested in moving their units to Machala to use the gas, some with barges and others with land-based power plants. With these expectations, a 230 kV transmission system is being built between the Milagro and Machala substations, which increases that zone's capacity to transport energy. This is one of the best alternatives to install new generation in Ecuador.

Speaking of thermoelectric generation forecasts, there are two fundamental factors to consider: fuel availability and pricing. This issues will be discussed in detail below.

### 5.3.3 In Geothermal Energy

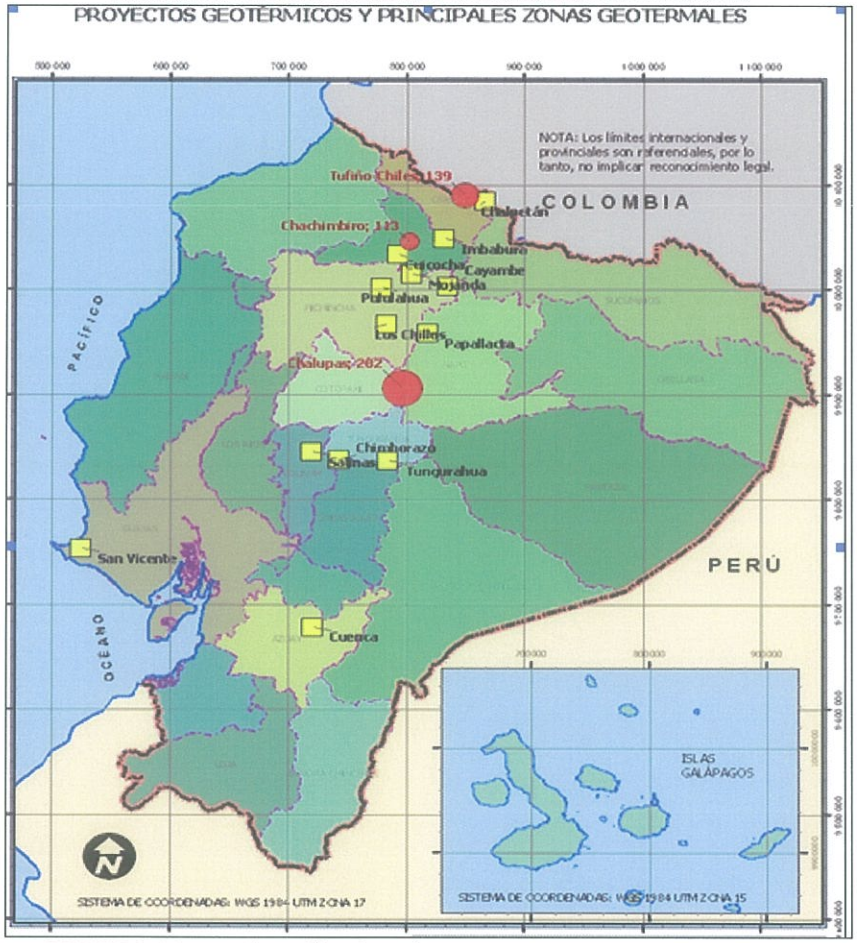
Another energy source to consider as a valid alternative for energy supply is geothermal, the energy that can be extracted from the inside of the Earth. It has been developed very little worldwide or in Ecuador, perhaps because the study and testing stages are quite costly.

The volcanic nature of Ecuador due to the impact of the Nazca plate against the Continental plate makes great geothermal potential available. These tectonic plates ram into each other at an average speed of 6 to 20 cm a year, and at an average depth of 100 km, which is the origin of the volcanic nature of the Andes mountain range. This phenomenon is reflected by the large number of hot springs at ground level in Ecuadorian territory (about 180).

Geothermal studies conducted in Ecuador have identified 17 geothermal energy sites that could produce energy for electricity, industrial and agricultural uses. Four of these 17 are low-enthalpy, and the remaining 13 (both high- and low-enthalpy) are at different phases of study.

Studies carried out by INECEL in Tufiño, Chachimbiro and Chalupas have quantified an installable power potential of 534 MW for these three sites. Illustration 19 shows the location of the three geothermal projects and the main geothermal zones in Ecuador.

**Illustration 19 GEOTHERMAL PROJECTS AND MAIN AREAS**




**Source**: CONELEC, Master Electrification Plan

The following table shows the main features of the sites identified:

**Table 5 MAIN FEATURES OF GEOTHERMAL PROJECTS IN ECUADOR**

**PROYECTOS GEOTÉRMICOS Y PRINCIPALES ZONAS GEOTERMALES**
Fuente: Estudios de INECEL/ OLADE/ CEPAL/ GTZ/ CONELEC/ Estudios de Manlio F. Coviello (2000) y E. Aguilera (2001)
Procesamiento: Dirección de Planificación del CONELEC (Junio 2005)

**PRINCIPALES PROYECTOS CON POTENCIAL GEOTÉRMICO PARA GENERACIÓN ELÉCTRICA**

| ÁREA GEOTÉRMICA | UNIDAD | TUFIÑO | CHACHIMBIRO | CHALUPAS | TOTAL |
|---|---|---|---|---|---|
| Superficie total (*1) | $km^2$ | 38,29 | 17,28 | 62,83 | 118,4 |
| Área aprovechable | $km^2$ | 4,40 | 3,20 | 12,90 | 20,50 |
| Profundidad media del reservorio | m | 1750 | 1750 | 1900 | |
| Espesor promedio | m | 500 | 500 | 400 | |
| Temperatura media anual | °C | 9,00 | 14,00 | 7,00 | |
| Fuentes termales principales (*2) | °C | 53,0 | 46,0 | 37,0 | |
| Temperatura máxima estimada (*3) | °C | 250 | 350 | 300 | |
| Temperatura media estimada (*3) | °C | 207 | 239 | 205 | |
| Recurso Geotérmico accesible | J | 1,09E+19 | 5,33E+18 | 1,40E+19 | 3,02E+19 |
| Recurso geotérmico económico | J | 8,15E+17 | 3,99E+17 | 1,07E+18 | 2,28E+18 |
| Reserva geotérmica | J | 1,34E+17 | 6,55E+16 | 1,55E+17 | 3,55E+17 |
| Factor de conversión a electricidad | % | 0,240 | 0,250 | 0,240 | |
| Energía primaria | kWh/año | 8,93E+09 | 4,55E+08 | 1,03E+10 | 1,97E+10 |
| Productividad específica | $kWh/km^2$ | 2,33E+08 | 2,63E+08 | 1,64E+08 | |
| **POTENCIA INSTALABLE** | **MW** | **139** | **113** | **282** | **534** |

Notas:
*1 Referido únicamente al nivel del reservorio. Se excluyen las reservas del basamento, profundidad de 3000 m
*2 Se refiere a la mayor temperatura medida en las fuentes termales
*3 Temperaturas estimadas a parir del modelo geotérmico

**PRINCIPALES ZONAS GEOTÉRMICAS DE INTERÉS ENERGÉTICO**

| ZONA GEOTÉRMICA | PROVINCIA | CARACTERIZACIÓN |
|---|---|---|
| Tufiño | Carchi | Recurso de alta y baja temperatura |
| Chalpetán | Carchi | Recurso de alta y/o baja temperatura |
| Iquen | Carchi | Recurso de alta y/o baja temperatura |
| Chachimbiro | Imbabura | Recurso de alta y baja temperatura |
| Cuicocha | Imbabura | Recurso de alta y baja temperatura |
| Imbabura | Imbabura | Recurso de alta y/o baja temperatura |
| Cayambe | Pichincha | Recurso de alta y/o baja temperatura |
| Mojanda | Pichincha | Recurso de alta y baja temperatura |
| Pululahua | Pichincha | Recurso de alta y baja temperatura |
| Valle de los Chillos | Pichincha | Recurso de media y/o baja temperatura |
| Papallacta | Napo | Recurso de alta y baja temperatura |
| Chalupas | Napo/Cotopaxi | Recurso de alta y baja temperatura |
| Tungurahua | Tungurahua | Recurso de baja temperatura |
| Chimborazo | Chimborazo | Recurso de media y/o baja temperatura |
| Salinas | Bolívar | Recurso de baja temperatura |
| San Vicente | Guayas | Recurso de baja temperatura |
| Cuenca | Azuay | Recurso de media y/o baja temperatura |

**Source:** CONELEC, Master Electrification Plan

Several studies are currently underway at once regarding different geothermal projects:

- The Ministry of Electricity is researching the area de influence of the Tufiño Chiles Cerro Negro project (Province of Carchi) and the Chachimbiro project (Province of Imbabura). For this purpose, they are hiring in drilling services and assessing available resources.
- CONELEC ordered a study of the "Profile of the Chalupas Geothermal Project", and the findings show that Chalupas is a top priority, higher than other geothermal areas. Chalupas is currently in the initial prefeasibility phase. To take

it to the feasibility phase will take exploratory geophysics work, mainly magneto telluric (MT) testing.

If feasibility is shown by deep test shafts (proving 25% of the resource, 12.5 Mwe – megawatts-electric) the project will continue developing the field with additional drilling until the full supply of steam is attained to operate the planned plant; and will continue designing, constructing and installing the 50 MWe generating plant.

- The State-owned CELEC-Electroguayas S.A. company is implementing a project for "Providing specialized services for advanced reconnaissance of the geothermal prospects of Tufiño, Chachimbiro, Chacana (Papallacta) and Chalupas". The study includes the four zones defined as geothermal prospects, located to the north of the inter-Andean region, in the provinces of Carchi, Imbabura, Pichincha and Cotopaxi. The main purpose is to evaluate existing knowledge about geothermal energy in Ecuador.

Some of these initiatives are expected to become actual geothermal projects. However, given the State's shortage of available resources, it is hoped that these initiatives find private investors. To this end, the State is funding the pre-investment stage, which investors are usually least eager to get involved in.

## 5.4 INTERNATIONAL INTERCONNECTIONS

Ecuador has electrical interconnection with Colombia through two 230 kV transmission lines linking the substations of Pomasqui in Ecuador and Jamondino in Colombia, which have a joint rated capacity of 500 MW. There is another regional interconnection at 138 kV with a capacity of 50 MW. Operational constraints limit the capacity of these linkages, especially during peak demand.

International electricity transactions with Colombia began in 2003 under the norms of the Community of Andean Nations (CAN). In December 2002, the Official Gazette of the Cartagena Agreement published Decision 536 by the Commission of the Andean Community, "General framework for subregional interconnection of electrical systems and intra-community electricity trade", establishing the principles to develop electricity transactions among the countries of the Andean Region.

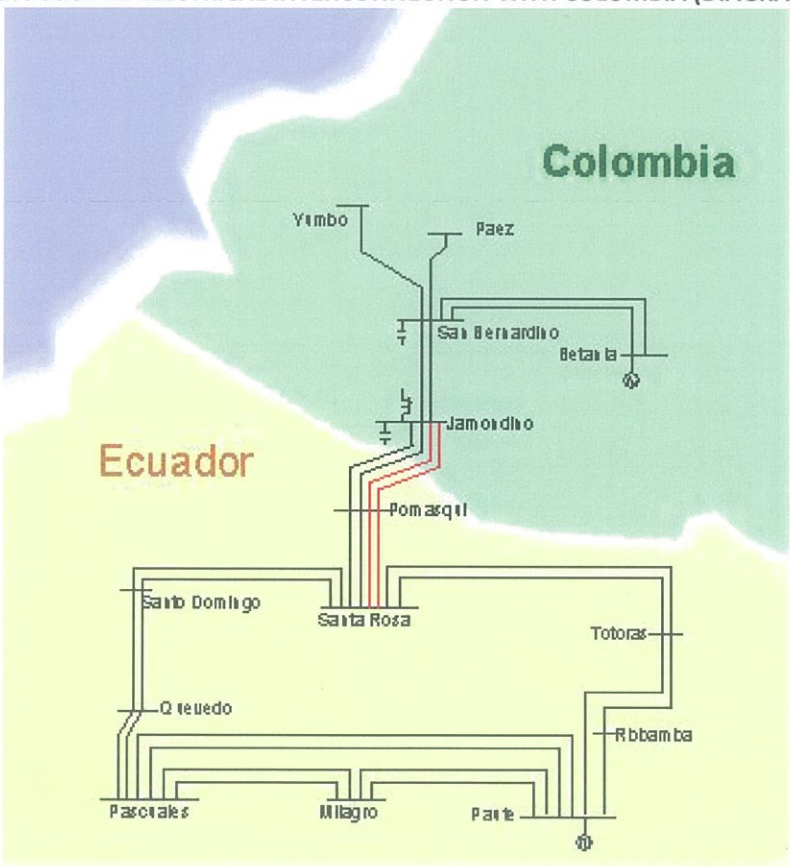
On the basis of this Community norm and domestic norms in Ecuador and Colombia, transactions between the two countries began on 1st March 2003, with benefits for both countries, although much more for Colombia, which revealed serious deficiencies in the business model, which fostered the accumulation of profits for the exporting country, unfavorably for the importing country, with the assumption of a balanced level of imports and exports between the two countries, which was not the case.

Because Ecuador has a generation deficit, and since this situation has not been reversed during these last few years, it has become a net importer, and therefore

Colombia has profited more. Their national laws have allocated much of these profits to supporting Colombian electric companies with deficits and rural electrification.

**Illustration 20 ELECTRICAL INTERCONNECTION WITH COLOMBIA**


**Illustration 21 ELECTRICAL INTERCONNECTION WITH COLOMBIA (DIAGRAM)**




The greatest differences come from the so-called "Congestion Revenues", which are simply the product of the difference of energy prices between the exporting and

importing countries, multiplied by the volume of energy transferred. Since Colombia has a large generation surplus, basically from hydroelectricity, with a gas- and coal-fired thermoelectric component, their prices are much lower than Ecuador's, which are sometimes dependent on the cost of diesel-fired generation. This price difference means profits almost totally for Colombia.

The following table shows the statistics on international electricity transactions (TIE) with Colombia, illustrating the above situation. These figures show that Colombia is a net exporter, whereas Ecuador is a net importer of electricity. Additionally, this quantifies the large profits that Colombia has earned as Congestion Revenues (USD 262 million) which is a premium added to the cost of the energy delivered to Ecuador, including the generators' profit margin.

**Table 6 ELECTRICITY TRANSACTIONS ECUADOR – COLOMBIA**

| Año | Energía (GWh) | | Valor (Millones de USD) | | | | |
|---|---|---|---|---|---|---|---|
| | Importación | Exportación | Importación | Exportación | Rentas de Congestión | | |
| | | | | | A favor de Colombia | A favor de Ecuador | Total |
| 2003 | 1129,26 | 67,20 | 80,61 | 2,49 | 45,13 | 0,56 | 45,69 |
| 2004 | 1681,09 | 34,97 | 133,66 | 0,76 | 75,22 | 1,93 | 77,15 |
| 2005 | 1757,87 | 16,03 | 148,55 | 0,50 | 66,83 | 3,19 | 70,02 |
| 2006 | 1570,47 | 1,07 | 124,79 | 0,05 | 54,55 | 2,43 | 56,98 |
| 2007 | 860,87 | 38,39 | 65,65 | 1,29 | 20,78 | 0,49 | 21,27 |
| 2008 | 509,78 | 37,53 | 34,01 | 2,29 | 0,29 | 0,02 | 0,31 |
| **Total Historia** | **7509,34** | **195,20** | **587,27** | **7,39** | **262,8** | **8,6** | **271,41** |
| Relación | 97% | 3% | 99% | 1% | 97% | 3% | |

This led Ecuador to object to Andean Community agencies, which engaged an independent outside consultancy to determine a better mechanism to eliminate the asymmetries of the current model. This consultancy recommended dividing the Congestion Revenues half and half, which the two countries have agreed to, and must be ratified by the Andean Community agencies to go into force.

Imports dropped significantly in 2008 when the 230 MW San Francisco power plant came on line, and could have been even lower, except that San Francisco was shut down for several months, due to problems detected in its construction (which are currently being address judicially).

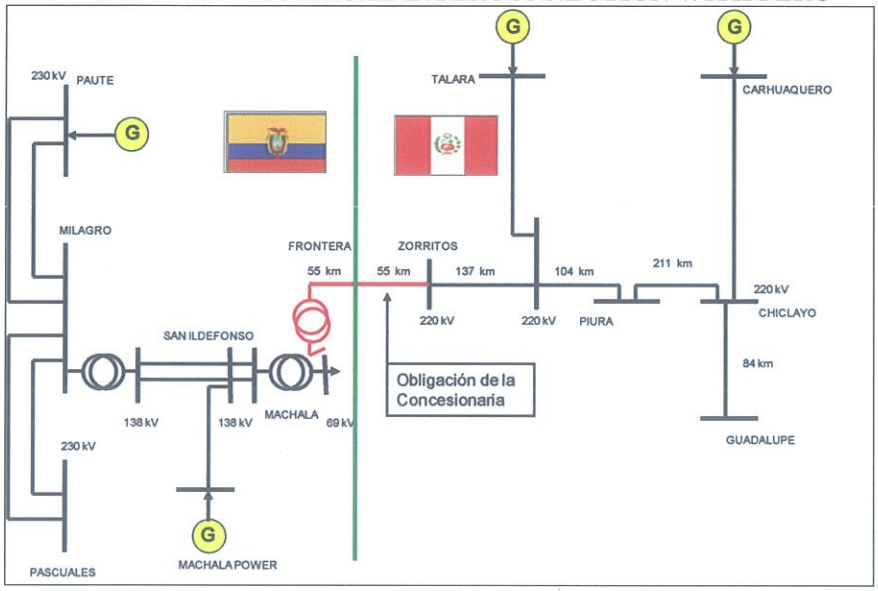
Ecuador has also built an electrical interconnection with Peru, through a 230 kV transmission line between the substations of Machala in Ecuador and Zorritos in Peru. Given the characteristics of the two systems, studies showed that they could not operate in synchronization, so a first stage of radial interconnection could be designed, so the load of the Machala substation could be taken by Zorritos, and its load could be taken by Machala, depending on energy pricing conditions.

Commercial agreements with Peru have not been achieved, despite great diplomatic efforts by Ecuador in past years. The two countries' regulations are incompatible in highly sensitive aspects of the economic equation, such as remuneration for power.

This has prevented commercial transactions between the two countries. The interconnection line has been operational since 2006 but operated only for a few days under emergency conditions.

The interconnection project with Peru envisaged a second stage with construction of a back-to-back type station for synchronized operation of systems, expanding to 250 MW for a third stage. The lack of trade agreements has made it seriously questionable whether these stages will be implemented.

**Illustration 22 ELECTRICAL INTERCONNECTION WITH PERU**




There are no clear expectations regarding the future of interconnection with Peru. It seems that the idea of materializing electricity transactions with Peru has been abandoned, except to cope with emergency conditions.

## 5.5 FUEL AVAILABILITY AND PRICING

One of the alternatives for self-supply is to install thermoelectric generation, so it is important to examine information on the availability of fuels to generate electricity.

A study by an inter-institutional team of the Ministry (MEER), CENACE and CONELEC, to determine short-term thermoelectric generation requirements, investigated the actual availability of fossil fuels, reaching the following conclusions.

### 5.5.1 Availability of Diesel

Domestic production does not cover domestic market demand for electrical generation, transport and productive uses. Therefore, to cover the needs for thermoelectric generation, Ecuador imports diesel at international market prices (currently some USD 60 / barrel) and sells it on the domestic market at USD 37 / barrel, as a direct subsidy by the Government.

Since Ecuador has a diesel deficit and government subsidy, this is not a favorable basis for setting up thermoelectric generation using diesel. Rather, the idea is to replace old diesel-burning units with internal combustion engines burning refinery slops.

### 5.5.2 Availability of Fuel Oil # 4, Fuel Oil # 6 and Slops

These heavy fuels are produced at the refineries of Esmeraldas, La Libertad and Shushufindi.

At the Esmeraldas State Refinery (REE): According to information from Petroindustrial, this refinery produces Fuel Oil #4, Fuel Oil #6 and Slops. It is estimated that the availability is 400,000 barrels / month, which is sufficient to provide 400 MW. A minimal percentage is currently consumed, and the difference is exported. According to official information from PETROCOMERCIAL, some 90,000 barrels a month could be available for generating electricity. This fuel would be used by the new thermoelectric plant to be set up in Esmeraldas.

Moreover, if the Esmeraldas refinery is upgraded and the new refinery is built in Manabí (in the place called El Aromo), this would significantly increase the production of gasoline, reducing availability of slops. This would make the actual availability of this fuel uncertain.

