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The impact of the Coca Codo Sinclair hydroelectric project in the energy matrix will be a generator of economic opportunities for Ecuador to the world

Graduation work prior to obtaining the *International Studies Bachelor's* degree with a bilingual emphasis in *Foreign Trade*

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Dedications

First of all, I dedicate this thesis project to God, my family and friends. God has blessed this arduous road with light, giving me the strength and perseverance to move forward. In the same way, he has favored me with wonderful parents who have watched over my welfare and security, giving me unconditional support in presence of implanted values.

To my brothers and sister who have always trusted my ability to complete this important stage of my life. To my friends that despite the obstacles, have expressed how proud they feel that I have engaged myself in this race and have been able to finish it. Everything I have just mentioned complemented to the love each one of them has given me in an essential way in my life have helped me achieve everything I have become nowadays.

María Gabriela Rodríguez Carreño

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Maria Gabriela Rodríguez Carreño

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Resumen

El proyecto Coca Codo Sinclair está considerado como el más importante del Ecuador puesto que con la implantación de esa central hidroeléctrica se planea satisfacer el 35% de la demanda eléctrica nacional, lo que suplirá el consumo de combustibles fósiles para la generación de energía eléctrica.

Actualmente el Ecuador mantiene una importante inversión en diésel para poder solventar la demanda eléctrica nacional a través de las plantas de generación térmica.

Una vez que se encuentren construidos todos los proyectos hidroeléctricos se espera que el Ecuador no solo esté en capacidad de satisfacer la demanda nacional, sino también de exportar energía eléctrica a países vecinos.

La ejecución de Coca Codo Sinclair está a cargo de la empresa china Sinohydro, con una inversión de 1.979 millones de dólares, financiados en un 15% por el gobierno del Ecuador y en el 85% restante, mediante recursos entregados en préstamo por China.

Un valor agregado a éste proyecto hidroeléctrico es que servirá para estrechar lazos comerciales y de cooperación con la comunidad internacional.

Abstract

The Coca Codo Sinclair is being considered as one of the most important projects in Ecuador considering that the implementation of this Hydropower plant is aimed to satisfy 35% of the national electricity demand, which will supply the fossil fuels consumption for the generation of electric energy in the country.

Currently, Ecuador has a significant investment in diesel to solve the national electricity demand generated through thermal generation plants.

Once all these hydropower projects are built, it is expected that Ecuador not only will be able to satisfy the national demand, but also to export electricity to neighboring countries.

The Chinese company Sinohydro is in charge of running the Coca Codo Sinclair project, investing 1,979 million dollars, from which 15% is financed by the Ecuadorian government, and the remaining 85% comes through resources loaned by China.

An added value to this project is that it will serve to strengthen trade ties and cooperation with the international community.

Introduction

The present study is composed of four chapters, which are broken down in the following order:

In the first chapter, the current energetic situation in Ecuador is analyzed by describing the environmental causes and effects of the adoption of renewable energy, the current demand of electric energy, and the offer of hydroelectric energy that is currently valid.

The second chapter investigates the planning of the energetic matrix, the utilization of renewable energy sources in the country to change the production model with added value, and the incident factors in the technologic development nationally.

The third chapter fully describes the Coca Codo Sinclair Project from the financial point of view, the investment applied, how this project originated, and who have intervened in its execution by giving small explanations about certain technical aspects.

Finally, the four chapter establishes the commercial opportunities and benefits that will present Ecuador with the implementation of the Coca Codo Sinclair project nationally and internationally, through bilateral agreements of mutual cooperation.

CHAPTER ONE

1. Energy situation in Ecuador

According to author Ramon Mujal "energy demand is found to be directly related to population growth but also to the environmental degradation and public health issues caused by the deficient management of resources, poor planning and regulation which tends to mitigate the climate impact" (Mujal, 2003, pág. 119).

On the other hand, the same author affirms that the intervention of communities "do not allow the free realization of hydroelectric generation projects, situation that causes less interest in private investment in the mentioned area, originating a shortage and thus, obliging the state to either import electric energy or to generate thermic energy" (Mujal, 2003, pág. 119)

The poor planning and the lack of interest in avoiding the environmental impact in the energy generation projects has lead the planet to a constant degradation process. It is not a viable option to stop depending on energy, but it is indeed possible to create projects that meet the energy demand, with minimum impact to the environment.