If slops are available from Esmeraldas, there are several possibilities to install thermoelectric generation, on barges near Jaramijó in the province of Manabí, or in Santo Domingo de los Tsáchilas. This second alternative is attractive because of the ease of connecting to the national system; however, there are serious constraints because of the need to transport the fuel overland in tanker trucks. Costs would involve the transport and the need for large storage capacity and fuel stock.

Additionally, the fuel can be transported in ships to barges, which could be located near Manta, Jaramijó or Santa Elena. Ships can dock in Manta harbor with up to 50,000 barrel capacity and a draft of 6.2 meters. In Santa Elena, smaller ships can dock, with a capacity of up to 35,000 barrels. However, transport costs from Esmeraldas to Santa Elena are high. PETROCOMERCIAL has ratified its willingness to deliver 160,000 barrels a month of slops for plants to be located in Jaramijó or Santa Elena.

Both cases would involve barges, which have helped supply domestic demand under critical conditions but face community opposition because of environmental effects.

At the La Libertad Refinery: They produce Fuel oil No.4. The exact volume available is unknown, but information from PETROCOMERCIAL officials indicates enough capacity to supply a 130 MW power plant. Assuming a yield of 15 kWh / gallon and a plant factor of 0.8, setting up a plant with this capacity would require 120,000 barrels / month. The fuel would be transported by a product pipeline.

At the Shushufindi Industrial Complex (CIS): They produce Slops with an estimated availability of 300,000 barrels / month, sufficient to install a 270 MW power plant

(which was committed for the Termoriente project, whose concession was withdrawn due to non-fulfillment of project implementation. However, in this zone there are serious constraints regarding transmission capacity, at least in the short term.

### 5.5.3 Availability of Naphtha

Ecuador produces two types of naphtha that can be used for thermoelectric generation: A "base naphtha" produced at the La Libertad Refinery, and a "reformed naphtha" produced at the Esmeraldas Refinery; the latter is better quality.

At present, Esmeraldas has 90,000 barrels a month of reformed naphtha available, left over from the stock exported at international prices. It could all be used for electrical generation.

For this purpose, a sales price must be set for the local market, so PETROCOMERCIAL is pursuing this process with the Ministry of Mines and Petroleum. PETROCOMERCIAL officials expect the price for reformed naphtha to be the equivalent of diesel on the local market.

Estimating a yield of 10.47 kWh / gallon, this amount of naphtha could supply a similar unit of approximately 100 MW capacity.

This fuel is available at the Esmeraldas Terminal and would have to be shipped. Because of carrying capacity and fuel discharge limitations, it would be best to have a 90,000 barrel ship make a single trip every month, but there is reportedly no such ship available in Ecuador. The best alternative may be two shipments monthly of 45,000 barrels each.

If the shipping is available for the fuel, it could be used by barges off Manta, Jaramijó, Santa Elena or Bajo Alto. Transport costs make the last two alternatives prohibitive. A plant could also be installed on land in Esmeraldas.

The La Libertad Refinery produces 210,000 barrels of base naphtha a month, of which 60,000 barrels a month could be available for the electrical sector, since the difference is used for different purposes on the local market. This capacity is not regular but varies depending on consumption. When available, this naphtha is delivered to Intervisa to operate the Victoria 2 barge. This naphtha's price is USD 31.41 / barrel.

Statistics show that in 2006, Intervisa's Victoria 2 barge consumed 34.4 million gallons of naphtha, equivalent to 819,000 barrels / year and 68,000 barrels per month.

That is, the La Libertad Refinery's capacity to provide naphtha is not sufficient to supply the requirements of Victoria II, and therefore not sufficient to cover additional generation.

### 5.5.4 Availability of natural gas

A major alternative to install new thermoelectric generation capacity are the gas reserves in the Amistad field located in the Gulf of Guayaquil, concessioned by the Ecuadorian Government to the EDC company, who jointly with the Machala Power generator company are subsidiaries of the Noble Energy company of the United States of America.

EDC has reported proven reserves of 225,000 million cubic feet (MMCF) and total reserves (proven + probable + possible) of 339,000 million cubic feet. According to 2006 statistics, the two Machala Power units (130 MW ) consume 9000 million cubic feet a year.

So, if 400 MW additional capacity is installed, with an approximate component of 110 MW in combined cycle, there would be reserves for an estimated 12 years considering total reserves, and eight years considering only proven reserves. Reserves could increase if the area of exploration is expanded, which is only 20% of the total concession area at present.

The Machala Power company is obliged to install nearly 180 MW including a combined cycle facility through phases 2 and 3 of its generation project. However, there is uncertainty about the future of that contract, on which the availability of sufficient gas for other companies depends.

It is unlikely that Machala Power will implement Phases 2 and 3 of its project any time soon, so the only alternative, would be the possibility that EDC might sell the gas, directly or through the government, to a private generator for a plant that could be set up in Bajo Alto or on a barge in Puerto Pitahaya, which would also require agreements with Machala Power, to use the transmission facilities from Bajo Alto to San Idelfonso.

### 5.5.5 Availability of natural gas from BPZ in northern Peru

According to information provided by BPZ Energy Inc., this company domiciled in Houston, Texas, whose affiliate in Peru has contracts under license to Petroperú, to explore for and extract hydrocarbons from four blocks in northwestern Peru, is interested in developing and implementing a Project to Construct and Operate a Private Main Gas Pipeline from Caleta Cruz to Arenillas, which is part of a binational scheme between Ecuador and Peru, that the company has been promoting.

BPZ Energy, Inc. in Peru extracts natural gas from an offshore field called Corvina, through its affiliate company for exploration and production in Peru. They will also build an undersea gas pipeline from the production platforms to the Caleta Cruz area.

A part of the natural gas production from the Corvina field, equivalent to 40 million cubic feet a day, will be used to supply the company's thermoelectric power plant, with a rated capacity of 160 MW, to be built near Caleta Cruz, and to dispatch the

electricity for Peru's interconnected system. They have signed a Memorandum of Understanding with the Luz del Sur distributor in Lima.

BPZ has made efforts to be able to export and market natural gas in Ecuador. However, so far that alternative has not materialized, and it seems that BPZ's gas reserves are not enough for this purpose, so this alternative has been discarded.

### 5.5.6 Biofuels

Biofuels are fuels obtained from agricultural products, and can be used in pure form or combined with fossil fuels to improve their quality while reducing emissions that affect the environment.

Biofuels include: bioethanol, biodiesel and vegetable oil.

Bioethanol: This biofuel is obtained by fermenting products naturally rich in sugar, starch or cellulose. Ecuador has 75,903 hectares planted in sugar cane to produce sugar, and 54,685 hectares of sugar cane planted for other uses. The production of anhydrous ethanol is 60,000 liters a day.

The National Biofuel Program intends to start with a Pilot Plan for the city of Guayaquil, to incorporate a percentage (5%) of anhydrous alcohol in regular gasoline, increasing as more anhydrous alcohol becomes available up to 10% of the blend, which would entail a consumption of 650,000 liters a day. With this percentage of blending, no engine modifications are required.

Biodiesel: This is the result of chemical transformation of vegetable oil using a alcohol. It is obtained from African palm oil and African palm olein. Engines must generally be adapted to use biodiesel, but it is inexpensive.

Transforming African palm oil into biodiesel (methyl ester) accounted for 40% of Ecuador's surplus oil, making Ecuador the continent's second largest supplier, exporting to Venezuela and Mexico during 2006, when the La Fabril company exported 76 thousand tons to the United States.

Despite the high costs of conversion and raw material, biodiesel became economically viable when petroleum prices soared higher than USD 70 / barrel, and developed nations returned to the plant-origin fuel that the inventors of the first engines used, as an economic alternative, and an environmental protection policy.

The National Biofuel Program considered reformulating diesel 2 with 5% biodiesel, which would require approximately 1,175,000 barrels of biodiesel a year to cover all sectors.

When petroleum prices fell, those who had invested in biodiesel faced difficulties. Nevertheless, experts assure us that producing this plant-origin fuel is a long-term

alternative since petroleum is running out and emissions cause environmental damage.

La Fabril is no longer producing biodiesel and no other such undertaking in Ecuador is reported.

Vegetable oil: Although it has a higher energy content, engines must be adapted to use it, which is expensive. The oil-bearing plants in Ecuador that are priorities for the National Biofuel Program are:

- African palm: with 207,000 hectares planted.
- Castor-oil plant: 3,700 hectares in Manabí.
- *Piñón*[1]: traditionally grown in Manabí as hedges.
- Others: soy, cotton, sunflower, and *maní de árbol*[2].

Ecuador produces 350,000 MT of palm oil with domestic consumption of 200,000 MT, leaving 150,000 MT available for export, which could be used as biofuel.

Artisanal production of *piñón* oil does not meet standards (dirtiness, phosphorus, magnesium and calcium. The extraction process must be substantially improved. However, a project is underway to use *piñón* oil for thermoelectric generation in the Galapagos Islands, to replace the fuel that is shipped in from the mainland, posing a hazard for the Islands' delicate ecosystems.

In conclusion, Ecuador has significant potential for producing biofuels, but there is no certainty regarding their short-term availability. Therefore, they cannot be considered as an alternative to generate electricity.

In summary, the availability of fuels to generate electricity is shown in the following table7:

**Tabla 7 AVAILABILITY OF FUELS TO GENERATE ELECTRICITY, 2008**

| Combustible | Disponibilidad | | Capacidad instalable (MW) | Ubicación factible | Transporte combustible | Comentarios |
|---|---|---|---|---|---|---|
| Residuo - Esmeraldas | 400.000 | Bls/mes | 300 | Esmeraldas, Manta, Jaramijó, (Sto. Domingo) | Directo o buque | Posible reducción a 150.000 Bar/mes. Problemas de transporte para Sto.Domingo |
| Residuo - La Libertad | 120.000 | Bls/mes | 130 | Santa Elena | Poliducto | Disponible |
| Residuo - Shushufindi | 300.000 | Bls/mes | 270 | Shushufindi | Directo | Disponible |
| Nafta Reformada - Esmeraldas | 90.000 | Bls/mes | 100 | Esmeraldas, Manta, Jaramijó | Directo o buque | Posible reducción por producción de gasolinas |
| Nafta base - Santa Elena | 60.000 | Bls/mes | N/D | N/D | N/D | No existe capacidad suficiente |
| Diesel | - | gal/mes | N/D | N/D | N/D | Producto importado - descartado como opción |
| Gas EDC - Reservas Probadas | 225.000 | MMPC* | 400 | Bajo Alto | Directo | Sujeto a arreglo con Machala Power y EDC |
| Gas BPZ | N/D | MMPC | 160 | N/D | N/D | No disponible en el corto plazo |

Bls = barriles (*) MMPC = Millones de pies cúbicos N/D = No disponible

[1] Piñón shares the name of the piñon nut of the Southwestern US, but the Barbados nut (*Jatropha curcas*) has poisonous seeds.

[2] Maní de árbol ("tree peanut") is also known as the Orinoco nut (*Caryodendron orinocense*).

*Note:* Availability may have changed for 2008. However, trends hold and are considered valid for this analysis of possibilities.

### 5.5.7 Fuel pricing

Fuel prices (for fuel oil, slops, naphtha and natural gas) for thermoelectric generation in Ecuador have been set by Executive Decree No. 338 as follows:

**Table 8 CURRENT FUEL PRICES**

| Combustible | Precio | Unidad |
|---|---|---|
| Fuel Oil | 0,6324 | USD/galón |
| Gas Natural | 3,77136 | (USD(KPC) |
| Nafta | 0,6678 | USD/galón |
| Residuo de Esmeraldas | 0,398 | USD/galón |
| Residuo Termoguayas | 0,392 | USD/galón |
| Fuel Oil estatal | 0,4896 | USD/galón |

KPC (Thousand cubic feet)

For studies to plan for expansion of generating capacity, such entities as CENACE and CONELEC use the following fuel price forecast, taken from a report by the Energy Information Administration of the United States of America with a cutoff at December 2008.

**Table 9 FUEL PRICE FORECAST**

| PROYECCION PRECIOS DEL DIESEL Y DE COMBUSTIBLES COMPUESTOS | | | | | | |
|---|---|---|---|---|---|---|
| Año | Diesel (USD/galón) | Residuo SHGHernadez (USD/galón) | Residuo SHGuangopolo (USD/galón) | Residuo Descanso (USD/galón) | Residuo Generoca (USD/galón) | Residuo Propicia (USD/galón) |
| 2009 | 2.63 | 0.61247 | 0.60014 | 0.61454 | 0.414947 | 1.05577 |
| 2010 | 2.62 | 0.61147 | 0.59914 | 0.61354 | 0.414847 | 1.05277 |
| 2011 | 2.86 | 0.63547 | 0.62314 | 0.63754 | 0.417247 | 1.12477 |
| 2012 | 3.06 | 0.65547 | 0.64314 | 0.65754 | 0.419247 | 1.18477 |
| 2013 | 3.19 | 0.66847 | 0.65614 | 0.67054 | 0.420547 | 1.22377 |
| 2014 | 3.44 | 0.69347 | 0.68114 | 0.69554 | 0.423047 | 1.29877 |
| 2015 | 3.53 | 0.70247 | 0.69014 | 0.70454 | 0.423947 | 1.32577 |
| 2016 | 3.54 | 0.70347 | 0.69114 | 0.70554 | 0.424047 | 1.32877 |
| 2017 | 3.53 | 0.70247 | 0.69014 | 0.70454 | 0.423947 | 1.32577 |
| 2018 | 3.57 | 0.70647 | 0.69414 | 0.70854 | 0.424347 | 1.33777 |
| 2019 | 3.58 | 0.70747 | 0.69514 | 0.70954 | 0.424447 | 1.34077 |
| 2020 | 3.56 | 0.70547 | 0.69314 | 0.70754 | 0.424247 | 1.33477 |

However, a fuel price forecast will depend on political decisions that are made, since in Ecuador fuel prices do not follow the market but the Government's policies.

## 5.6 RISKS AND BARRIERS

On the basis of this situational analysis, the following risks to private investment in generation may be identified:

Institutional instability:
Changes in electrical sector institutions pose a risk because Government powers are concentrated through the Ministry of Electricity and CENACE and CONELEC have lost autonomy.

- Contracts for new generation capacity based on public processes.
- Prices of contracts established on the basis of pre-defined criteria, which facilitates preparation and evaluation of bids in public processes, and negotiation if the contract is awarded.

Additionally, the specific rule that CONELEC will prepare is expected to include a key factor for private capital's involvement in this process, namely:

- Guaranteed payment for generation, granted by the State.

### 5.7.2 For generation based on Non-Conventional Renewable Energies (ERNC)

Additionally, there are incentives for generation based on non-conventional renewable energies (ERNC), established by Rule No. 09/06:

- Special prices for ERNC
- Preferential dispatch

Prior to Rule No. 013/08, according to Market Regulations (Article 20), preferential dispatch from plants based on non-conventional renewable energies could not exceed 2% of the installed capacity of MEM generators.

The amendments incorporated in Rule No. 013/08 include Article 35, which establishes that preferential dispatch from generation plants using non-conventional renewable energies, may not exceed 6% of the installed and operating capacity of the generators on the electric market.

Considering that, according to 2008 statistics, there are 3400 MW of generating capacity available, the preferential treatment for ERNC would be approximately 200 MW.

The rule defines ERNC to include:

- Biomass-based generation: plants generating electricity using as fuels: forestry, agricultural, agroindustrial, livestock and urban wastes.

- Biogas-based generation: plants generating electricity using as fuel the biogas obtained from a digester as the result of anaerobic breakdown of organic wastes.

- Wind-based generation: plants generating electricity using the kinetic energy of wind.

- Geothermal generation: plants generating electricity using the steam coming from inside the Earth as their primary energy.

- Solar photovoltaic generation: plants generating electricity using the energy from the photons in sunlight, which hit the plates of semiconductor material on the solar photovoltaic panel, releasing the electrons from the outermost orbit, which can be collected as electrical current.

- Small hydropower generation: hydropower plants with an installed capacit of up to 10 MW.

## 5.8 PRIVATE EXPERIENCE INVESTING IN GENERATION

A small number of generation projects have been implemented with private capital. The largest are shown in the following table 10:

**Table 10 GENERATION BY PRIVATE CAPITAL**

| Nombre de la Empresa | Potencia (MW) | Tipo | Condición |
|---|---|---|---|
| Hidroabanico | 38,45 | Hidráulica pasada | Autogenerador |
| Enermax | 17,60 | Hidráulica pasada | Autogenerador |
| Ecoluz | 2,30 | Hidráulica pasada | Autogenerador |
| Ecoelectric | 32,50 | Térmica Turbovapor | Autogenerador |
| Ecudos | 35,30 | Térmica Turbovapor | Autogenerador |
| San Carlos | 35,00 | Térmica Turbovapor | Autogenerador |
| Lafarge | 16,48 | Termica MCI | Autogenerador |
| Hidrosibimbe | 16,00 | Hidráulica pasada | Generador |
| Machala Power | 140,00 | Térmica turbogas | Generador |
| Intervisa Trade | 105,00 | Térmica turbogas | Generador |
| Ulysseas | 30,00 | Termica MCI | Generador |
| Termoguayas | 150,00 | Termica MCI | Generador |
| Generoca | 37,60 | Térmica MCI | Generador |
| **Total** | **656,23** | | |
| **Total autogeneradores** | **177,63** | **27%** | |
| **Total generadores** | **478,60** | **73%** | |
| **Total Hidráulica** | **74,35** | **11%** | |
| **Total Térmica** | **581,88** | **89%** | |

This chart shows that private investment has mainly been in thermoelectric generation, which is understandable considering that the risks are lower than in hydroelectric generation, with its longer payback periods and greater risks during construction and operation, as well as almost systematic opposition by residents, mobilized by environmental advocacy NGOs.

Our investigations and statements by electrical sector officials would indicate that many of these actions to oppose hydropower projects are supported behind the scenes by private economic interests.

At present, 285 MW of thermoelectric generation belonging to Intervisa, Ulysseas and Termoguayas, is operating on barges.

Another important issue is that 73% of private investment has been for self-supplying generation, in most cases selling their surplus energy to the market. There is only one private hydroelectric generation company on the market as a generator. However, they are reported to have begun the process to become self-supplying generators.

The case of Machala Power deserves specific discussion. On 15 October 2001, a Concession Contract was signed for construction, installation and operation of a plant to generate electrical energy, with the MACHALA POWER C. LTDA. company, to install and operate the Machala Project, which will have a power plant with a generating capacity of up to 312 MW.
Phase I of this project has been in commercial operation since September 2002, and has been contributing its energy to supply the domestic market's demand.

The following phases had these characteristics and conditions:

- Phase II (70 MW) was to begin construction in September 2003, and start operating in July 2005, for an implementation timeframe of 22 months.
- Phase III (112 MW) was to start in August 2006 and begin operating in April 2008, for an implementation timeframe of 22 months.

The implementation timeframes for the following phases have changed, and will depend on the amendment contracts. At this writing, implementation of Stages 2 and 3 has not been defined, but there are serious doubts as to whether Machala Power will remain on the market. It is speculated that they may sell their facilities to Duke Energy of the United States, owner of the Electroquil generator, which has operated for over a decade, although so far they have not signed any concession contract.

Machala Power uses the gas from the Amistad field located in the Gulf of Guayaquil, concessioned by the Ecuadorian Government to the EDC company, who jointly with Machala Power are subsidiaries of the Noble Energy company of the United States of America.

EDC has reported proven reserves of 225,000 million cubic feet (MMCF) and total reserves (proven + probable + possible) of 339,000 MMCF. According to 2006 statistics, the two Machala Power units (130 MW ) consume 9000 MMCF a year.

The Wholesale Electric Market has built up debts to Machala Power, which according to the latest consolidation total around USD 67 million up to December 2007. This has led to a lawsuit brought by the Company with CIADI against the Ecuadorian Government and several of its institutions, which could be dropped if the State would meet these obligations.

The State has acknowledged this debt and there is agreement regarding the amount. Three payments were agreed upon, of which the first two have been paid and the last

is due to be completed by late April. However, the debt accrued since January 2008 remains, which totals some USD 15 million.

There are many other private initiatives to install generation in Ecuador that have not materialized either because of difficulty in project financing or because of community opposition to building the facilities.

This is the case of the Angamarca 70 MW plant, promoted by a group of Ecuadorian companies, which had to suspend work due to community opposition. This project is currently on hold, as are many others, and its shareholders seem to be unwilling to continue with it.

CONELEC has a roster of numerous projects, some under contracts and others with permit certificates, which have not materialized.

***In summary, experience with private generation in Ecuador has not shown very good results to date. It is to be hoped that, with new market rules and more assertive action by the State to support project implementation, this situation can be turned around.***

## 6. THE TRANSMISSION SYSTEM

Transmission in Ecuador is under the responsibility of a single state-owned enterprise, which up to a few months ago was the TRANSELECTRIC S.A. Transmission Company, currently merged into the newly-formed Electric Corporation of Ecuador (CELEC S.A.).

As a government-owned monopoly, transmission is subject to prices and quality conditions established by the regulatory authority. Norms ensure distributors and generators free access to the transmission system. Therefore, the transmitter cannot deny access to its system to any agent, except for technical reasons. The rules and procedures for free access are set in the Regulations for Free Access to Transmission and Distribution Systems.

According to Article 9 of those Regulations: *"The transmitter and distributors must grant free access by third-party agents of the MEM to the existing or remnant transport capacity of their systems and, in the case of a dedicated interconnection line, free access will be conditioned on its system's remnant capacity...."*.

As defined in these Regulations, a dedicated line "*...Corresponds to facilities for transmitting electrical energy that, under the conditions established in a dedicated interconnection line license granted by CONELEC, proves electrical energy transport services to link agents of the MEM with the SNT or with international interconnection nodes".*

An agent wishing to connect to the National Transmission System (SNT) must submit an application to the transmitter and meet a series of requirements, which are established in Article 30 of those Regulations:

> *"Article 30. Applications for access.*
>
> *Interested parties requiring access to the SNT's existing or remnant transmission capacity must submit a written application to the transmitter, which must contain and attach the following information:*
>
> *a) Description and technical characteristics of existing facilities to link the user to the SNT, if it has been connected previously;*
>
> *b) Description and technical characteristics of facilities and/or devices to connect to the SNT in the event of a new connection, and/or the change to be made in an existing connection, and the location planned for the new connection, which must be at an SNT bar. For this purpose, the necessary information must be supplied for planning and expansion of the transmission system, which is mandatory to submit under current norms;*
>
> *c) Date to commission the service required by the user and, as applicable, the schematic timetable for construction or adaptation of the facilities;*

d) *Requirements for public energy transmission service and power, by six-month seasonal period, for the coming four (4) half-years and estimates for the following eight (8) years, with the studies needed to suitably justify the requirement if the application for access involves new demand or increase in demand by distributors;*

e) *Studies by the SNT, regarding the steady state and any electromechanical and electromagnetic transitional occurrences, as needed to verify the application's technical feasibility, indicating adjustments or modifications required in facilities of other agents, if any. These studies must be done by a company approved by the transmitter and submitted for analysis and monitoring;*

f) *The information required for the purposes of Article 20(e), sub-section 8 of the Regulations replacing the General Regulations must be forwarded to CONELEC by the transmitter; and*

g) *Any other information deemed necessary to assess the project or that may be required.*

The transmitter conducts its technical activity mainly subject to the following rules: Rule 006/00 "Dispatch and Operation Procedures", Rule 004/02 "Reactive Power Transactions on the MEM", and Rule 003/08 "Quality of Electricity Transport and of the Service of Transmission and Connection in the National Interconnected System".

On the basis of the studies conducted by CENACE and approved by CONELEC, the following voltage limits have been set for transmission system points of delivery:

- For the 230 kV level: +/- 5%
- For the 130 kV level: +5%, -7%
- For the 69 kV level: +/- 3%

The transmitter has the obligation to expand the system on the basis of the Ten-Year Transmission Expansion Plan approved by CONELEC and reviewed yearly. This Plan aims to guarantee that demand will be covered with quality, safety and reliability pursuant to the norms. According to Rule No. 013/08, the transmitter must submit the Expansion Plan by 31 March each year, and CONELEC has two weeks to review it, followed by a period of adjustment, review and final approval that takes approximately a month. This modality was applied for the first time in 2009.

The rate for transmission system use is set by CONELEC on the basis of a cost study. Up to July 2008, the transmission rate had a component to cover administration and operating costs, and another to finance expansion, pooled in a specific fund especially created for that purpose.

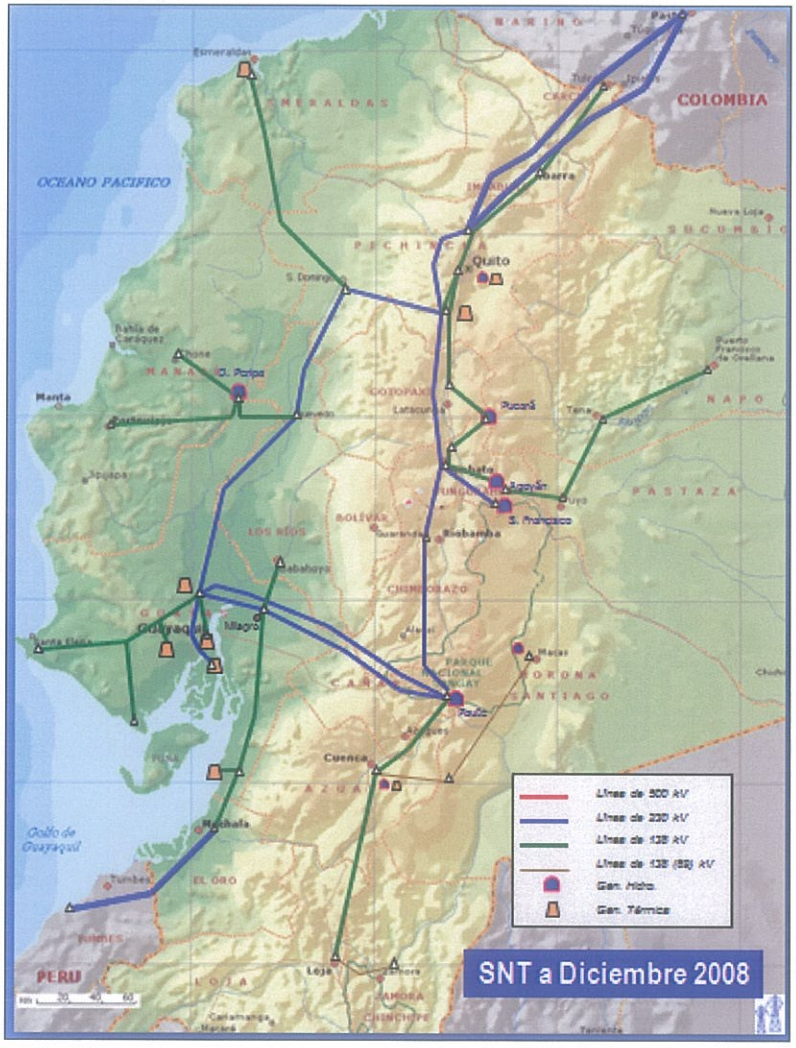
As of August 2008, a new rate scheme was implemented by the resolutions contained in Constitutional Mandate No. 15, eliminating the component for expansion which the

State will finance directly. Under this new arrangement, CONELEC set a Transmission Rate of USD 1.56 / kW-month, equivalent to USD 0.03423 (3.423¢) / kWh in energy terms.

## 6.1 CURRENT SITUATION

The National Transmission System of Ecuador (SNT) is configured as shown in Illustration 23, comprising 1,481 km of 230 kV circuits (dual-circuit lines), 1,629 km insulated for 138 kV and 7,305 MVA with peak capacity at substation transformers.

**Illustration 23 NATIONAL TRANSMISSION SYSTEM – 2008**
**SNT as of December 2008**
**500 kV line**
**230 kV line**
**138 kV line**
**138 kV (69) line**
**hydroelectric**
**thermoelectric**




The system basically comprises a 230 kV ring linking the main sources of hydroelectric generation located in Paute, Agoyán, San Francisco and Pisayambo, with the main load

centers located in Quito and Guayaquil and their areas of influence. The country's thermoelectric generation facilities are also concentrated around Guayaquil.

The 230 kV system has 138 kV branches feeding regional systems on the Coast, in the Highlands and the Amazon region.

There are also international interconnection lines with Colombia and Peru. Interconnection with Colombia is achieved through two dual-circuit 230 kV transmission lines linking the substations of Pomasqui in Ecuador and Jamondino in Colombia, which have a joint rated capacity of 500 MW. Interconnection with Peru consists of a single-circuit 230 kV line with 100 MW capacity, starting at the Machala substation in Ecuador and leading to the Zorritos substation in northern Peru. This line was constructed in 2006 but is in disuse due to a lack of agreements for commercial operation.

## 6.2 PROJECTS BEING DEVELOPED

The projects under development worth discussing because of their significant impact on the SNI are the following:

- Totoras – Quevedo 230 kV Transmission system that will make the current 230 kV ring into a dual ring, increasing system reliability;

- Milagro – Las Esclusas – Trinitaria 230 kV Transmission system which, together with the Trinitaria – Salitral system, will establish a 230 kV ring around Guayaquil.

- Milagro-Machala 230 kV Transmission system which, as well as improving safety conditions for supply in southwestern Ecuador, will incorporate new generation using gas from the Gulf of Guayaquil.

- Quevedo – Portoviejo and Portoviejo – Manta 230 kV Transmission system, and Chongón Lake – Santa Elena 230 kV Transmission system, which will improve operating conditions in these different regions of the country.

- Paute (Zhoray) – Cuenca (Sinincay) 230 kV Transmission system to expand the energy supply capacity for the city of Cuenca, due to start operation the fourth quarter of 2009.

- Cuenca – Loja 138 kV Transmission system (second circuit), to improve reliability and operating conditions in southern Ecuador, due to start operating the first quarter of 2010.

- Loja-Cumbaratza 138 kV Transmission system, which will reinforce and operate the Loja-Cumbaratza 138 kV line belonging to the transmitter at 138 kV (currently operating at 69 kV) to serve the eastern province of Zamora Chinchipe (Zamora, Nambija, El Pangui, Gualaquiza, etc.) and due to start operating in 2012.

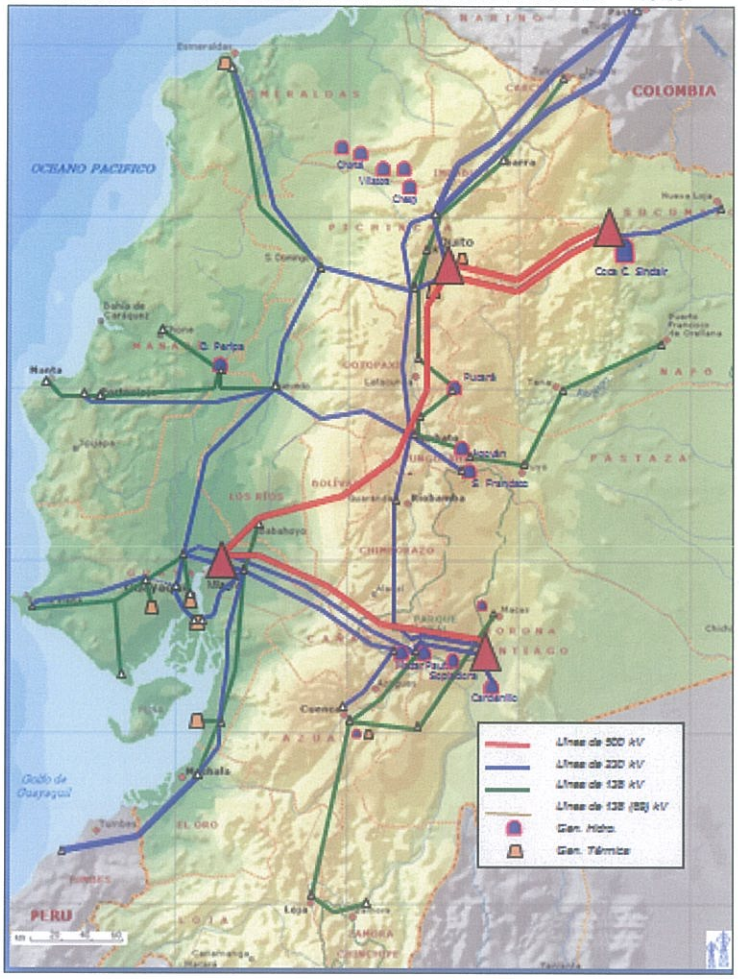
## 6.3 TEN-YEAR EXPANSION PLAN

The Transmission Expansion Plan for the 2009-2020 period submitted by the transmitter to CONELEC for approval includes the following projects to be implemented during that period:

**Table 11 TRANSMISSION EXPANSION PLAN, 2009-2020**

| TRANSMISSION EXPANSION PLAN, 2009-2020 | | |
|---|---|---|
| **Item** | **Description** | **Budget (USD x $10^3$)** |
| 1 | Expanding substations. | 59,169 |
| 2 | Substation reserve (service quality records). | 14,077 |
| 3 | Modernizing substations and measuring service quality. | 6,673 |
| 4 | Event recording system – first phase. | 600 |
| 5 | Milagro - Machala 230 kV transmission system. | 39,108 |
| 6 | Cuenca – Loja 138 kV transmission system. | 4,482 |
| 7 | Quevedo - Portoviejo 230 kV transmission system. | 34,612 |
| 8 | Zhoray - Cuenca 230 kV transmission system. | 12,651 |
| 9 | Lake Chongón - Santa Elena 138 kV transmission system. | 15,198 |
| 10 | Capacitative compensation. | 17,671 |
| 11 | Interconnection with Colombia, second 230 kV line. | 14,055 |
| 12 | Northeast 138 kV transmission system. | 5,694 |
| 13 | Salitral - Trinitaria 138 kV transmission system. | 3,872 |
| 14 | Nueva Prosperina (Perimeter) 230/69 kV substation. | 10,134 |
| 15 | Trinitaria - Las Esclusas 230 kV transmission system. | 7,905 |
| 16 | Pifo (El Inga) 230/138 kV substation. | 12,072 |
| 17 | Totoras - Quevedo 230 kV transmission system. | 26,779 |
| 18 | Loja - Cumbaratza 138 kV transmission system. | 4,708 |
| 19 | Quinindé 138/69 kV substation. | 5,063 |
| 20 | Totoras - Ambato 138 kV transmission line (upgrade). | 507 |
| 21 | CCSinclair - Nueva Loja 230kV transmission system. | 15,536 |
| 22 | Totoras - Guaranda 138 kV transmission system. | 7,744 |
| 23 | S. Gregorio - San Juan de Manta 230 kV transmission system. | 12,913 |
| 24 | Machala-La Unión-Minas 230 kV transmission system. | 16,717 |
| 25 | Pomasqui - Chespi 138 kV transmission system. | 7,720 |
| 26 | Toachi Pilatón 230 kV transmission system. | 10,276 |
| 27 | Yaguachi - Nueva Salitral 230 kV transmission system. | 14,490 |
| 28 | Chavezpamba (Tabacundo) 138/69 kV substation. | 5,063 |
| 29 | Dos Cerritos - Las Orquideas 138 kV transmission system. | 19,166 |
| 30 | Dos Cerritos - Durán 138 kV transmission system. | 9,900 |
| 31 | Nueva Loja - Orellana 138 kV transmission system. | 9,887 |
| 32 | N. Prosperina - Santa Elena 230 kV transmission system. | 8,636 |
| 33 | La Troncal (ex Milagro) 230/69 kV substation. | 6,803 |
| 34 | Esmeraldas - Sto.Domingo 230 kV transmission system. | 42,897 |
| 35 | Milagro - Las Esclusas 230 kV transmission system. | 25,098 |
| 36 | Las Esclusas - Caraguay 138 kV transmission system. | 16,775 |
| 37 | Pascuales 138/69 kV substation expansion. | 3,198 |
| 38 | 500 kV transmission system | 364,438 |
| | **Overall total** | **892,288** |

**Illustration 24 NATIONAL TRANSMISSION SYSTEM – 2020**




The system features a dual 230 kV ring with 230 kV branches for the different regions of the country, except for a few zones: northeast, south and southeast will remain at 138 kV. Quito and Guayaquil will have 230 kV rings.

The 500 kV system that will link the major generating plants located in Coca Codo Sinclair (1500 MW) and the Paute complex, comprising the cascade power plants of Mazar, Molino, Sopladora and Cardenillo (2000 MW), with the main load centers for the system located in Quito and Guayaquil, will call for building four 500/230 kV substations located in Coca Codo Sinclair, Pifo, Yaguachi and Sopladora, although the exact construction sites have not yet been chosen.

The Pifo and Yaguachi substations will interconnect with each other through a 500 kV single circuit transmission line initially plans to run the route of Quito – Ambato – Guaranda – Babahoyo – Guayaquil. A complementary dual link will be constructed from Coca Codo Sinclair to Pifo, and a single link between Sopladora and Yaguachi.
The Sopladora 500/230 kV substation could be a point of access for the lines supplying the mining zone of Zamora Chinchipe.

This Expansion Plan has not considered special loads that major sectors will be requiring, such as petroleum refining (Refinery in El Aromo), mining in southeastern Ecuador, the metallurgical industry (in Posorja) and so on.

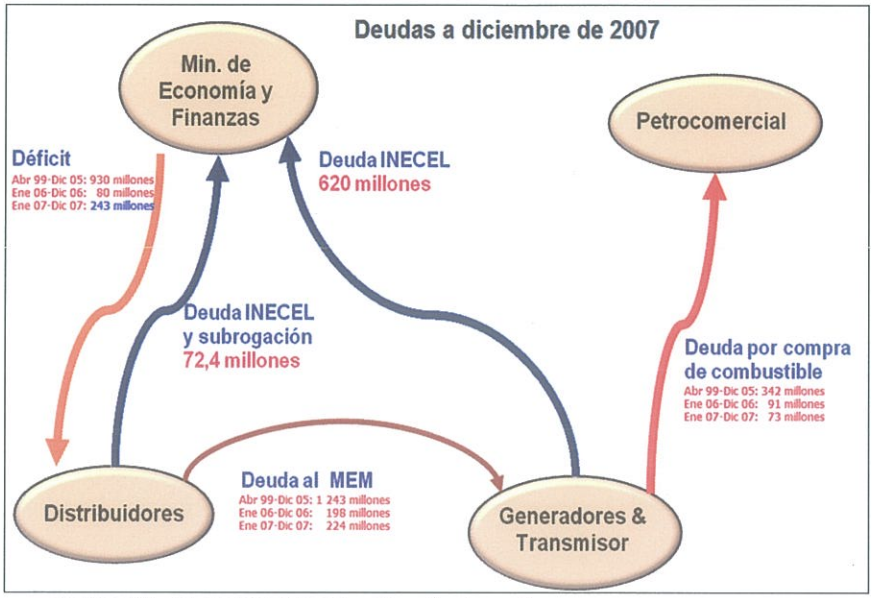
Therefore, and in view of the priority that the Government is granting especially to mining in Zamora Chinchipe, the expansion plan is likely to be updated, incorporating infrastructure for that region.

Financing for the currently version of the Expansion Plan (with a budget of USD 892 million) is at serious risk due to lack of State funding capacity. External financing sources will be sought to avoid postponing these projects, at least the most urgent ones.

## 7. THE ELECTRICAL SECTOR'S FINANCIAL SITUATION

The great weaknesses that the electrical sector has shown are revealed through its financial situation, building up a debt surpassing one billion dollars. The 2007-2016 Electrification Master Plan, which is the most recently published one, portrays this situation through the following diagram:

**Illustration 25 LIABILITIES DECEMBER 2007**




**Source**: CONELEC - PME 2007-2016 with adjustments

This illustration shows what the Ministry of Finance owes distributor companies for the rate deficit, what distributor companies owe generators for not paying for energy purchased on the Market, and what generators owe PETROCOMERCIAL for fuel purchases. Distributor companies, generators and the transmitter also owe the Ministry of Finance for the foreign debt of the former INECEL, which was transferred to the companies constituted with its assets.

Mandate No. 15 canceled these accounts among the Ministry of Finance, generation, transmission and distribution companies and Petrocomercial to put an end to this situation. As the figure shows, this is not so strange, because all the debts begin and end with the State, and can therefore be canceled out.

Table 12 shows some figures on the debts built up on the Market, where canceling accounts left a balance payable to private generators on the order of USD 81 million, itemized below:

Table 12 BALANCES AFTER CANCELING MUTUAL DEBTS IN THE ELECTRICAL SECTOR

| BALANCES FROM CROSS/CANCELATION OF GENERATION SECTOR ACCOUNTS | | |
|---|---|---|
| Period | Private | Public |
| April 1999-Dec. 2005 | 22,025,940 | 323,040,073 |
| 2006 | 34,496,716 | 72,805,272 |
| 2007 | 24,652,314 | 125,459,473 |
| Total | 81,174,970 | 521,304,818 |

Clearly this process should result not only in canceling accounts to consolidate balances owed, but also in payment of the arrears, especially to private stakeholders. In this regard, the largest outstanding debt is owed to the Machala Power company (of the Noble Energy group from the United States, also including the EDC company, which is extracting natural gas from the Amistad field), a total of USD 67 million, as itemized below.