"The Ecuadorian energy sector has a great impact on the economy; therefore, it must take responsibility for planning, based on the policies that can meet demand" (Sardón, 2003, pág. 278).

To comply with this mandate the national government, through the Electricity and Renewable Energy Ministry (MEER), has defined the following policies:

- To retrieve to the state, stewardship, and power sector planning, coordinating, managing and directing sectorial planning implementations.

- By developing energy resources, to implement processes of local and regional governments, ensuring its self-sufficiency, focusing on the effective use of energy as a whole.

- To leverage the hydroelectric potential of the different basins through the development of hydroelectric power projects.

- To generate electric power by promoting and encouraging the development of renewable sources.

- To implement planning for the adequate and efficient use of electric power through programs.

- To comply with international standards, thus increasing the ability of the distribution sytems to sell electric power.

- To develop nationally the public sector for electric power.

- To encourage and promote sustainable electrical systems. (National Electricity Council, 2012)

Ecuador is the smallest petroleum producer of the OPEC, the Organization of Petroleum Producing Countries. In the same way, its refining capacity is limited, creating situations that restrict net income to Ecuador. Ecuador's energy sources are fossil-based, renewable, and hydro-eclectric.

Ecuador has extracted 239.5 million barrels annually, reaching "an average of 505.00 barrels per day (bbl./d) in 2012. This production has lead to 76% of the total energy demand needed by Ecuador. (OPEP, 2012).

It has been determined a low production of renewable energy, which is sustainable, and with a less environmental impact, depends on hydrocarbon generation whose source is not renewable and causes more contamination.

> Another fuel product that the energy sector has requested for consumption during 2007 in Ecuador was diesel fuel, which has reached 100.7 million barrels. It was diesel with 29.0 % participation; this is used for transportation and generation of thermoelectric plants, followed by extra gas with 17.08% oil blended gas with 11.7% used essentially for food preparation; hydroelectricity 6.7%, electricity through other sources with 5.5%, Super gas of 5.5% used primarily in transportation. (Horta, 2008, pág. 52).

One of the main sources of electricity has been petroleum products, representing 57.78% in 2007 and that same year the participation of the application of renewable energy was 11%, demonstrating the country's dependence on fuel and generating great ecological impact. (Castells, 2012)

> Objective Number 11 of the Ecuadorian National Plan of Good Life states that the necessary approaches for a reorientation of the national electrical needs to be efficient, have reduced environmental impact, guarantee nature's rights and promote a healthy and sustainable environment. It is expected to reach 6% of the contributions of alternate energies, different to hydroelectricity in relation to the total electric capacity intalled in 2013. (PNBV, 2009-2013)

It is planned to restructure energy sources in Ecuador using renewable sources that are aimed to diminish environmental impact. This point is important because it would allow the country to experiment with energy reindustrialization.

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The change in the energy matrix in the country is presented as a strategy that permits the required change through the application of strategic projects that shall take effect in a long term; however, this change would need a structured process:

First point, the need to build an infrastructure that permits the required change through strategic projects that become the base of the restructure is needed.

As a second point to consider, the change of the energy matrix will require a structural change in the economy of the country. This will cause it to change from being a primary exporting eonomy to a production economy. This will create industrial goods with high added value and a post-oil economy.

Under this context, hydroelectric power plants are presented as mainstay, since Ecuador will start exporting energy to the world and we will become a reference entity so that other countries invest in Ecuador, which will count on optimal power supplies, thus achieving its productive development.

"The development through the application of renewable energy must be considered as a system that will lead to the independence of fossil fuel and less energinstead of keep observing them as a simple technical parameter" (González, 2009, pág. 53).

The diversity of the energy production sources, its limitations and the technology that is required to be applied, are part of the process of the generation of a technology era based on the utilization of fuel that is environmentally friendly, unlike fossil fuel-based energy and other energies that are not renewable. It is the natural unpredictability and variability of the first ones that makes electric generation a primary focuse for the future.

"In order to maintain energy provision and to supply the needs of generating electricity through fossil fuel, the variable energetic sources require each time higher investment, adequate adaption of the energetic systems, and be able to incorporate them in the matrix" (Roldán, 2012, pág. 10).

The energy Ecuador requires is characterized by its dependence on hydrocarbons, whose use originates high levels of environmental damage. This situation is looking to employ clean energies that correspond to energetic needs that avoid a higher environmental impact, by applying processes of utilization of renewable resources.