Machala Power has brought suit before CIADI, against the Ecuadorian Government and several of its institutions. That lawsuit will be withdrawn once the State pays the outstanding debt, which is as yet unpaid due to lack of fiscal liquidity.

Arrears to the Machala Power generating company are outlined below:

Table 13 SITUATION OF MACHALA POWER

| LIQUIDATION OF ACCOUNTS MACHALA POWER | |
|---|---|
| Period | Balance |
| April 1999-Dec. 2005 | 35,049,672 |
| 2006 | 15,240,987 |
| 2007 | 16,834,372 |
| Total | 67,125,031 |

This debt is being paid in three parts, two of which have been paid and the last is scheduled for late April 2009. However, for the period from January 2008 to the present, further debt of approximately USD 15 million has accumulated, and is unresolved. In view of this situation, the lawsuit by the generator against the Ecuadorian Government with CIADI is still pending.

Despite the apparently good results of this cross-cancelation of accounts, the electrical sector's financial weakness can actually improve when the true causes of this situation are addressed, which include:

- High losses by distribution companies.
- Low collection rates in some of them.
- High expenses for administration, operation and maintenance.
- Lack of investment in infrastructure that could reduce technical losses.
- Lack of planning for distribution with a medium- and long-term vision.
- Inadequate administrative management of enterprises.

- Excessive political meddling with companies, above all in appointing administrators.
- Application of a rate that does not cover costs.
- High impact of State subsidies that are recognized but not paid on a timely basis.

It is understood that changes that have happened and will soon happen in the sector will address many of these weaknesses. However there is serious concern about the rate and the actual availability of funds to invest in infrastructure.

The high availability of funds when oil prices were high in the first half of 2008 made the government and those drafting the new Constitution over-optimistic, leading them to expect that situation to continue sustainably in the medium-term. This enthusiasm led them to underestimate the need for private capital in the electrical sector and they made structural changes so all investment in the electrical sector will be with State monies, so the expansion component was removed from the rate, while setting a single nationwide rate and creating new subsidies through the so-called "Dignity Rate".

When oil prices plummeted, the situation changed and State funding, which had been plentiful, began running dry. No reversal of the rate policy is likely, because of the social and political cost that would entail. This makes for an uncertain future for electrical sector investment projects, given the treasury's limited possibilities.

## 7.1 RESOURCES NEEDED TO INVEST IN EXPANDING THE ELECTRICAL SYSTEM

According to the Electrification Master Plan for 2007-2016, investment requirements for the electrical sector during that period total USD 6.187 billion dollars, of which USD 4.155 billion are for generation, USD 333 million for transmission and USD 1.7 billion approximately for distribution.

**Table 14 INVESTMENTS IN 2007-2016 MASTER PLAN**

| ITEMS | INVESTMENT REQUIRED (USD) X $10^3$ |
|---|---|
| Investments in generation | 4,154,700 |
| Investments in transmission | 333,718 |
| Investments in distribution (including FERUM) | 1,698,519 |
| **TOTAL 2007 – 2016** | **6,186,937** |

Just for 2009, the requirement is USD 1.625 billion.

Unofficially, the updated Master Plan for 2009-2020 (currently under review) significantly changes these figures, increasing to nearly USD NINE BILLION, of which USD 5.3 billion would be for generation, USD 892 million for transmission and the rest for distribution.

## 7.2 AVAILABLE RESOURCES

Compared to this required funding, Ecuador's policy and decision-maker agencies are allocating barely USD 520 million for 2009, approximately 30% of the amount required.

Most of this funding (USD 400 million) is for generation projects that have received State support, namely: Coca Codo Sinclair, Toachi-Pilatón, Baba, Sopladora, Cardenillo, Quijos-Baeza and studies for projects on the Guayllabamba river in the province of Pichincha. This allocation is not sufficient to pursue all these projects. Just Coca Codo Sinclair requires some USD 400 million for 2009.

Further, the allocation for investment in transmission of USD 30 million is completely insufficient to address the needs, which are on the order of USD 150 million for 2009. The same goes for distribution, with only USD 40 million allocated versus requirements of some USD 150 million.

**Table 15 ALLOCATIONS FOR INVESTMENT IN 2009**

| ITEMS | AVAILABLE FUNDS 2009 (USD) X $10^3$ |
|---|---|
| Generation projects | 400,000 |
| Transmission projects | 30,000 |
| Distribution projects | 40,000 |
| Rural Electrification Program | 24,000 |
| Others | 26,000 |
| **TOTAL 2007 – 2016** | **520,000** |

There are other funds available from the Solidarity Fund, which was authorized by Constitutional Mandate No. 9 to use them for investment projects. These funds are earmarked for transmission projects in the city of Guayaquil for USD 30 million, and to fund loss reduction projects in the distribution companies showing the lowest efficiencies. The Ministry of Electricity has reportedly committed USD 30 million of its budget to support distribution and transmission projects.

## 7.3 OTHER FUNDING SOURCES

In view of this situation, funding sources are being sought through loans from countries with which Ecuador has made connections, such as China and Iran, in addition to some lines of credit from multilateral agencies such as the IDB and CAF.

Financing from countries such as China and Iran will focus on generation.

There is reportedly an "Agreement of Understanding for Bilateral Cooperation in the Hydro and Energy Sectors of the Republic of Ecuador" signed by the Ministers of Electricity of Ecuador and Iran, involving Iranian companies in building the Quijos-Baeza (100 MW) and Río Luis (15MW) projects with financing from Iran's export development bank (Export Guarantee Fund of Iran- EGFI). Iranian missions have visited

Ecuador to check on these projects, but no concrete action has been taken yet. The Government of Iran is expected to present a bid, directly or through Iranian companies that have shown interest, for the Quijos and Baeza projects in the course of the next few months. Iran is also known to be interested in some of the projects on the Guayllabamba river, but no details are known.

Moreover, in the tender process to finance and construct the Coca Codo Sinclair project, on the basis of an agreement between Ecuador and Argentina through their State companies, Termopichincha and ENARSA, the Chinese companies, Sinohydro and Gezhouba, have submitted bids. These firms are offering to finance 85% of the total project cost, i.e., approximately USD 1.7 of the USD 2 billion the project will cost, through Chinese government-owned banks (Export-Import Bank of China-Eximbank)

Loans are also being arranged with the CAF and IDB to finance transmission projects. The IDB is reported to have offered a grant of USD 1.4 million to finance studies for a new 500 KV transmission system required to handle the output from the Coca Codo Sinclair project and the Paute hydroelectrical complex (comprising the Mazar, Molino, Sopladora and Cardenillo power plants).

Among all these alternatives, the only concrete one seems to be financing of the Coca Codo Sinclair Project by China, for which the State must grant its sovereign guarantee. In early April 2009, the Minister Coordinating Economic Policy announced that the following loans had been granted:

**Table 16 FUNDING BY FOREIGN LOANS**

| ITEMS | LOANS OBTAINED 2009 (USD) x $10^3$ |
|---|---|
| Inter-American Development Bank (IDB) | 150,000 |
| Andean Development Corporation (CAF) | 120,000 |
| Latin American Reserve Fund (FLAR) [1] | 482,000 |
| **TOTAL 2007 – 2016** | **752,000** |

(1) to be defined concretely by late April 2009

It is also reported that a loan will be negotiated for USD 1 billion with China Development Bank, and a total of USD 500 million will be received in 2009 from IDB, to finance strategic projects, particularly in the energy and petroleum area. However, the amount allocated for the electrical sector and for which projects is unknown.

## 8. MARKET, COSTS AND RATES

### 8.1 SPOT MARKET AND CONTRACT MARKET

As indicated, current legislation allows only spot market or short-term sales or long-term contracts on this market.

***Spot market***. This involves short-term transactions in which the energy price is set on an hourly basis according to optimal dispatch of the generation resources required to cover the demand. This market is open to generators who deliver their energy, and to distributors and large consumers who buy it. CENACE operates the System and administers the Market, notifying tall market players of the energy sale price for each hourly period, which is the marginal cost for that period. This price equals all sales made during each hourly period. The cost of the capacity or power charge, calculated on the basis of a procedure set by regulations, is added to this price.

***Contract Market***. Also called the long-term market, it comprises all term contracts freely agreed or tendered publicly between generators and large consumers, and those between generators and distributors, for at least on year's time. Term contracts must be fulfilled by generators, regardless of whether their generation units are dispatched. If not dispatched, the seller must fulfill the contract by paying the generator dispatched in its place, at the market price for the period when this happens.

During the 2000-2008 period national demand has grown by 844 MW, whereas the generating capacity has increased by only 750 MW. Additionally, considering that about 180 MW of obsolete generating facilities have been withdrawn, the actual increase in generation capacity, without counting interconnections with Colombia and Peru, is on the order of 570 MW.

These figures show that investments in generation are falling short, reducing reserves by 274 MW, and this reduction is significant under circumstances when generation units have unscheduled shutdowns or for maintenance. In fact, CENACE operating reports show levels of unavailability of power plants that often reach 800 MW.

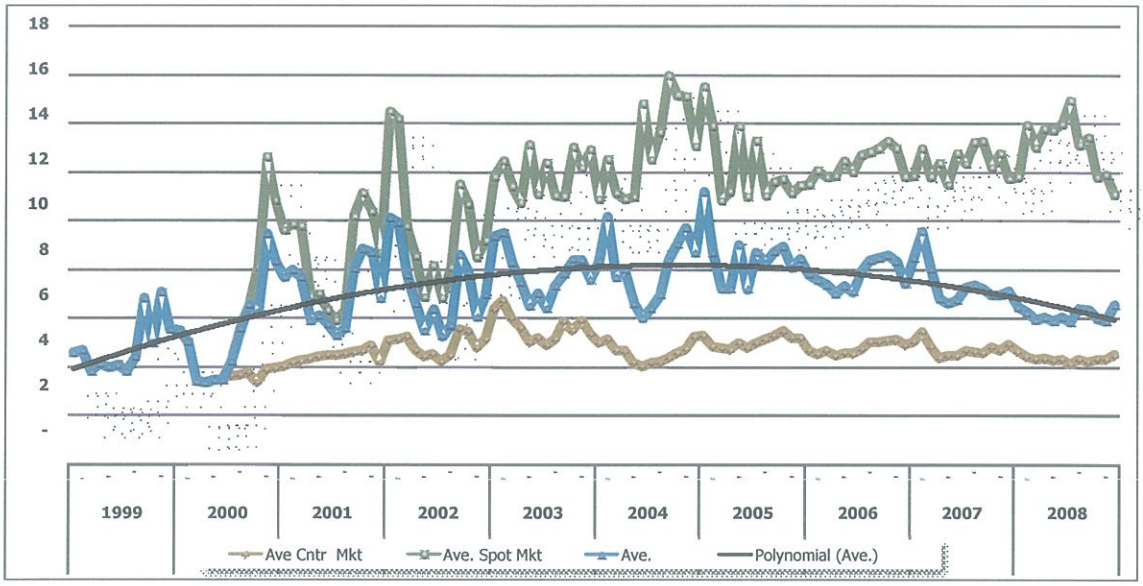
This situation has made the system increasingly dependent on the hydrological conditions of the power plants located on the Amazon basin side of the mountains, especially during the dry season, which normally runs from October to March. Further, fossil fuel prices have risen, including diesel which must be imported, with increasing dependence on energy imports from Colombia.

This has all affected energy prices on the Wholesale Electric Market:

- Rising trend
- Highly volatile
- High prices

Spot and contract market price trends are shown below:

**Illustration 26 ENERGY PRICES ON THE WHOLESALE ELECTRIC MARKET**




Spot market prices have historically been quite volatile, tending to rise up to 2005, when Executive Decree No. 338 of 25 July 2005 fixed fuel prices for electrical generation, curbing this trend. Spot market prices held fairly steady until a new growth period in 2008 till the third quarter, then dropping sharply toward year-end.

The contract market has behaved differently, with prices staying within a band, sagging slightly in 2008. This does not seem quite logical, since contract market pricing usually follows spot market behavior.

This is explained by contracts signed by State-owned generators with distributor companies, also State-owned, at prices not negotiated at market conditions, but imposed, under clear policy guidelines, attempting to buffer the companies' financial crisis.

Distributor companies, according to 2008 statistics, got 74.4% of their energy through contracts and 25.6% on the spot market, so they were hard-hit by spot pricing, having to cope with spot prices higher than the Reference Price for Generation (PRG) that they are paid under the rate.

This is one of the factors weighing heavily on the electrical sector's economic and financial situation, so along with investment in generation and management of distributor companies, it has been necessary to review the Wholesale Electric Market's operating model to minimize the impact of spot market volatility, show better performance for private stakeholders who want to invest in generation, and adapt to a new reality of increasing, direct State participation.

Constitutional Mandate No. 15 issued by the Constitutional Assembly meant a change in major features of the electrical sector, including the way the market operates. Pursuant to that Mandate, CONELEC has issued Regulations No. 006/08 and 013/08,

which set the new rules for electric market operation, emphasizing long-term contracts, and substantially reducing short-term energy market transactions, which will tend to disappear.

This model, which could be called a Regulated Contracting Model, is described in Rule No. 013/08 and has the premise of recognizing generation costs (fixed and variable), for both private-capital generators and those with public of governmental ownership. Contract prices are set on the basis of an individualized analysis of costs, which in the case of public generators will be regulated by CONELEC, whereas for contracts with private generators they will be subject to individualized negotiation with each stakeholder.

The mechanisms are currently being discussed for tenders for new generation contracts.

## 8.2 DISPATCH

Dispatch is pursuant to the Regulations on Dispatch and Operation, approved by Executive Decree No. 591 of 11 February 1999, published in Official Gazette No. 134 of 23 February 1999.

According to these Regulations, CENACE – the agency charged by Law with operating the system – performs the following tasks:

- Plans operation, coordinates and issues the maintenance program for generating plants and the transmission system.
- Supervises compliance with the maintenance program.
- Calculates and reports on hourly economic dispatch, overseeing implementation and performing real-time supervision of the National Interconnected System.

All this is geared toward optimally utilizing the generation resources subject to central dispatch, including international interconnections. For this purpose, CENACE updates the Annual Operating Plan quarterly.

CENACE calculates the hourly economic dispatch of generation resources subject to central dispatch and energy transfers y international interconnections, to cover the hourly demand and minimize operating costs, considering:

a) Prediction of hourly demand;
b) Variable Costs of Generating Units;
c) Technical restrictions imposed on the whole system or part of it, including generation with obligations regarding service quality criteria, electrical safety or inflexibilities in operation;
d) The maintenance program for generation units subject to central dispatch;
e) Electricity import and export forecasts for international interconnections;
f) The generation reserve margin according to criteria of reliability and service quality established in Dispatch and Operating Procedures; and

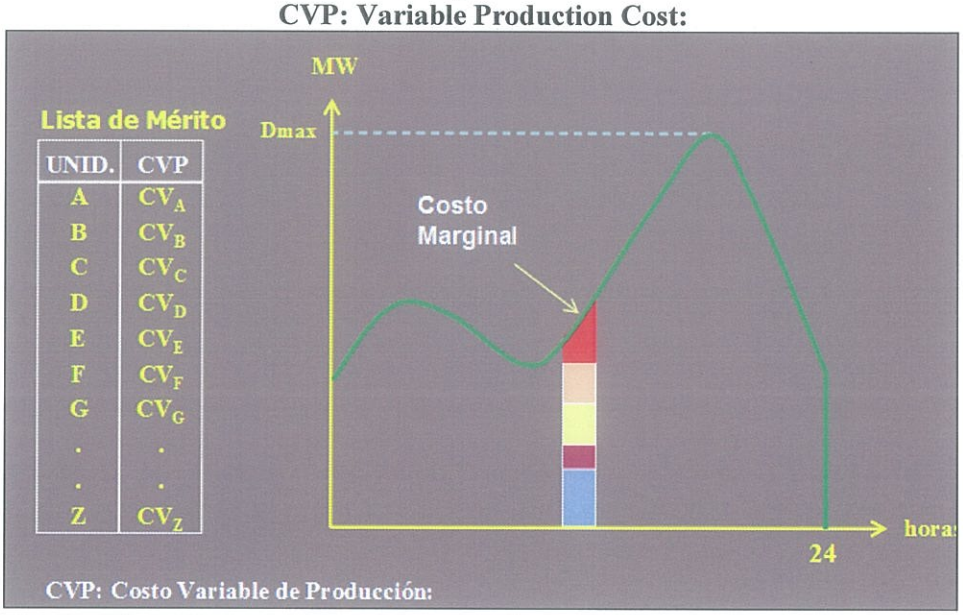
g) Other particular aspects to be indicated in the Dispatch and Operation Procedures.

CENACE notifies generators of hourly dispatch on a daily basis, supervising and overseeing compliance. The Hourly Dispatch may be modified during operation in system real time, to adjust to operating conditions and available system resources.

All Generators with a unit rated at 1 MW or higher and synchronized to the National Interconnected System are subject to centralized dispatch by CENACE. Centralized dispatch is done by generating units for thermoelectric power plants, and by plants for hydroelectric plants.

Generators are obliged to operate their units according to the hourly generating program established by CENACE. All generation, exports and imports over international interconnections are recorded with CENACE.

**Illustration 27 HOURLY ENERGY DISPATCH**
**List of merit**
**Unit CVP**
**Marginal cost**
**CVP: Variable Production Cost:**




Dispatch from generation units is fundamentally done on the basis of their variable production costs, calculated according to Rule No.03/03, Declaration of Variable Production Costs. Variable costs are declared by generators and audited by CENACE. Units are dispatched, from lowest to highest variable cost, until the hourly demand is covered.

Illustration 26 the Variable Production Costs of thermoelectric generators. For dispatch purposes, CENACE has assumed a variable cost of USD 2 /MWh for hydroelectric generation.

According to the norms, the last unit to be dispatched is the marginal unit and its variable cost is the marginal cost that, in turn, sets the price of energy for the hourly band. On the spot market, energy is sold at the hourly marginal price.

This arrangement was supposed to encourage private investors to install efficient generation efficient and lower operating costs. Including this type of units in the Dispatch will displace the least efficient units with the highest variable costs, reducing energy prices.

This should signal a multiple positive effect, including:

- Incorporating efficient generation
- Reducing energy prices
- Reducing end user rates

However, the lack of involvement of new stakeholders and the absence of new generation projects has prevented these results and, on the contrary, yielded some negative effects:

- Profit margins that are too high, for the existing hydroelectric generators.
- Ever-higher energy prices, as high operating cost thermoelectric units must be dispatched to cover increasing demand.
- High energy prices cannot be passed on to the end user rate.
- Rate deficit and the need to apply government subsidies.
- Late payment or non-payment of subsidies.
- Overall deficit, sector-wide.

The first effect listed above would have encouraged investment in hydroelectric generation, but the other negative factors prevented this, such as non-payment to generators.

Changes in market regulation do not affect economic dispatch of units or system operation, which continues under the same principles, rules and norms as before, from Rule No.006/00, Dispatch and Operating Procedures.

Nevertheless, item 11 of Rule No. 013/08 changes the definition of hourly marginal cost, to "hourly energy cost", i.e., the economic cost obtained from actual generation dispatch at the end of each hour. Further, *"The hourly energy cost will be determined as a function of the economic dispatch by CENACE to cover system demand, considering the criteria set in Article 13 of the current Regulations for Operation of the Wholesale Electric Market. The cost set in this way, which will not consider incremental transmission losses, will be the same for all bars in the system."*

This is a formal change in terminology and does not affect the concept of Economic Dispatch itself. The fundamental change, rather, involves market rules, which are oriented toward a contract market, in which the energy price will be negotiated between parties, and will not depend on dispatch conditions.

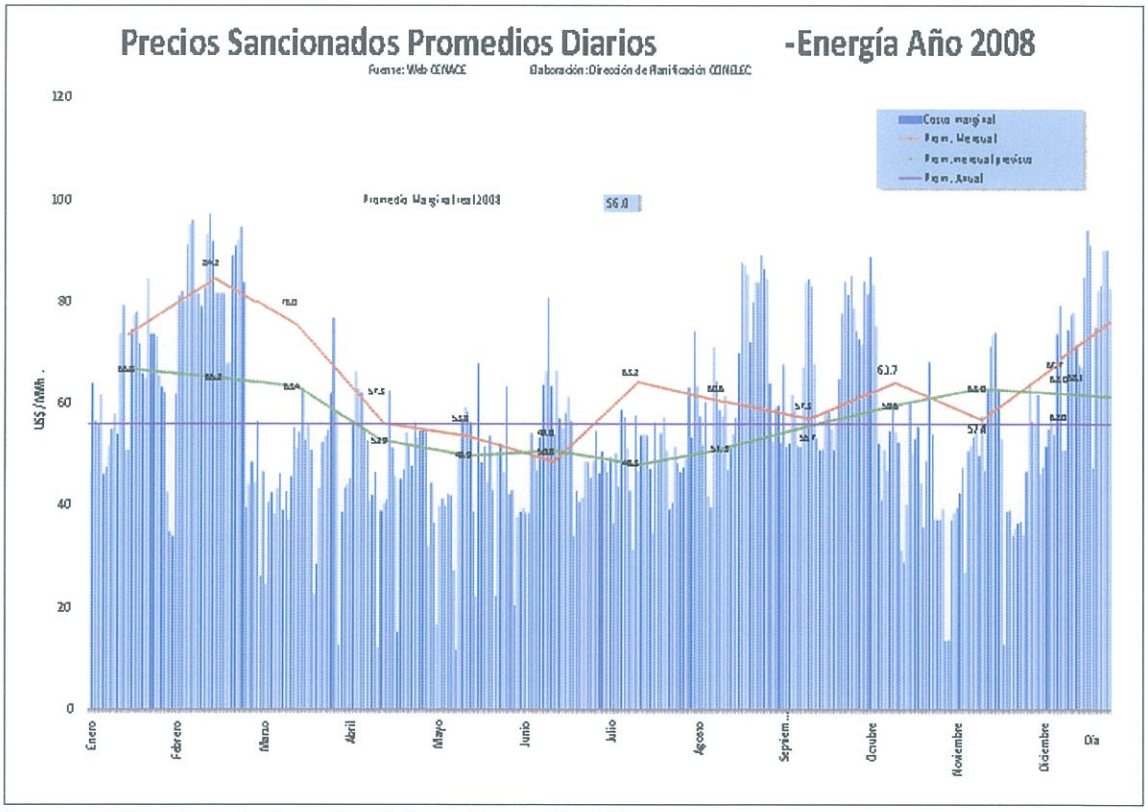
Dispatch will continue independently of contracts, which will become solely financial instruments. Accordingly, signing a term contract for energy purchase and sale will be no guarantee of dispatch for the units involved.

## 8.3 ENERGY PRICE VOLATILITY

Volatility of short-term or spot market prices will be highly dependent on hydrological conditions on the rivers flowing down on the Amazon basin side, where most of Ecuador's hydroelectric generation capacity is located.

Hydrological conditions in this region come under two clearly defined seasonal periods: A rainy period from April to September and a dry period without rains from October to March, driest from December to February, which is when thermoelectric generation is needed most.

**Illustration 28 SPOT MARKET ENERGY PRICE VOLATILITY**
**Average daily approved prices - 2008 energy**
**Source: Web CENACE Prepared by: CONELEC Planning Department**
**Marginal cost**
**[illegible]**
**Average for 2008**
**January February March April May June July August September October November December Day**




**Source**: CONELEC, Early Operating Information on the SNI

The illustration shows price behavior on the spot market for 2008, with energy price variation ranging roughly from 10 USD/MWh to 100 USD/MWh. It also shows that prices are highest during the dry season, October - March. However, during different

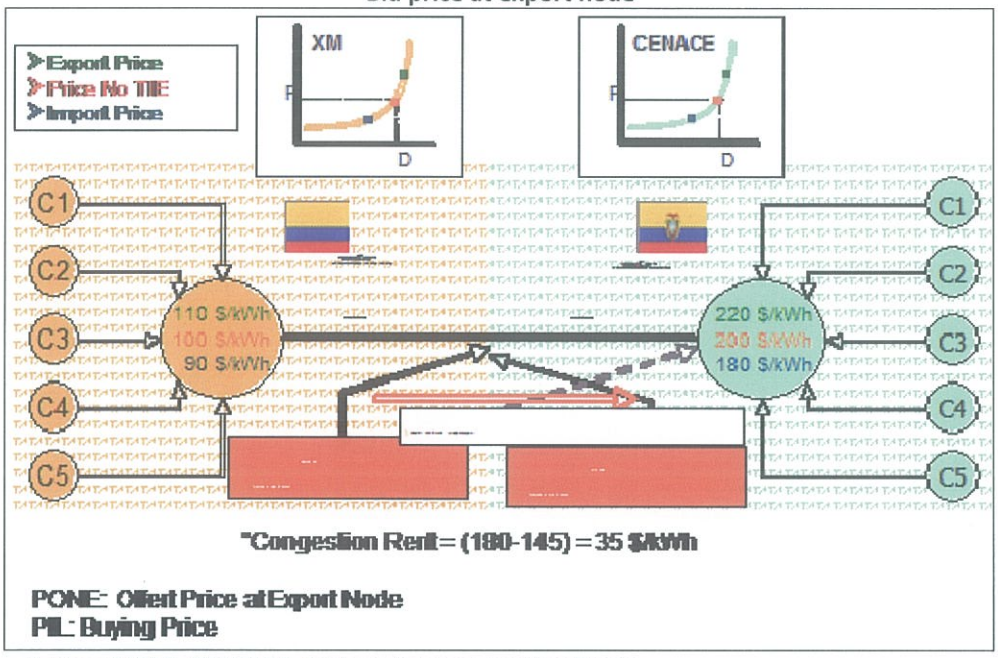
months of the year there are periods when prices rise significantly, due to brief drought or when major generation units interrupt operation.

This price volatility generates uncertainty, discouraging private investment in hydroelectric generation. This condition is reversed in the new market model, in which energy prices are stabilized and established on the basis of generators' cost structure.

## 8.4 ECONOMIC CONDITIONS FOR IMPORT AND EXPORT

International electricity transactions (TIE) involving imports and exports are based on the guidelines set by Decision 536 of the Community of Andean Nations (CAN) and the internal norms set on that basis in the "Regulations for International Electricity Transactions" (Executive Decree No. 3448 of 12 December 2002, Official Gazette No. 735 of 31 December 2002.)

**Illustration 29 ENERGY TRANSACTIONS BETWEEN ECUADOR AND COLOMBIA**
**Non-TIE price**
**Congestion Revenue**
**Bid price at export node**




**Source**: MEER, CONELEC, Andean Interconnection Study

The illustration explains how TIE operate between Ecuador and Colombia. The Colombian operator (XM) does its economic dispatch and sets its energy price for export, which must be the same as for its domestic market, including fixed costs, variable costs and other charges. Then the Ecuadorian operator (CENACE) compares the price bid by Colombia with the domestic marginal cost resulting from its hourly dispatch. If Colombia bids a lower price, the importation happens. The import is treated the same as any local generator and therefore the energy is valued at the Ecuadorian market price.

In international transactions theory, if the physical link between two systems had unlimited capacity, the prices of the two markets would tend to balance. Since in

practice this does not happen and links have transfer limitations, there is a price differential between interconnection nodes. This price differential, multiplied by the energy transferred in import or export comprises what is called "Congestion Revenue".

Under the commercial arrangement still in force, congestion revenue belongs to the exporter. Under the new arrangement expected to take effect soon, this revenue is divided 50-50 between exporter and importer.

A consultancy funded by UNDP for a feasibility study of regional electrical interconnection described this procedure:

"The example in the figure shows the export price in Colombia, $110/kWh, as the result of economic dispatch with domestic demand plus export demand. This new dispatch gives rise to a net transfer of $10/kWh from Colombian consumers to Colombian producers. Similarly, the import price in Ecuador, $180/kWh, is lower than the price prevailing without imports, $200/kWh, and represents a transfer of $20/kWh from the producer to consumers. The price bid at the export node in Colombia, $145/kWh, is the sum of the export price, $110/kWh, plus transmission charges and others in Colombia of $35/kWh. In this example, the Colombia-Ecuador interconnection capacity is fully used as long as the import price in Ecuador ($180/kWh) is higher than the export price in Colombia (US$ 145/MWh), which yields a congestion revenue of $35/kWh. This is allocated almost 100% to the exporter and is equivalent to the difference between the import price in Ecuador and the PONE in Colombia (180-145= US$35/kWh)."[3]

The effects of importing energy from Colombia into Ecuador include:

- Reducing spot market energy prices.
- Reducing the impact of thermoelectric generation on dispatch.
- Reducing consumption of fossil fuels, particularly diesel.
- Reducing State payments to subsidize fuels.
- Improving reserve levels in the Ecuadorian system.
- Improving operating conditions in Ecuador's system.

For the Colombian system, which is approximately three times larger than Ecuador's, there are benefits, too:

- Utilizing installed generation capacity that would be unused without the exports.
- Improving generators' capacity to recover fixed costs.
- Increasing income for the electrical sector.
- Earning funds to finance rural electrification in Colombia.

These benefits led to the decision to build a second 230 kV link that has been operational since November 2008, expanding to 500 MW rated transfer capacity.

[3] Consultancy by associated firms: E.E. Ltda., KAS, COSANAC

Operational conditions reduce transfer capacity, especially during peak demand hours (17:00 – 22:00).

If the major hydroelectric projects that the State has supported in Ecuador materialize, particularly Coca-Codo Sinclair, Ecuador could achieve surplus capacity and an energy price level that would make it an exporting country. This is all the more likely because Colombia is beginning to foresee problems with its installed capacity in the medium term.

The regional electric interconnection feasibility study funded by UNDP is attempting to find other possibilities for energy exchanges with the countries of the region through physical links and financial instruments. The preliminary report of this consultancy found interesting hydrological complementarity between Ecuador and Chile, which means that Ecuador can purchase energy from Chile, during drought conditions. This would require a physical link enabling interconnected operation of these systems, and implementation of financial instruments, e.g., swaps.

## 8.5 SETTING PRICES AND RATES

One basic issue, perhaps the most important in a country's regulatory scheme, involves setting end user energy prices. With monopolies in both transmission and distribution, the State must intervene through a regulatory body setting criteria and, in some cases such as Ecuador's, the amounts to be applied for end user energy prices. When energy prices are regulated, they are called "rates". The instruments establishing the different rate charges and defining their application are called Rate Schedules.

Rates and rate schedules are approved by the CONELEC Board, subject to the current norms based on the National Constitution, followed by provisions of Constitutional Mandate No. 15 issued on 23 July 2008, the Electric Sector System Law and its Regulations, policies issued by the Government and Rules approved by CONELEC.

Studies underpinning rate schedules are based on technical and economic information provided by the generation companies, the transmission company and the distribution companies, complemented by an analysis of the country's micro and macroeconomic indicators.

In the electrical sector, rates are defined as the price that electricity service end users must pay for the electricity they consume to meet their needs.

### 8.5.1 Legal basis for setting rates

The main legal foundation for end user rate setting comprises:

- Electric Sector System Law - LRSE, (Article 13-d) empowering CONELEC, pursuant to Chapter VIII, Article 57 of that same body of law, to approve rate schedules for

regulated transmission services and end consumers of distribution as well as adjustment formulas, which will go into effect on January 1st of each year.

- The codification of the Electric Rate Regulations and amendments introduced by the Law to Reform the Electric Sector System Law, published in Official Gazette No. 364 of 26 September 2006.

- Constitutional Mandate No. 15 empowering CONELEC to set specific new regulatory parameters to set a single nation-wide rate for each consumer category.

- Rule No. CONELEC 006/08 of 12 August 2008 establishing the specific regulatory parameters to set the single rate that electric distribution companies must apply for each type of electrical consumption.

- Rule No. CONELEC 013/08 of 27 November 2008 complementing the previous rule in aspects of electric market operations.

### 8.5.2 Rate principles

Rate principles are established in Article 53 of the LRSE, Mandate No.15 and Rule No. 06/08 as follows:

- Rates applicable to end consumers will cover: the Reference Price for Generation, the transmission system costs, and cost of the distribution system for all distribution companies in the country. (LRSE)
- Rates must reflect actual costs of the service, based on parameters of quality and efficiency (LRSE).
- Cost studies must be prepared considering management indices established by CONELEC rules (LRSE).
- The rate structure for end consumers must reflect costs resulting from customers' modalities of consumption and their supply voltage level (LRSE).
- A single nationwide rate will be applied for users belonging to a single consumption category. (Mandate 15)
- If the single rate established nationwide is under the rate determined by a distributor's own costs, CONELEC will calculate the difference, including all subsidies or compensations that the State has granted. (Mandate 15)
- Rate schedules must be prepared taking into account the right of the lowest-income consumers to access electric service under economic conditions suited to their possibilities (LRSE).
- Accordingly, low-consumption consumers must be subsidized by high-consumption residential users in each geographical zone (LRSE).

Clearly, there is an apparent contradiction between the rate principles set in the Law and the single-rate scheme set by Mandate No.15. Since the latter overrides the former, its provisions override the Law and are the ones in force.

### 8.5.3 Rate components

Rates applicable to consumers are set considering the following items:

- The Reference Price for Generation
- Costs of the transmission system
- Costs of the distribution system

The latter, in turn, comprise:

- Costs associated with the consumer
- Operation and maintenance costs associated with distribution
- Costs to operate, maintain and improve public street lighting
- Costs from technical losses of power and energy, at the maximum levels accepted by the regulator.

### 8.5.4 Rate Schedule

The Rate Schedule is subject to the above norms, with Constitutional Mandate No. 15 at the top, followed by the General Law for Consumer Defense and its Regulations.

The Rate Schedule contains:

- End consumer rates
- Transmission rates
- Distribution tolls
- Public lighting rates

According to the particular characteristics of the different types of users and their consumption, three categories of rates have been established:

- Residential
- General
- Public lighting

The residential rate category is applicable to electrical service exclusively for domestic use; the general category is basically for commercial activities, providing public and private services and industry, and finally the category of public lighting applies to the public lighting of streets, avenues, plazas, parks, other routes of public circulation, and systems for lighted signs used to control traffic.

According to the voltage supply levels at the point of delivery, users are classified into high-, medium- and low-tension customers, as follows:

- High-tension customers have supply voltages higher than 40 kV, associated with sub transmission.
- Medium-tension customers receive delivery from 600 V to 40 kV; and

- Low-tension customers are supplied at the delivery point at less than 600V.

### 8.5.5 Evolution of the Electric Rate

Since 1998, rate schedules have been approved by CONELEC, apparently following the norms, although in practice actually following the economic and social policies of the different governments. In fact, cost studies underlying what has been called the "target rate" have not been reflected in the rates applied to users, which has generated a "rate deficit" that has not been fully acknowledged until Mandate No.15 was issued. Chart 9.1 shows the evolution of the Average National Rate and each of its components, highlighting the change for rates when the single nationwide rate was applied under Constitutional Mandate No. 15, since August 2008.

**Table 17AVERAGE NATIONAL RATE**
**(USD¢/kWh)**
**[NOTE: when putting in the decimal points – rather than the Spanish decimal commas – all the hundredths jumped to the next line...]**

| Item | Rates (USD cents /kWh) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | Nov. 2005 | | | | |
| | Nov. 2002 Oct.2003 | Nov. 2003 Mar. 2004 | Abr. 2004 Oct. 2004 | Nov. 2004 Oct.2005 | Oct.2006 Dec 2007 | Jan. 2008 Jul 2008 | Aug 2008 Dec 2008 (1) | Jan. 2009 Dec 2009 |
| Reference Price for Generation -PRG | 5.81 | 4.63 | 4.17 | 5.94 | 5.70 | 5.98 | 4.68 | 4.59 |
| Energy Component -PRG(E ) | 4.50 | 3.55 | 3.09 | 4.99 | 4.69 | 4.99 | - | - |
| Power Component -PRG(P) | 1.31 | 1.08 | 1.08 | 0.96 | 1.01 | 0.99 | - | - |
| Transmission Rate -TT | 0.76 | 0.71 | 0.71 | 0.69 | 0.66 | 0.64 | 0.47 | 0,.7 |
| Value Added by Distribution -VAD | 3.80 | 3.82 | 3.82 | 4.11 | 4.44 | 3.85 | 3.17 | 3.17 |
| **Average Rate -TM** | **10.38** | **9.16** | **8.69** | **10.75** | **10.80** | **10.47** | **8.23** | **8.23** |

(1) Since August 2008 the Value Added by Distribution has changed to Distribution System Cost.
**Source**: CONELEC

Table 18 shows the evolution of average prices for each distributor company, and the average price nationwide.

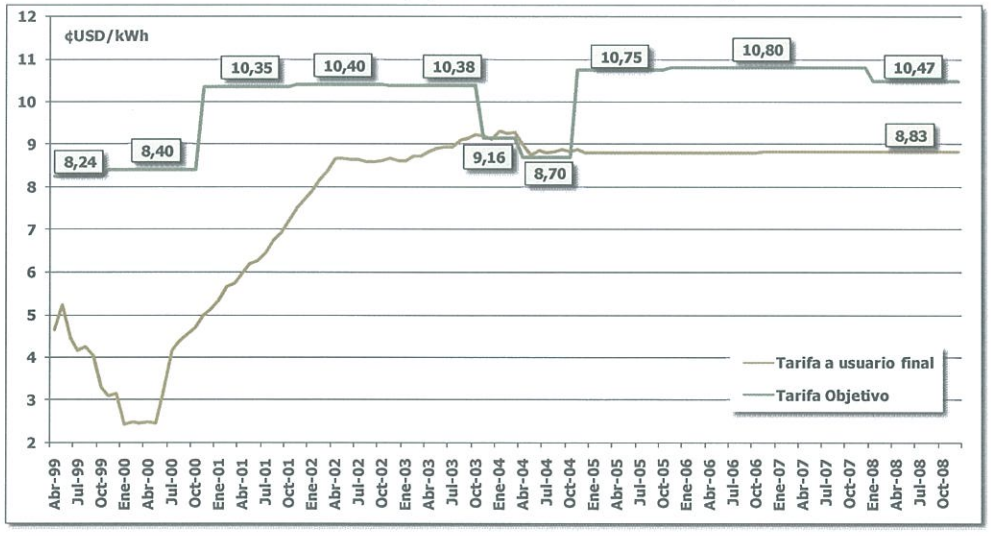
**Tabla 18 AVERAGE PRICE**
**(USD¢/kWh)**
**[All commas are "decimal commas", i.e., equivalent to decimal points.]**

| Company | Month and year of approval | | | | | | |
|---|---|---|---|---|---|---|---|
| | Oct. 2003 | Mar. 2004 | Oct. 2004 | Oct. 2005 | Jun. 2007 (1) | Oct. 2008 (2) | Feb. 2009 |
| Ambato | 11,32 | 10,77 | 12,05 | 11,20 | 10,99 | 9,21 | 9,35 |
| Azogues | 14,53 | 14,00 | 15,69 | 15,23 | 10,99 | 12,22 | 12,38 |
| Bolívar | 15,34 | 14,77 | 17,35 | 17,15 | 10,99 | 12,42 | 13,87 |
| CATED-D | 8,14 | 7,57 | 9,61 | 9,55 | 9,53 | 7,31 | 7,30 |
| Centro Sur | 10,39 | 9,88 | 12,54 | 12,70 | 10,99 | 9,76 | 9,13 |
| Cotopaxi | 10,45 | 9,91 | 12,28 | 11,03 | 10,99 | 9,55 | 9,38 |
| El Oro | 9,38 | 8,85 | 10,84 | 11,08 | 10,88 | 8,21 | 8,39 |
| Guayas-Los Ríos | 9,00 | 8,45 | 10,80 | 11,55 | 10,99 | 9,02 | 8,12 |
| Esmeraldas | 9,75 | 9,21 | 10,36 | 10,31 | 10,24 | 7,77 | 7,87 |
| Los Ríos | 9,45 | 8,88 | 11,13 | 11,24 | 10,99 | 8,65 | 8,62 |
| Manabí | 9,57 | 9,00 | 10,75 | 10,75 | 10,52 | 7,88 | 7,94 |
| Milagro | 9,16 | 8,61 | 10,62 | 11,03 | 10,92 | 8,38 | 8,80 |
| North | 10,61 | 10,07 | 12,43 | 12,55 | 10,99 | 9,73 | 9,56 |
| Quito | 8,75 | 8,21 | 10,40 | 10,42 | 10,92 | 8,20 | 8,10 |
| Riobamba | 11,81 | 11,28 | 14,39 | 15,32 | 10,99 | 11,21 | 10,52 |
| Santa Elena | 10,05 | 9,51 | 11,81 | 12,14 | 10,99 | 8,92 | 8,36 |
| Sto. Domingo | 9,06 | 8,53 | 10,80 | 11,55 | 10,99 | 8,69 | 8,67 |
| South | 12,98 | 12,43 | 15,79 | 15,42 | 10,99 | 11,26 | 11,92 |
| **Average** | **9,16** | **8,69** | **10,75** | **10,80** | **10,47** | **8,30** | **8,23** |
| Galápagos | 10,09 | 11,47 | 11,59 | 12,17 | 10,18 | 9,32 | 14,35 |
| Sucumbíos | 11,94 | 9,52 | 11,95 | 14,05 | 10,18 | 9,96 | 10,55 |
| (1) Average prices considering the subsidy for average VAD established in Art.12 of the Law to Reform the Electric Sector System Law, published in Official Gazette No. 364 of 26 September 2006 | | | | | | | |
| (2) Average prices pursuant to Constitutional Mandate No. 15 issued on 23 July 2008 | | | | | | | |