In this way, Ecuador seeks to have alternatives that can contribute to the energy sector dynamic as the follows:

> One of the examples of renewable energy, would be the main natural gas reservoir that is found in the city of Guayaquil. Operated by Petroecuador with a production of 60 million cubic feet per day (Mms/d) in 2012, and in 2013 with a reservoir of 247.000 million cubic feet (mpc) since its low utilization is due to the few infrastructures for its process and commercialization that feeds the plant of 130 megawatts (MW) in Machala that provides electricity to the Guayaquil region. (Kozulj, 2004, pág. 41).

It is necessary to use the natural gas surplus and orient it to the production of energy, backing in processes that allow the country's efficient application of less polluting processes.

1.1 Analysis of the energy sector of Ecuador

"The analysis of the energy sector allows viewing energy as a productive process through effective administration, following a methodology, and in this way, determine the level of resources through an energetic audit, which must be founded in quantity, transformations and costs" (Ruiz, 2002, pág. 39).

The hydroelectric resources inventory as a source of usable energy encourages a better study and application thereof with an advanced technology, making it possible to get different conclusions and generally, more optimist ones about the alternatives that will improve the energy sector.

> The energy sector seeks efficiency through transformation in its structure and its institutions, and through reforms in the regulatory framework made in 1996 about private participation through regulatory framework; which despite the Ecuadorian high rates in comparison to certain South American countries, have produced subsidies, generating a great state important expense that suffers in 2005 a rate increasing deficit with approximately $237 million with an average loss of 23% of the electric sector, plus 50% were non-technical losses in distribution (Acosta, 2008, pág. 142).

Thus, despite all the strategic changes made on the energetic sector, it should be considered the way the development factors of the energy demand interact, as they are so sensitive and volatile, ensuring a non-violent effect.

> According to executed projections, during the period 2000-2030, the world demand on energy will increase at a rate of 1.8% annual. The impact of the economic and demographic growth (which will situate, respectively, annually is 3.1 % and 1% will be leveled by an annual decrease of the energetic intensity of 1.2% as a consequence of the combined effect from the structural changes in the economy, the technological advances and the increasing cost of energy. (Montes del Castillo, 2009, pág. 330).

According to Guillaume Fontaine, one of the most serious problems of the Ecuadorian electric sector is the one related to the high loses of electric energy that present most of the distributors of electric companies.

> Losses in the energy sector are defined as all the energy that is lost during the process of distribution in each one of its phases or stages (transmission, substations, medium tension nets, distribution transformers, luminaires, and measurers). In addition, a different kind of loss is the one called non-technical, which is produced by the lack of measuring and/or billing to the costumers who receive electric supply illegally or in some way, measure systems might suffered some kind of damage. (Fontaine, 2004, pág. 110).

Losses of energy in Ecuador have increased in the last four years. This situation is due to two factors detailed below:

- The process of transportation of energy coming from power plants such as the case of the hydroelectric in Paute, using lines that allow transition, to distribution plants and to the customers due to the fact that the equipment now counts on extended use, causing loss at national level reaching 8.5% in 2012 when counting on optimal level.

- Another point is the losses of non-technical type or commercial losses, which is the name given to everything distributors don't charge users.

The last factor is occurs for three reasons:

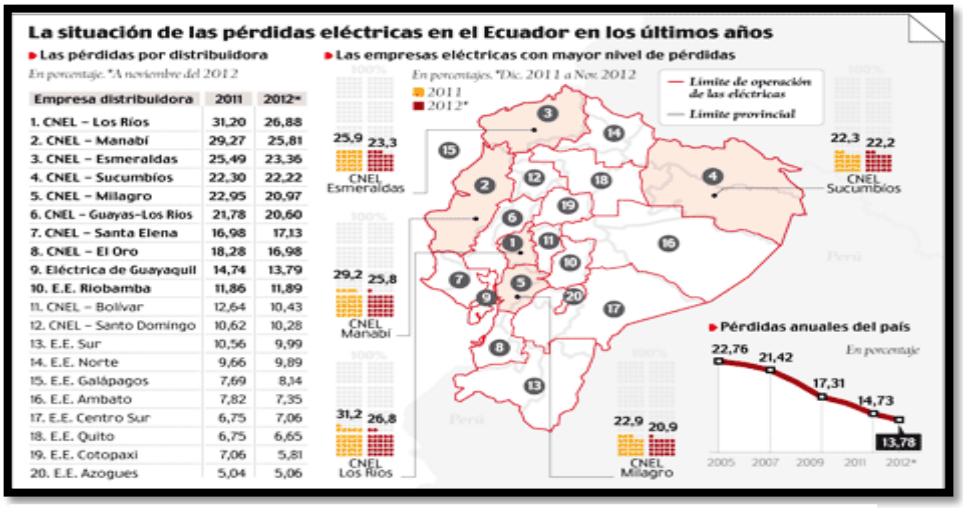
- Inadequate collecting system.
- Underground connections
- Altered system gauges.