**Source**: CONELEC

The following illustration shows the historical behavior of the electric rate up to the present:

**Illustration 30 EVOLUTION OF THE ELECTRIC RATE**
**(April 1999 – December 2009)**




**Source**: CONELEC

**Illustration 31**
End user rate
Target rate
Apr. Jan....
**[All commas are "decimal commas", i.e., equivalent to decimal points.]**

| Company | Month and year of approval | | | | | | |
|---|---|---|---|---|---|---|---|
| | Oct. 2003 | Mar. 2004 | Oct. 2004 | Oct. 2005 | Jun. 2007 (1) | Oct. 2008 (2) | Feb. 2009 |
| Ambato | 11,32 | 10,77 | 12,05 | 11,20 | 10,99 | 9,21 | 9,35 |
| Azogues | 14,53 | 14,00 | 15,69 | 15,23 | 10,99 | 12,22 | 12,38 |
| Bolívar | 15,34 | 14,77 | 17,35 | 17,15 | 10,99 | 12,42 | 13,87 |
| CATED-D | 8,14 | 7,57 | 9,61 | 9,55 | 9,53 | 7,31 | 7,30 |
| Centro Sur | 10,39 | 9,88 | 12,54 | 12,70 | 10,99 | 9,76 | 9,13 |
| Cotopaxi | 10,45 | 9,91 | 12,28 | 11,03 | 10,99 | 9,55 | 9,38 |
| El Oro | 9,38 | 8,85 | 10,84 | 11,08 | 10,88 | 8,21 | 8,39 |
| Guayas-Los Ríos | 9,00 | 8,45 | 10,80 | 11,55 | 10,99 | 9,02 | 8,12 |
| Esmeraldas | 9,75 | 9,21 | 10,36 | 10,31 | 10,24 | 7,77 | 7,87 |
| Los Ríos | 9,45 | 8,88 | 11,13 | 11,24 | 10,99 | 8,65 | 8,62 |
| Manabí | 9,57 | 9,00 | 10,75 | 10,75 | 10,52 | 7,88 | 7,94 |
| Milagro | 9,16 | 8,61 | 10,62 | 11,03 | 10,92 | 8,38 | 8,80 |
| North | 10,61 | 10,07 | 12,43 | 12,55 | 10,99 | 9,73 | 9,56 |
| Quito | 8,75 | 8,21 | 10,40 | 10,42 | 10,92 | 8,20 | 8,10 |
| Riobamba | 11,81 | 11,28 | 14,39 | 15,32 | 10,99 | 11,21 | 10,52 |
| Santa Elena | 10,05 | 9,51 | 11,81 | 12,14 | 10,99 | 8,92 | 8,36 |
| Sto. Domingo | 9,06 | 8,53 | 10,80 | 11,55 | 10,99 | 8,69 | 8,67 |
| South | 12,98 | 12,43 | 15,79 | 15,42 | 10,99 | 11,26 | 11,92 |
| **Average** | **9,16** | **8,69** | **10,75** | **10,80** | **10,47** | **8,30** | **8,23** |
| Galápagos | 10,09 | 11,47 | 11,59 | 12,17 | 10,18 | 9,32 | 14,35 |
| Sucumbíos | 11,94 | 9,52 | 11,95 | 14,05 | 10,18 | 9,96 | 10,55 |
| (1) Average prices considering the subsidy for average VAD established in Art.12 of the Law to Reform the Electric Sector System Law, published in Official Gazette No. 364 of 26 September 2006 | | | | | | | |
| (2) Average prices pursuant to Constitutional Mandate No. 15 issued on 23 July 2008 | | | | | | | |

The latest cost study has been approved on 12 February 2009, finding an average real price of USD 0.0823 (8.23¢) / kWh.

### 8.5.6 Rate Structure in 2009

The CONELEC Board, in Resolution No. 020/09 of 12 February 2009, agreed on the cost analysis for the January – December 2009 period, as follows:

**Table 19 RATE STRUCTURE IN 2009**
**(USD¢/kWh)**

| Item | Rates | Units |
|---|---|---|
| Reference Price for Generation -PRG | 4.5868 | USD ¢ /kWh. |
| Unit Price to Pay for Power | 5.70 | USD/kW-mes. |
| Transmission rate for using the SNT | 1.56 | USD/kW-mes. |
| **Average National Price** | **8.23** | **USD ¢ /kWh.** |

Table 20 shows power and energy tolls for each distribution company.

**Table 20 DISTRIBUTION TOLLS**

(USD/kWh)

| Companies | Power toll (USD/kW-mes) | | | | | Energy toll (USD/kWh) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Subtransmission | | Distribution | | | Subtransmission | | Distribution | | |
| | Lines | subst. | Primary | Trans. | Secondary | Lines | subst. | Primary | Trans. | Secondary |
| Ambato | 0,3589 | 1,5192 | 3,4474 | 5,3011 | 9,6322 | 0,0003 | 0,0004 | 0,0012 | 0,0023 | 0,0067 |
| Azogues | 0,9171 | 2,1845 | 3,9391 | 6,1757 | 16,8511 | 0,0003 | 0,0004 | 0,0007 | 0,0019 | 0,0056 |
| Bolívar | 0,3855 | 2,5836 | 6,4264 | 8,2030 | 14,5413 | 0,0010 | 0,0013 | 0,0024 | 0,0038 | 0,0084 |
| CATEG-D | 0,0748 | 1,3524 | 1,8662 | 3,8243 | 5,9261 | 0,0003 | 0,0004 | 0,0017 | 0,0043 | 0,0118 |
| Centro sur | 1,1929 | 2,7301 | 5,9703 | 7,6067 | 12,5839 | 0,0003 | 0,0005 | 0,0011 | 0,0026 | 0,0066 |
| Cotopaxi | 0,2589 | 1,2482 | 4,1201 | 6,7965 | 17,5848 | 0,0008 | 0,0013 | 0,0029 | 0,0045 | 0,0096 |
| El Oro | 0,3876 | 1,3518 | 2,7573 | 3,5635 | 5,6254 | 0,0008 | 0,0009 | 0,0021 | 0,0034 | 0,0072 |
| Guayas-Los Ríos | 0,5127 | 1,2263 | 2,8991 | 7,0240 | 10,9682 | 0,0014 | 0,0017 | 0,0029 | 0,0044 | 0,0088 |
| Esmeraldas | 0,6980 | 1,4929 | 2,7345 | 3,5531 | 5,9705 | 0,0006 | 0,0012 | 0,0039 | 0,0053 | 0,0106 |
| Los Ríos | 0,1372 | 1,1070 | 2,5672 | 3,0794 | 5,7504 | 0,0004 | 0,0006 | 0,0027 | 0,0040 | 0,0080 |
| Manabí | 0,3292 | 0,8052 | 2,0592 | 2,9547 | 5,3931 | 0,0007 | 0,0010 | 0,0031 | 0,0044 | 0,0093 |
| Milagro | 0,4014 | 1,3008 | 3,1022 | 3,9419 | 7,5395 | 0,0012 | 0,0013 | 0,0034 | 0,0045 | 0,0104 |
| Norte | 0,3525 | 2,1081 | 3,9152 | 5,9766 | 9,6638 | 0,0007 | 0,0011 | 0,0019 | 0,0034 | 0,0069 |
| Quito | 0,3958 | 1,6664 | 3,3023 | 5,2772 | 8,6550 | 0,0004 | 0,0006 | 0,0015 | 0,0035 | 0,0062 |
| Riobamba | 0,7348 | 2,5748 | 6,0433 | 9,3013 | 16,6924 | 0,0005 | 0,0014 | 0,0027 | 0,0044 | 0,0095 |
| Sta. Elena | 0,6967 | 2,2014 | 4,1730 | 5,1099 | 7,5439 | 0,0003 | 0,0007 | 0,0017 | 0,0036 | 0,0058 |
| Sto. Domingo | 0,2523 | 1,2476 | 1,9083 | 4,2344 | 7,2184 | 0,0006 | 0,0007 | 0,0014 | 0,0045 | 0,0077 |
| Sur | 0,7618 | 4,2960 | 9,9282 | 11,2320 | 16,0981 | 0,0003 | 0,0008 | 0,0017 | 0,0033 | 0,0065 |
| Sucumbios | 1,0489 | 2,3927 | 5,4753 | 7,2240 | 12,7824 | 0,0021 | 0,0029 | 0,0038 | 0,0059 | 0,0098 |
| Galapagos | - | 0,0045 | 6,5544 | 16,8840 | 37,7006 | - | - | 0,0004 | 0,0011 | 0,0037 |

**commas are "decimal commas", i.e., equivalent to decimal points.]**

| Company | Month and year of approval | | | | | | |
|---|---|---|---|---|---|---|---|
| | Oct. 2003 | Mar. 2004 | Oct. 2004 | Oct. 2005 | Jun. 2007 (1) | Oct. 2008 (2) | Feb. 2009 |
| Ambato | 11,32 | 10,77 | 12,05 | 11,20 | 10,99 | 9,21 | 9,35 |
| Azogues | 14,53 | 14,00 | 15,69 | 15,23 | 10,99 | 12,22 | 12,38 |
| Bolívar | 15,34 | 14,77 | 17,35 | 17,15 | 10,99 | 12,42 | 13,87 |
| CATED-D | 8,14 | 7,57 | 9,61 | 9,55 | 9,53 | 7,31 | 7,30 |
| Centro Sur | 10,39 | 9,88 | 12,54 | 12,70 | 10,99 | 9,76 | 9,13 |
| Cotopaxi | 10,45 | 9,91 | 12,28 | 11,03 | 10,99 | 9,55 | 9,38 |
| El Oro | 9,38 | 8,85 | 10,84 | 11,08 | 10,88 | 8,21 | 8,39 |
| Guayas-Los Ríos | 9,00 | 8,45 | 10,80 | 11,55 | 10,99 | 9,02 | 8,12 |
| Esmeraldas | 9,75 | 9,21 | 10,36 | 10,31 | 10,24 | 7,77 | 7,87 |
| Los Ríos | 9,45 | 8,88 | 11,13 | 11,24 | 10,99 | 8,65 | 8,62 |
| Manabí | 9,57 | 9,00 | 10,75 | 10,75 | 10,52 | 7,88 | 7,94 |
| Milagro | 9,16 | 8,61 | 10,62 | 11,03 | 10,92 | 8,38 | 8,80 |
| North | 10,61 | 10,07 | 12,43 | 12,55 | 10,99 | 9,73 | 9,56 |
| Quito | 8,75 | 8,21 | 10,40 | 10,42 | 10,92 | 8,20 | 8,10 |
| Riobamba | 11,81 | 11,28 | 14,39 | 15,32 | 10,99 | 11,21 | 10,52 |
| Santa Elena | 10,05 | 9,51 | 11,81 | 12,14 | 10,99 | 8,92 | 8,36 |
| Sto. Domingo | 9,06 | 8,53 | 10,80 | 11,55 | 10,99 | 8,69 | 8,67 |
| South | 12,98 | 12,43 | 15,79 | 15,42 | 10,99 | 11,26 | 11,92 |
| **Average** | **9,16** | **8,69** | **10,75** | **10,80** | **10,47** | **8,30** | **8,23** |
| Galápagos | 10,09 | 11,47 | 11,59 | 12,17 | 10,18 | 9,32 | 14,35 |
| Sucumbíos | 11,94 | 9,52 | 11,95 | 14,05 | 10,18 | 9,96 | 10,55 |
| (1) Average prices considering the subsidy for average VAD established in Art.12 of the Law to Reform the Electric Sector System Law, published in Official Gazette No. 364 of 26 September 2006 | | | | | | | |
| (2) Average prices pursuant to Constitutional Mandate No. 15 issued on 23 July 2008 | | | | | | | |

**Source**: CONELEC

### 8.5.7 Cross-subsidy

Pursuant to Article 53 of the LRSE, the cross-subsidy benefits residential sector consumers whose monthly consumption is under the residential average for the electric company providing the service, and in any event under the national average residential consumption, i.e., 130 kWh/month.

For this purpose, residential users whose monthly consumption is over the average residential consumption for the electric company providing their service must contribute to financing this cross-subsidy, with a monthly amount equivalent to 10% of

their electric bill, without including other surcharges, except for CATEG-D, for which 5% is applied.

### 8.5.8 Dignity Rate

Decree Executive No. 451-A, published in the Supplement to Official Gazette No. 125 on 12 July 2007 enacted the Dignity Rate Subsidy for Residential Sector consumers whose monthly energy consumption is lower than 110 kWh-month for distributor companies in the Highlands Region and 130 kWh-month on the Coast / in the Amazon region / in the Galapagos Islands.

The purpose of this provision, applied to residential users since the second half of 2007, is to reduce the electricity bill paid by low-income sectors.

Residential users who qualify currently pay, on their electric bill, the equivalent of the following:

| | |
|---|---|
| For energy consumption | USD 0.04 /kWh |
| For marketing | USD 0.70 / user-month |

The difference between the real rate that ought to be applied and the dignity rate is a subsidy granted by the State and appearing on the bill as "Subsidy for Dignity Rate". This subsidy should be transferred monthly to companies by the Ministry of Finance. It has cost, up to December 2008, a total of 63.7 million dollars.

Reportedly, these disbursements are often late, which helps worsen companies' serious financial situation.

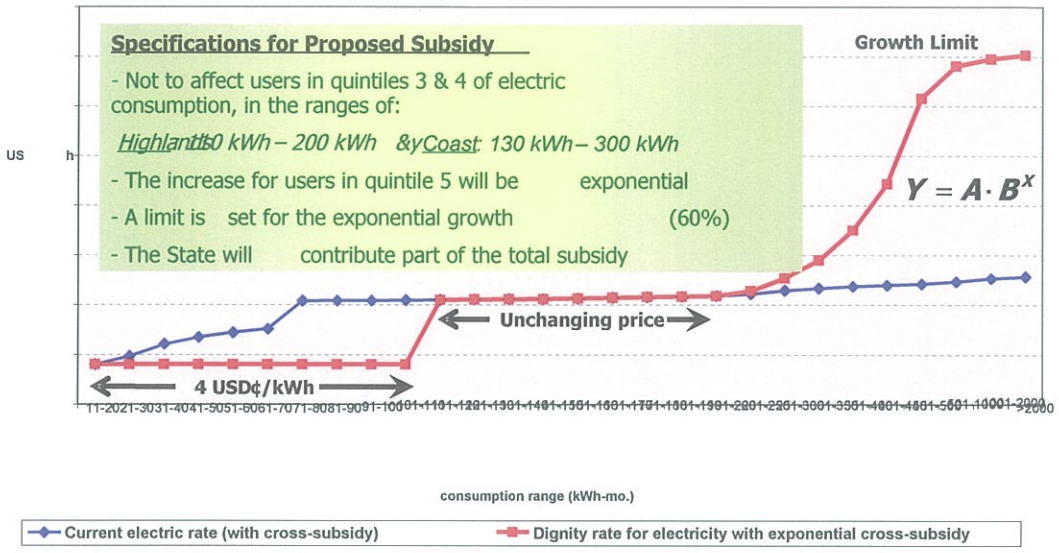
## 8.6 PROSPECTS

If the Government maintains its current policy, no changes in the rate structure are foreseen. Subsidies will continue and tend to increase. The subsidy trend, under the Electrification Master Plan, is to adjust rates for consumption over 250 kWh, to cover the dignity rate subsidy.

In other words, this subsidy currently granted by the State and paid with public funds supplied by taxes will be covered by higher-consumption users.

This arrangement is shown in the following illustration:

Illustration 32 PROPOSED CROSS-SUBSIDY




**Source**: CONELEC

However, some rate incentive schemes may be implemented to use renewable energy sources, implement energy efficiency mechanisms and apply prepayment systems.

## 9. CONCESSION PROCESSES

Concession is the legal arrangement by which the State transfers some of its competencies to a private party. In the particular case of the electrical sector, there are specific norms in this area, listing the types of concession according to the rated power of the generation projects.

- Projects with a rated power higher than 50 MW
- Projects with a rated power lower than 50 MW
- Projects with a rated power lower than 1 MW

The term "concession" is applied to the first group, whereas the second are called "permits". This division is ultimately semantic, because overall they are concessions.

In the case of hydroelectric generation, electrical concessions are closely linked to permits for using water for electric generation. Environmental issues are also directly involved in this type of processes.

Therefore, in discussing concessions, one must refer not only to the electric concession arrangements, but also to the water use permit and the environmental license.

### 9.1 ELECTRICAL CONCESSIONS

Concession processes for activities to generate electrical energy must abide by the Electric Sector System Law and the Regulations on Concessions, Permits and Licenses.

These two documents, Law and Regulations, come from the institutional structure and policy orientation that were in effect up to the enactment of the new Constitution, which opened up the possibility for broad private sector participation, relegating the State to regulation and oversight.

The new Constitution in effect since 20 October 2008 contains very important changes regarding this concept, focusing direct State involvement in strategic areas (including electricity), leaving marginal and exceptional leeway for the private sector.

With this background and considering that the transitional system following publication of the new Constitution of the Republic, the status of procedures and applications for concessions and permits to generate electricity in CONELEC.

For this purpose, Article 316 of the current Constitution states:

> *"Article 316. The State may delegate participation in the strategic sectors and public services to mixed public-private companies in which it is the majority stockholder. Delegation shall be subject to the national interest and shall respect the timing and limits set in the Law for each strategic sector.*

*The State may exceptionally delegate the exercise of these activities to private initiative and to grassroots solidary economy, in cases established by Law."*

We have learned that, due to the change in political concept regarding State participation represented by this constitutional provision, CONELEC has queried the Attorney General of the Nation (official letter No. DE-08-2249 of 28 October 2008, regarding the procedure to follow with new concessions and those being processed.

The Attorney-General responded with a report contained in official letter No. 5115 of 28 November 2008, concluding:

*"Accordingly, I feel that applications for certificates or permits that have entered CONELEC, as well as signing of the corresponding concession contracts or permits, and new applications for such concession certificates or permits, must follow the above constitutional norm and the Law that will be issued for this purpose."*

Subsequently, in response to the request for reconsideration submitted by CONELEC, in official letter No. 0624 of 6 February 2008, the Attorney General of the Nation ruled as follows:

- Concession applications that entered CONELEC before the new Constitution went into effect (20 October 2008) shall abide by the laws in effect at the time the application was submitted, and must continue procedures until the respective contracts are formalized. This includes applications for concessions involving government / public capital and those involving private investment.

- For those cases of applications submitted after the new Constitution has gone into effect, no previous legal or regulatory provisions that are in contradiction with constitutional precept cited in the ruling for which reconsideration is requested may be applied, under the principle of the Constitution's supremacy, contained in Article 424 thereof.

Pursuant to this ruling, which is binding and mandatory for all State agencies, especially for the one that made the query, CONELEC cannot accept new applications for concessions or permits until a new law is enacted for the Electrical Sector and the norms for procedures to follow in these cases.

This situation has affected a number of processes, including public-capital enterprises that submitted their applications a few days after the new Constitution was published in the Official Gazette.

***Therefore, a legal and procedural vacuum currently prevails for electrical sector permits and concessions, which will be filled when a new Electrical Law is enacted and new Concession Regulations.***

Additionally, there is uncertainty about the sector's institutions once the new Electrical Law is enacted, because several drafts for this new Law have proposed putting the Ministry of Electricity and Renewable Energy in charge of granting concessions; this will be confirmed only when the time comes.

Nor can it be known whether permits and concessions will remain as such, much less if the requirements set by the Concessions, Permits and Licenses Regulations will remain in effect.

However, it is considered that some requirements deemed essential will be kept, such as:

- Preliminary and Final Environmental Impact Study
- Permit to use water (ruling by SENAGUA)
- Environmental license

## 9.2 WATER CONCESSIONS

CONELEC and the former National Directorate of Water Resources signed a 7 June 2006 Agreement for Cooperation and Institutional Coordination, in order to coordinate procedures involving implementation of hydroelectric generation projects, for which they established Procedural Flowcharts for Water Concessions and for Electrical Energy service and Optimization of administrative processes involving the Right to Use Water.

***The procedures established aim to prevent speculative use of permits for water use to generate electrical energy, so they will be granted only to those companies having an electrical concession application being processed by CONELEC at the time of application.***

With the creation of the National Water Secretariat (SENAGUA) in place of the National Water Resource Council, new procedures must be established, so an agreement is being drafted for CONELEC and SENAGUA to sign.

## 9.3 ENVIRONMENTAL MANAGEMENT

Environmental norms are contained in the Environmental Regulations for Electrical Activities (RAAE), published in Official Gazette No. 396 on 23 August 2001.

All generation projects require:

- Preliminary Environmental Impact Study (EIAP), including the Certificate of Non-Intersection with the Protected Area System (SNAP), issued by the Ministry of the Environment, which must be submitted along with the Concession or Permit application.

- Definitive Environmental Impact Study (EIAD) and Environmental License, issued by the Ministry of the Environment, which must be submitted to sign the Concession or Permit contract.

- If the interested party has the Definitive EIS, it will not need to prepare the Preliminary EIS, providing that it contains a detailed analysis of alternatives technically and environmentally justifying the option selected, pursuant to Article 22 of the RAAE.

Projects located in Protected Zones must have Ministry of the Environment authorization and must also be declared high priority for the electrical sector by the National Government. (Article 41 of the RAAE).

### 9.3.1 Summary of the Procedure

To apply for a specific concession, the Bidder must submit the following documents:

- Preliminary Environmental Impact Study (EIAP)
- Letter of Commitment to submit the Definitive Environmental Impact Study (EIAD)
- Certificate issued by the Ministry of the Environment (MAE) indicating whether the project intersects zones considered in the National System of Protected Areas (SNAP).

If the project intersects with the SNAP, CONELEC forwards the draft EIAP to the MAE for the Ministry to rule on the project's viability or not. If the project does not affect the SNAP, the EIAP is reviewed to verify compliance with environmental norms.

### 9.3.2 Requirements for granting the Environmental License

To obtain an environmental license to build and operate electrical projects the promoter must comply with the following:

1. Obtain the Certificate of Intersection from the Ministry of the Environment
2. Obtain Approval of the Archaeological Prospecting Study from the National Institute of Cultural Heritage (INPC).
3. Have the Definitive Environmental Impact Study approved by CONELEC
4. Pay the Ministry of the Environment registration fee of 2% of the EIAD cost and 0.2 mills (0.02%) of the project budget. Submit the receipt for this payment to CONELEC.
5. Post a bond for faithful compliance with the Environmental Management Plan (PMA). This is for private companies without social or public purposes.

Once these requirements, the project promoter must apply for CONELEC to issue the Environmental License.

If the project is located totally or partially in the National System of Protected Areas, they must arrange to obtain the Environmental License directly in the Ministry of the Environment.

### 9.3.3 Preliminary Environmental Impact Study

The Preliminary Environmental Impact Study (EIAP) must be prepared in the initial phases of the electric project studies. It must provide an initial, basic assessment of the environmental impacts that the project will cause, and is a fundamental decision-making tool for selecting alternatives, both technologically and for the location.

The EIAP must contain at least the following:

1. Introduction
2. General Data (Bidder, Legal Representative, Consultant, etc.)
3. Study goals and scope
4. Legal and institutional framework
5. Project Description
6. Definition of direct and indirect areas of influence
7. Description of the environmental baseline
8. Identification and evaluation of environmental impacts
9. Analysis of implementation alternatives
10. Environmental Management Plan
11. Attachments (maps, blueprints, photographs)
12. Bibliography

### 9.3.4 Definitive Environmental Impact Study

The Definitive Environmental Impact Study (EIAD) is prepared during the advanced phase of project studies. It provides a detailed assessment of the environmental impacts that the project will cause and will be a decision-making tool to prevent, mitigate and/or compensate for significant negative impacts and enhance positive ones that are identified.

The EIAD will be prepared once the Terms of Reference are approved by CONELEC and must comply strictly with them.

The EIAD must contain at least the following:

1. Executive summary of the EIAD
2. Introduction
3. General Data
4. Study goals and scope
5. Methodologies used
6. Legal and institutional framework
7. Project Description
8. Determination of direct and indirect areas of influence and sensitive areas

9. Description of the environmental baseline
10. Identification, prediction and evaluation of environmental impacts
11. Environmental Management Plan
12. Attachments
13. Bibliography

The Environmental Management Plan must contain at least the following:

- Prevention, mitigation and compensation programs.
- Waste management
- Environmental training
- Monitoring and follow-up
- Citizen participation
- Industrial and safety and occupational health
- Contingency and risk plan
- Rehabilitation of affected areas
- Withdrawal

### 9.3.5 Technical Environmental Standards

The Ministry of the Environment issued the Technical Environmental Standards to Prevent and Oversee Environmental Pollution for the Infrastructure Sectors: Electrical, Telecommunications and Transport (Official Gazette Supplement 41 of 14 March 2007).

One salient feature of these Technical Standards is the "ecological flow", defined as:

> *"The volume of water that must be kept flowing in a hydrographic sector of the river to conserve and maintain the ecosystems, biodiversity and quality of the river environment and to ensure that the water can be used for consumption and other non-consumption uses, downriver in the area of influence of a hydroelectric power plant and its reservoir, where applicable. The ecological flow must be representative of the river's natural regime and maintain the landscape features of the environment."*

***The Technical Standards establish procedures to determine the ecological flow, which must not be lower than 10% of the mean annual flow rate.***

## 10. ANALYSIS OF THE COUNTRY'S FUTURE ENVIRONMENT FOR SELF-SUPPLYING PRODUCERS

The preceding analysis regarding the current situation of the electrical sector and changing policies and norms would indicate that the environment for self-supplying producers will have the following characteristics:

- Norms will allow self-supplying generators to sell their surpluses.
- The rules for selling surplus energy have not yet been defined.
- It is assumed that a single price will be set (in US cents per kWh for surplus energy and that there will be no payment for power. The unified price will include both fixed and variable costs.
- Conditions for marketing surpluses will enable self-supplying producers to cover their costs, with a reasonable profitability.
- Surplus sales will have to involve contracts with all distributor companies in the country, proportionally to their demand.
- There is no expectation of any future possibility of delivering surplus energy to large-scale consumers.
- In view of the new conditions and rate levels for regulated users, large consumers are expected to progressively disappear, because it will be more favorable for them to be customers of a distributor company, rather than purchasing their energy directly from a generator.
- A polemical issue regarding self-supplying producers is the obligation to transfer their facilities to the State when their concession expires. For the time being, this obligation is applicable only to generators, but this issue is still being discussed.

### 10.1 FUELS

An analysis of fuel availability in the relevant part of this report is essential. Moreover, Ecuador has no real prospects of developing biofuels, except for a project for the Galapagos Islands, based on piñón oil.

For fuel supply, if the thermoelectric solution is chosen, the following alternatives should be explored:

- Slops from the Shushufindi Refinery:

  There is the capacity to install 270 MW of thermoelectric generation. A government-owned thermoelectric power plant is planned for this site. For the time being, that project is not proceeding because of a lack of financing. It is not clear whether this fuel could be used, as it might be reserved for the State.

- Gas from the Amistad field in the Gulf of Guayaquil, currently under concession to the EDC company.

The future of this concession is quite doubtful. The debt that the State has accrued with the Machala Power generating company (which, along with EDC, belongs to Noble Energy) is being repaid partially, but this has prevented the company from pursuing its plan to install 180 MW in addition to the current 140 MW, with combined-cycle and gas-fired turbines.

There are other problems with the gas concession contract. It seems that expanding gas production will depend on revising the contract, regarding the royalties to be paid to the State.

Pursuant to the contract that EDC has signed with PETROECUADOR, for up to 30,000,000 cubic feet per day production, the royalties for the State would be 10%. However, if production increases to 60,000,000 cubic feet per day, the royalties would increase to 30% and, for higher production, to 31%. Another problem is that the royalties are calculated in reference to international fuel oil prices, but the gas is sold locally at a lower price.

These conditions affect EDC's economic equation, so they have asked for a contract revision. The State is analyzing different alternatives regarding this concession.

Several thermoelectric generating companies are interested in using that gas. One is Electroquil, belonging to Duke Energy, which would move its equipment from its current site near Guayaquil. Another company that is interested is Intervisa Trade, which operates with the Victoria II barge (105 MW) at Las Esclusas, also near Guayaquil.

All these circumstances make it impossible to establish a clear prediction as to whether this gas will be available, but it remains an alternative.

## 10.2 SPECIFIC REGULATORY FRAMEWORK

This is a time of changes in the regulatory system. Constitutional Mandate No. 15 established new operating rules for the electrical sector regarding rates and financing for expansion, and authorizing CONELEC to make the regulatory changes required to apply a blanket rate nationwide.

On that basis, CONELEC has issued two rules (006/08 and 013/08) for market operations, with a clear tendency toward regulated contracts rather than spot market transactions. These changes entail the following prospects:

- From now on, all energy sale transactions between generators and distributors are expected to involve contracts.

- Generators and self-supplying generators will have to sell their energy to all distributor companies proportionally to their demand.

- Energy pricing, for private generators and self-supplying generators, will be set through public auctions, under parameters determined by the Ministry or by CONELEC.

Additionally, new regulatory adjustments are expected regarding:

- Eliminating limitations on monopolies by changing to a State monopoly.
- A public tender system to sign contracts.
- New adjustments in the rate scheme to set rates higher for larger consumers in order to finance subsidies for the Dignity Rate.
- New rules for operation by self-supplying producers who sell their surplus.

One issue of concern is the procedure for electrical concessions, currently on hold awaiting approval of a new law and new regulations on concessions.

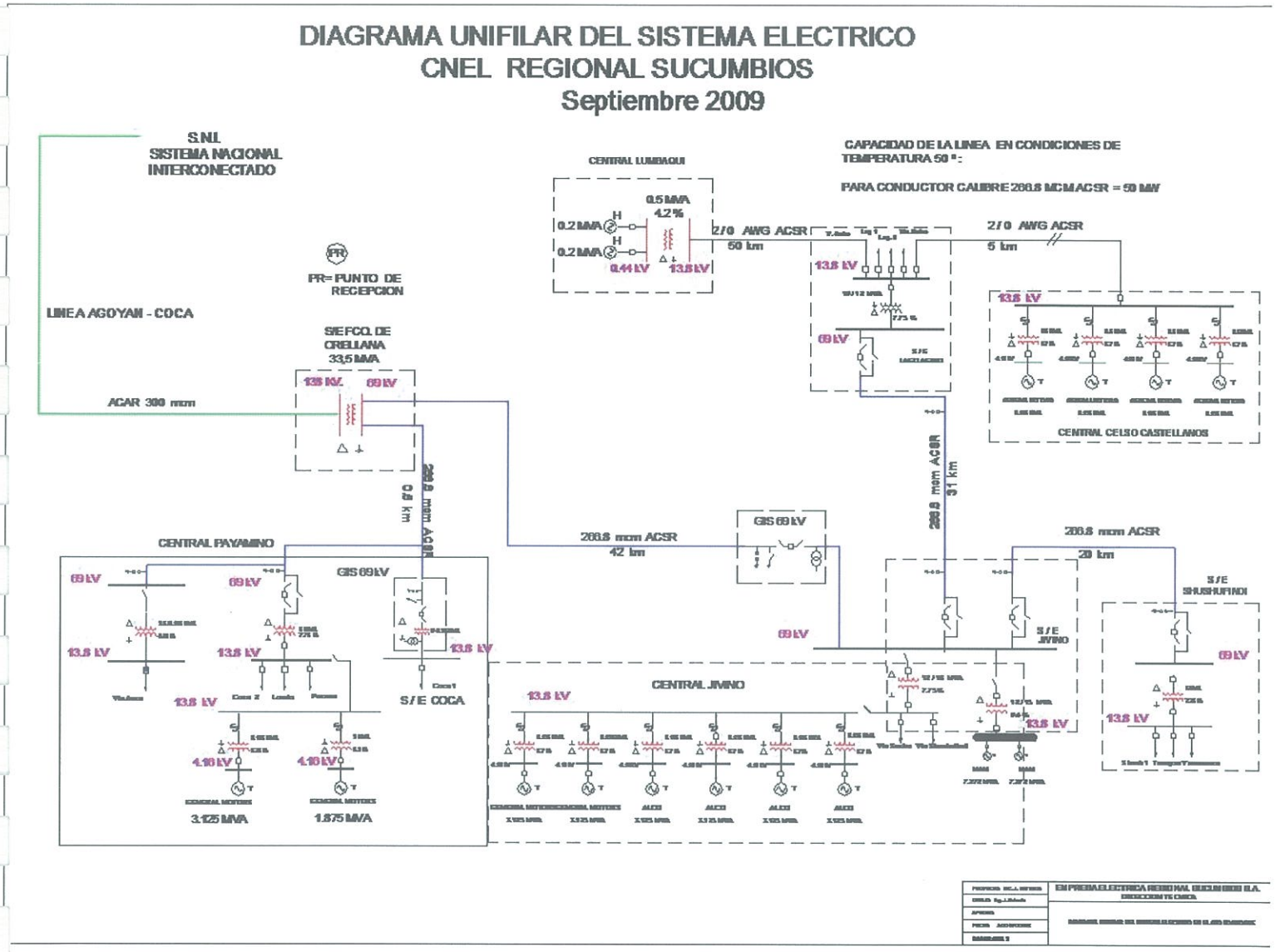
Changes are also expected in electrical sector institutions. The Ministry of Electricity (MEER) may handle concessions instead of CONELEC, although the latter would continue performing technical review of documentation and projects.

## 11. CHARACTERISTICS OF THE CNEL - SUCUMBIOS REGIONAL SUBTRANSMISSION SYSTEM

### 11.1 SUBSTATIONS

The subtransmission system of the CNEL – Sucumbíos Regional electric company comprises four (4) substations (Lago Agrio, Coca, Jivino and Shushufindi) which are operating under normal conditions at a load under 100% in all cases (no over-loading). Voltage levels are within normal operating range, largely due to the connection with the national interconnected system (SNI), which supplies approximately 20 MW of the company's demand.

Illustration below is a diagram of the substations with a detail of the bar arrangement and several additional characteristics.



## 11.2 GENERATION

### 11.2.1 Local Generation

CNEL – Sucumbíos Region generates energy of its own, from different points in the concession area, summarizing some of the characteristics and the location of each generating groups.

- Payamino Thermoelectric Power Plant: Located in the canton of Francisco de Orellana (Coca), it has two General Motors units and two Caterpillar units (these latter two undergoing maintenance). This power plant contributes 3 MW at peak demand.

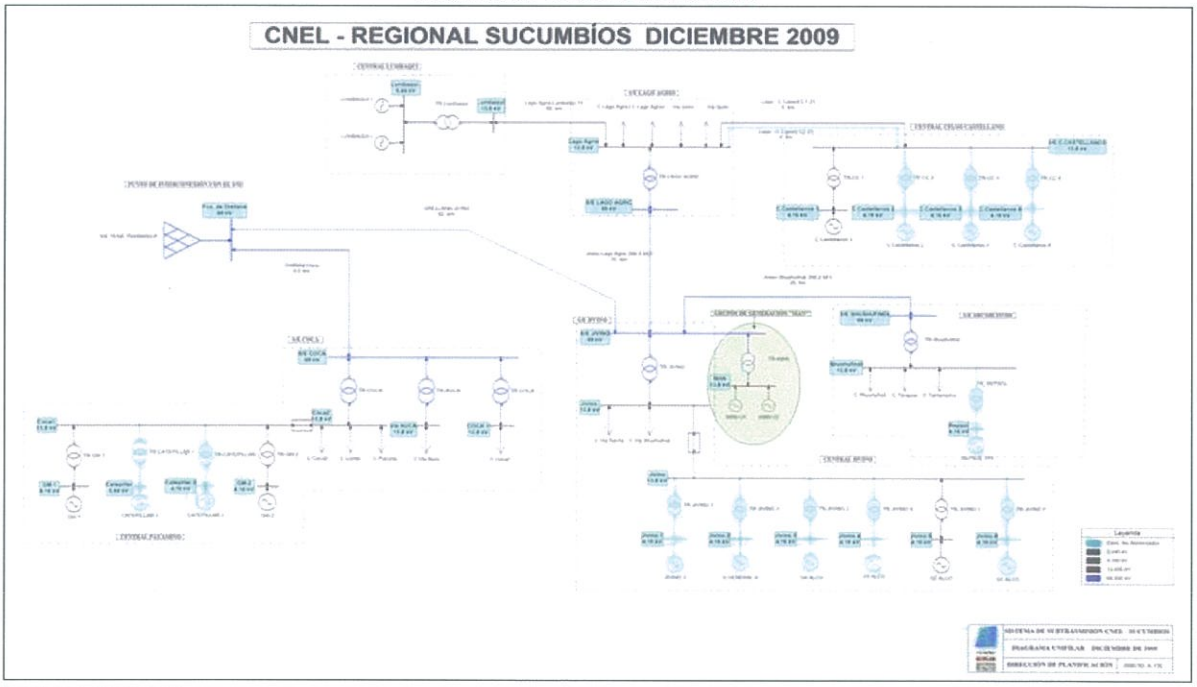
- Jivino Thermoelectric Power Plant: Six Alco units and two "MAN" generating units, the last two beginning operation in January of this year, contributing 9.8 MW at peak demand.

- Celso Castellanos Thermoelectric Power Plant: Four units contributing 1.5 MW at peak demand for the subtransmission system.

- Lumbaqui Hydroelectric Power Plant: Two units contributing 200 kW at maximum demand.

The single-wire diagram is shown in illustration 33:

**Illustration 33 CNEL-REGIONAL**




**Source:** Conelec

### 11.2.2 Interconnection

20.28 MW of active power is being added by the SNI from the Agoyán power plant, which is part of the concession area of the Ambato Electric Company.

### 12.2.3 Possible New Generation to be Incorporated

The generators that will be incorporated are synchronous machines, 2 MW each, driven by internal combustion engines. The Table below shows the main characteristics of the generating groups.

**Table 21 CHARACTERISTICS OF THE EQUIPMENT TO INCORPORATE**

**SPECIFICATIONS**

**CAT SR4B GENERATOR**

| | |
|---|---|
| Frame Size | 825 |
| Pitch | 0.6667 |
| No. of poles | 4 |
| Excitation | Static regulated brushless PM excited |
| Constructions | Single bearing, close coupled |
| Insulation | Class H |
| Enclosure | Drip proof IP22 |
| Alignment | Pilot shaft |
| Overspeed capability – % of rated | 125% of rated |
| Voltage regulator | 3 phase sensing with Volts-per-Hertz |
| Voltage regulation | Less than ± ½% voltage gain |
| Adjustable to compensate for engine speed droop and line loss | |
| Wave form deviation | Less than 5% deviation |
| Telephone Influence Factor (TIF) | Less than 50 |
| Harmonic Distortion (THD) | Less than 5% |

**CAT 3615C DIESEL ENGINE**

| | |
|---|---|
| 3516C C-16, 4-Stroke diesel | |
| Bore – mm (in) | 170 (6.7) |
| Stroke – mm (in) | 190 (7.5) |
| Displacement – L (cu in) | 69 (4,210) |
| Compression ratio | 15:1 |
| Aspiration | ATAAC |
| Fuel system | EUI |
| Governor type | Caterpillar ADEM™ A3 Control System |

**TECHNICAL DATA**

Materials and specifications are subject to change without notice.

| Generator Set Technical Data | | 50 Hz | | 60 Hz | |
|---|---|---|---|---|---|
| | Units | Prime | Standby | Prime | Standby |
| Performance Specification | | DM8754 | | DM8264 | |
| Power Rating | kW (kVA) | 1310 (1637) | 1440 (1800) | 1825 (2281) | 2000 (2500) |
| Lubricating System | | | | | |
| Oil pan capacity | L (gal) | 401.3 (106) | | 401.3 (106) | |
| Fuel System | | | | | |
| Fuel Consumption | | | | | |
| 100% load | L (gal) | 350.1 (92.5) | 372.9 (98.5) | 483.2 (127.6) | 525.7 (138.9) |
| 75% load | L (gal) | 281.9 (74.5) | 302.8 (80) | 380 (100.4) | 408.2 (107.8) |
| 50% load | L (gal) | 205.5 (54.3) | 350.1 (92.4) | 270.5 (71.5) | 294.2 (77.7) |
| Fuel tank capacity | L (gal) | 4731 (1,250) | | 4731 (1,250) | |
| Running time @ 75% rating | Hours | 16.7 | 15.6 | 12.5 | 11.5 |
| Cooling System | | | | | |
| Radiator coolant capacity including engine | L (gal) | 630 (166) | | 630 (166) | |
| Air Requirements | | | | | |
| Combustion air flow | m³/min (cfm) | 114.8 (4052) | 118.1 (4173) | 174.7 (6169) | 180.3 (6367) |
| Maximum air cleaner restriction | kPa (in $H_2O$) | 6.2 (24.9) | | 6.2 (24.9) | |
| Generator cooling air | m³/min (cfm) | 140 (5,933) | | 168 (4,995) | |
| Exhaust System | | | | | |
| Exhaust flow at rated kW | m³/min (cfm) | 311.3 (10,993) | 320.8 (11,335) | 404 (14,260) | 428.6 (15,137) |
| Exhaust stack temperature at rated kW – dry exhaust | °C (°F) | 502.1 (935.8) | 513.1 (955.6) | 387 (728) | 405 (762) |
| Noise Rating (with enclosure) | | | | | |
| @ 7 meters (23 feet) | dB(A) | 77 | 78 | 78 | 79 |
| @15 meters (50 feet) | dB(A) | 73 | 74 | 74 | 75 |

| Model | Length mm (in) | Width mm (in) | Height mm (in) | Weight | |
|---|---|---|---|---|---|
| | | | | With Lube Oil and Coolant kg (lb) | With Fuel, Lube Oil and Coolant kg (lb) |
| XQ2000 w/o Chassis | 12 192 (480) | 2438 (96) | 2896 (114) | 34 019 (75,000) | 38 102 (84,000) |
| XQ2000 w/Chassis | 12 192 (480) | 2438 (96) | 4267 (168) | 38 102 (84,000) | 42 184 (93,000) |

## 11.4 AVAILABILITY OF SPACE AT SUBSTATIONS AND POWER PLANTS

Alternatives are analyzed below to install thermoelectric generating groups at the different substations of the CNEL- Sucumbíos subtransmission system, taking into account the available physical space and infrastructure.

- **Jivino Substation:** at this time, a 69 kV bay is available. At the Jivino substation, there is enough space to install and house six approximately 2 MW units, to complete a total of 10 MW.

- **Coca Substation:** There is not enough physical space to expand new connection bays; the **Payamino** power plant, next to the Coca substation, has two General Motors units and there is room to install a generating unit. At the Payamino power plant there is not enough space to make additional constructions.

- **Lago Substation:** At this 10/12 MVA substation, physical space is quite limited. No bays are available for connection.

- **Shushufindi Substation:** This 5 MVA substation does not have enough physical space to install additional bays or generating units.

- **Celso Castellanos Power Plant:** There are four General Motors generating units.

Accordingly, in terms of available space and infrastructure, the best alternative to install generating units up to 10 MW is the Jivino substation, which has the most physical space, enough to adapt the handling yard and the civil works needed to house the new generating capacity. An additional advantage of this position is its physical location, equally distant from the main substations.

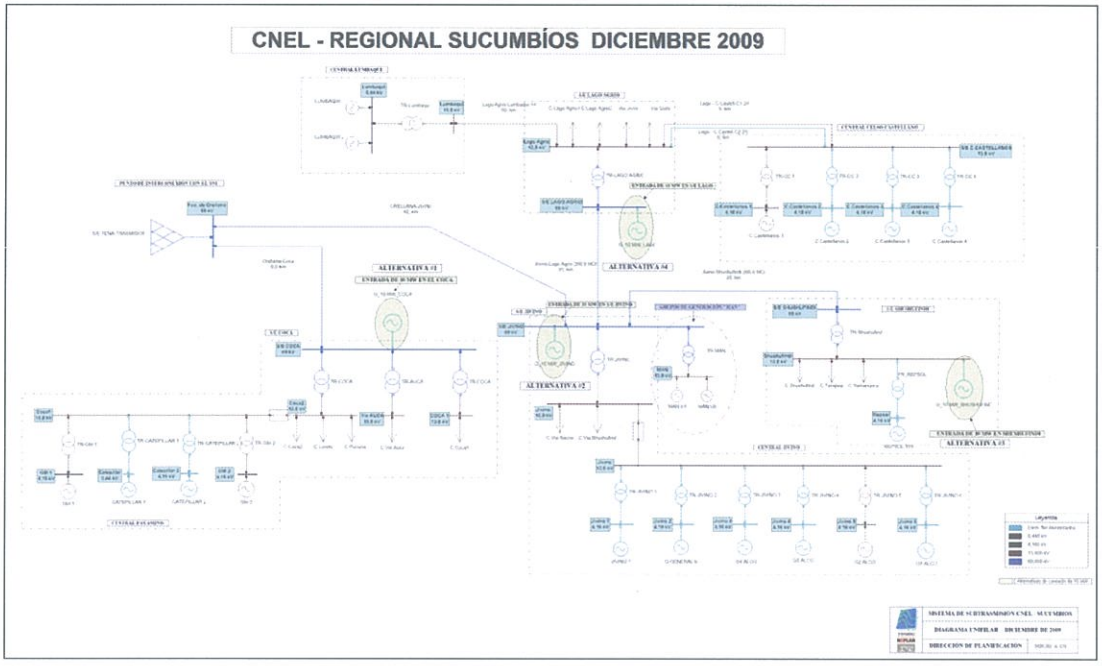
The diagram below shows the substation layout. The land has an area of 38,795.8 $m^2$; the space where the older machines are located (ALCO) has an approximate area of 1680 $m^2$, the new power plant with the MAN groups occupies an approximate area of 3,477,6 $m^2$, the substation handling yards for 13.8 kV and 69 kV have an approximate area of 958.3 $m^2$. The rest of constructions add up to an approximate area of 4,953 $m^2$.

**Illustration 34 PLOT PLAN – JIVINO POWER PLANT**

## 12. ALTERNATIVES TO GET 10MW INTO THE CNEL – SUCUMBIOS REGIONAL SYSTEM

The greatest concentration of load is distributed among the feeds of the Coca and Lago Agrio substations. The figure shows the different alternatives available to implement the new generating units.

**Illustration 35 CNEL-SUCUMBIOS ONE-WIRE DIAGRAM**




To determine the best alternative, an electrical study of power flows has been conducted for each possible installation site for the 10 MW of generation, that is, for each substation of CNEL – Regional Sucumbíos described above. An analysis of the Power Flow findings reveals the location with the best operating conditions for the system, regarding both losses, and voltage profiles. These results are then contrasted with the physical space and infrastructure available.

This study considers a contribution of approximately 20 MW from the national system to the CNEL-Sucumbíos subtransmission system under maximum demand conditions.

Considering these results and that the greatest load concentration is distributed between the substations of Coca and Lago Agrio, and that the substations of Lago Agrio and Jivino are relatively close, the Jivino substation is a suitable location to implement new generation.

The illustrations shown below present the results for voltage on the 69 kV bars, obtained by considering the different alternatives to connect the new generation.

**Illustration 36 VOLTAGES ON 69 KV BARS WITHOUT CONSIDERING THE 10MW ENTERING**

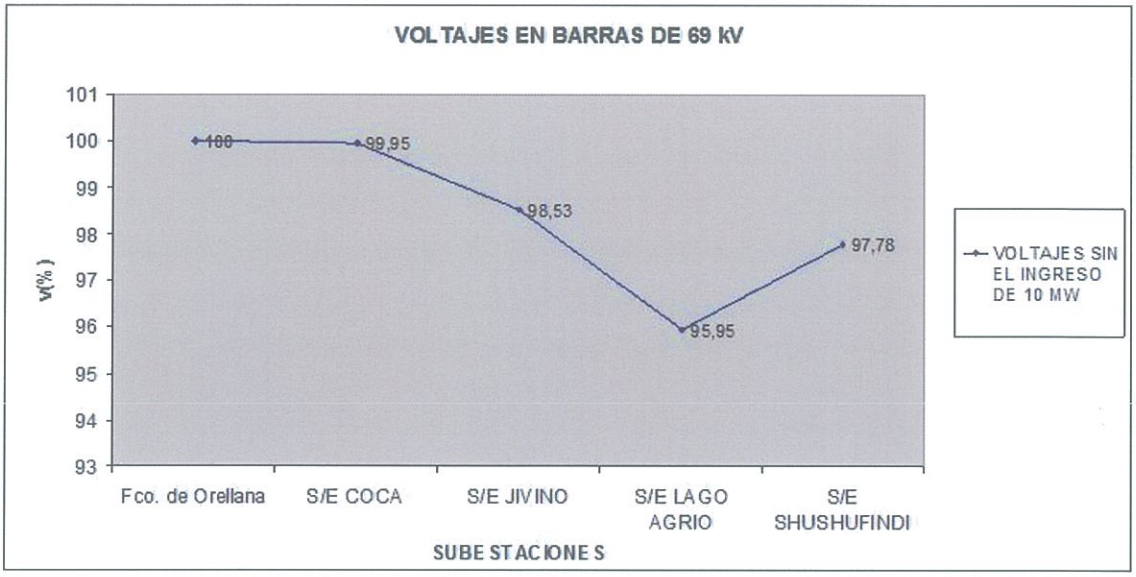



**Illustration 37 VOLTAGES ON 69 KV BARS INCORPORATING 10 MW ALTERNATIVE Nº1: COCA SUBSTATION**

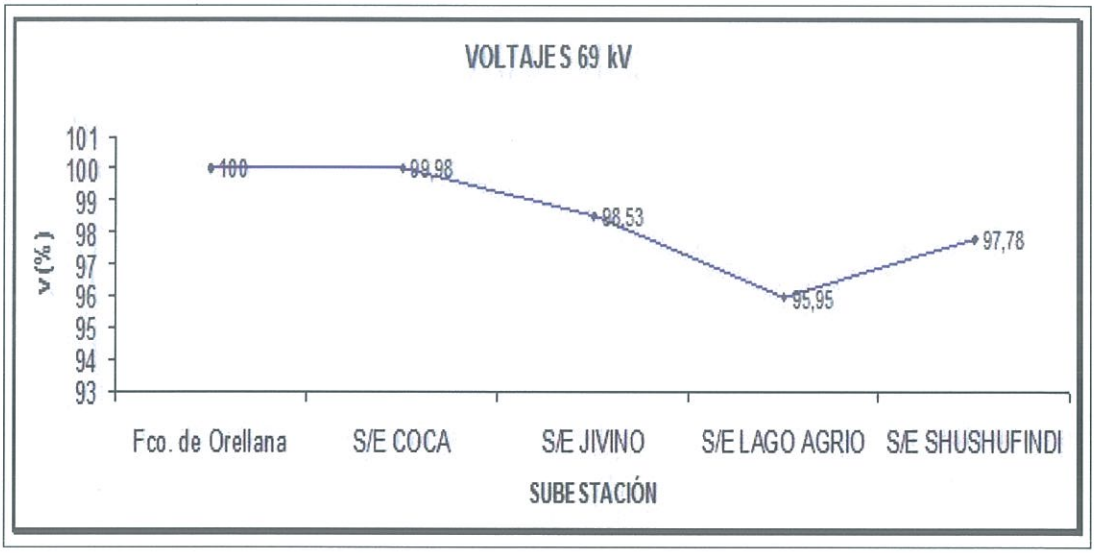


**Illustration 38 VOLTAGES ON 69 KV BARS INCORPORATING 10 MW ALTERNATIVE Nº2: JIVINO SUBSTATION**

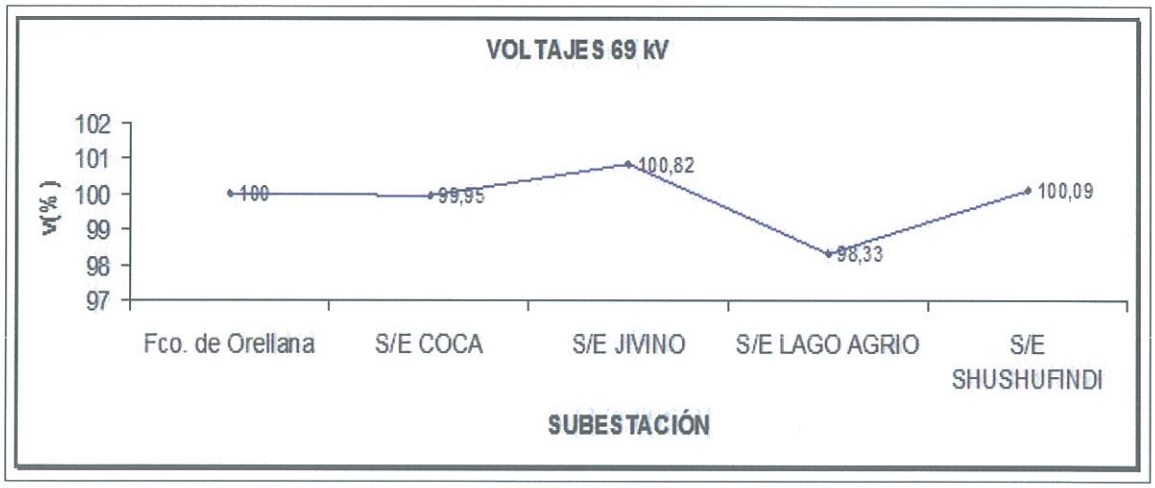



**Illustration 39 VOLTAGES ON 69 KV BARS INCORPORATING 10 MW ALTERNATIVE Nº3: SHUSHUFINDI SUBSTATION**

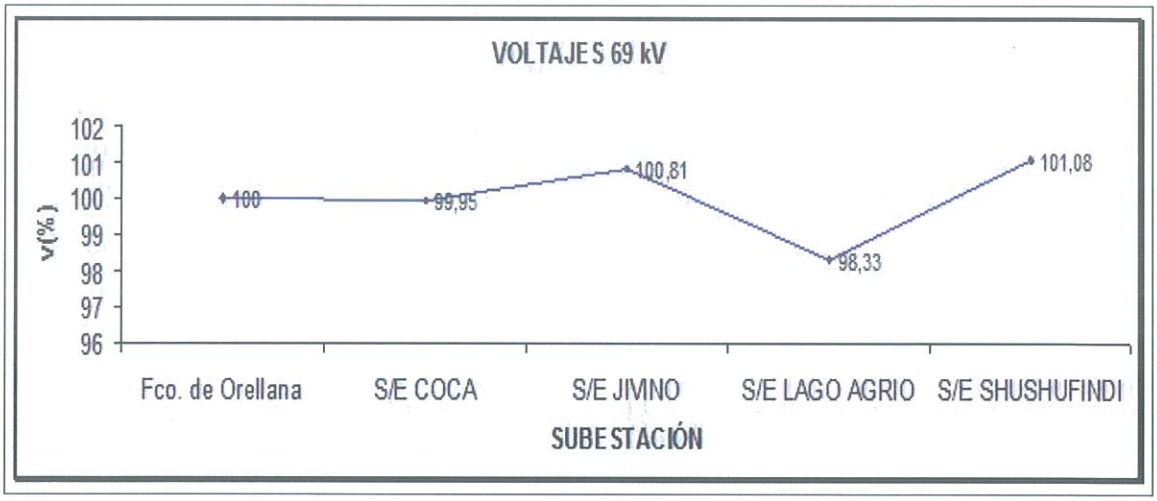
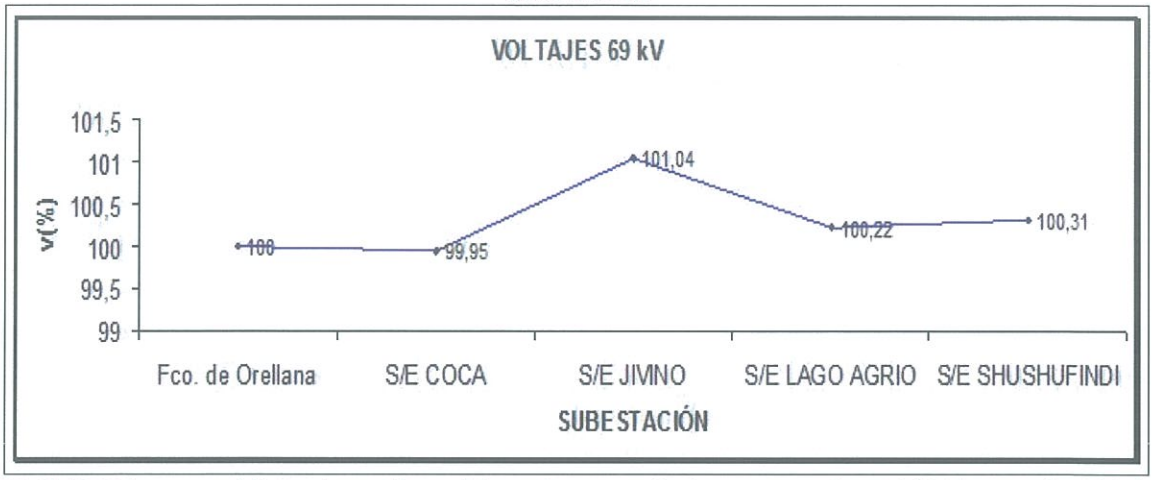


**Illustration 40 VOLTAGES ON 69 KV BARS INCORPORATING 10 MW ALTERNATIVE Nº4: LAGO AGRIO SUBSTATION**




CONELEC has established an allowable voltage variation range, for 69 kV bars, of +3% / -3%.

Incorporating 10 MW of generation at any substation in the CNEL-Sucumbíos system will reduce, by approximately that amount, the delivery of power by the National Interconnected System, which will improve voltage conditions.

Alternative Nº 1 features voltages above 0.97 p.u. except for the 69 kV bar of the Lago Agrio substation which, for this alternative, would have a value of 0.95 p.u.

Alternative Nº 2 features voltages within the allowable range. The results show better voltage regulation along the main substations.

Alternative Nº 3 features good voltage regulation for the system overall. However, there are constraints in the physical space required to install the new generation.

Alternative Nº 4 features good conditions electrically. However, the substation does not have enough physical space to expand the handling yard, much less to install the new generators. Further, there is a 10/12 MVA transformer operating at 93% load during peak demand hours that is about to run out its useful lifetime.

## 12.1 FUEL SUPPLY:

Fuel could be supplied to six Caterpillar units by tank trucks, since processed fueld is not available via the product pipeline in the concession are of the Sucumbíos Electric Company. However, the roadway system will carry this type of cargo vehicle, with a 10000 gallons (gal) capacity.

## 12.2 OPERATING ROUTINE:

Plant operation has been determined as a function of demand curve behavior, so preliminarily a rough approximation has been made on the basis of diesel 2

consumption. However, fuel supply must be carefully analyzed to provide for supply logistics as well as storage capacity to ensure energy supply to the system.

**Table 24 OPERATING ROUTINE**

| Modelo Unidad | Número de Unidades | 1 - Operación 0h00- 8h00 | 2 - Operación 8h01 -16h59 | 3 - Operación 17h00 a 23h59 |
|---|---|---|---|---|
| XQ2000 | 5 | 50% | 75% | 100% |

## 12.3 FUEL CONSUMPTION CALCULATION:

Fuel consumption has been calculated on the basis of the above operation and specified yields, as follows:

**Table 25 FUEL CONSUMPTION CALCULATION**

| Modelo Unidad | Número de Unidades | 1 - Operación 0h00- 8h00 | 2 - Operación 8h01 -16h59 | 3 - Operación 17h00 a 23h59 |
|---|---|---|---|---|
| XQ2000 | 5 | 50% | 75% | 100% |

This analysis shows that expected consumption per machine is approximately 2595.2 gal, so, for the four machines the consumption and number of tank trucks per day required would be as follows:

**Table 26 CALCULATION OF CONSUMPTION AND NUMBER OF TANK TRUCKS PER DAY**

| Consumo Total Gal | Capacidad de Tanquero Gal | # de Tanqueros Día |
|---|---|---|
| 15.571,20 | 10.000,00 | 1,56 |

Roughly, local supply for a 10-day reserve capacity would be as follows:

**Tabla 27 STORAGE CAPACITY**

| Capacidad Tanque de Alamcenamiento | Días Autonomía de Almacenamiento |
|---|---|
| 100000 | 6,42 |

## 13. CONCLUSIONS AND RECOMMENDATIONS

- Having analyzed the conditions (physical space, infrastructure and the load flow study results) the Jivino substation is found to be the best location to install the new generation equipment.

- Taking into account the system's operating conditions, incorporating 10 MW of local generation is highly favorable for CNEL-Sucumbíos.

- Incorporating this generation, significantly improves voltage regulation from all substations, entailing a number of additional benefits: reduced technical energy losses, and improved service quality for users.

- A detailed electrical study should be conducted immediately with the relevant authorization to connect to the distribution system or the National Interconnected System.

- Finally, it is recommended to conduct all studies required by law once the concessions are granted for generating electricity and for the 10 MW.