Currently, one of the most efficient countries in the electricity world is Korea, where the energy losses do not exceed 4% while the best electricity companies in Chile, Mexico, and Brazil less than 8% leakage, while i Latin America, the average is 13%.

> Among the distributors that have registered bigger losses, there are: CNEL-Los Ríos, CNEL-Manabí, CNEL-Esmeraldas y CNEL-Sucumbíos where the average overcame 20% during 2012. These companies are part of the National Electricity Corporation (CNEL) which in 2009 gathered ten electricity companies of the region along with Sucumbios. CNEL manager Tito Torres indicated that the losses have lowered from 30% to 20.5 in the last four years, thus demonstrating important improvements in the production and distribution of electricity.. (Araujo, 2013)

Graphic N° 1

Situation of the electricity losses in Ecuador in the last years



Source: Environment and sustainable development

According to the loss levels registered in the provinces of the Electric Company in Ecuador, prevention plans should be implemented to avoid the theft of electric energy thus generating more losses. This is what the energy matrix needs, so that the country no longer suffers energy losses (and thus, money), through monitoring programs to improve operation processes from the different electric entities.

1.2 Environmental and social Causes and Effects of the renewable energy adoption.

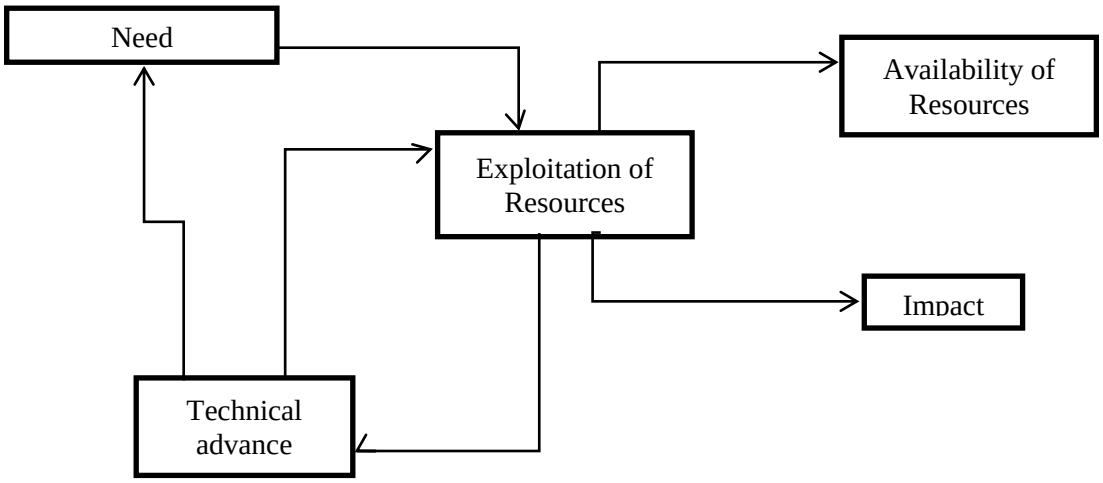
One of the main problems that the earth and humanity are facing in the 21st century is climate change, which is generated by the economic and industry development, indiscriminate cutting of trees used for energy and the constant extraction of the earth's resources, turning mankind into the main environmental predator.

The climate change topic has become something important for the whole international community, because its effects increase every year making us come to the conclusion that the development models for energy that countries carry out, are no longer effective, thus causing increasing damage to our planet.

> From the fifties, the accumulation of greenhouse gasses have increased dramatically due to the industrial revolution, and the use of gasoline. These gases produced by the burning of fossil fuels then cause massive destruction of the planetary flora that is a natural pollutant gas controller. (Faust, 2009, pág. 18)

Historically, men have learned to help the environment on its own behalf through science and technology. However along with its capacity to harness nature and its resources, mankind has caused negative impact on the environment, which can be sometimes irreversible.

Graphic N° 2



Source: Environment and sustainable development
Created by: María Gabriela Rodríguez Carreño

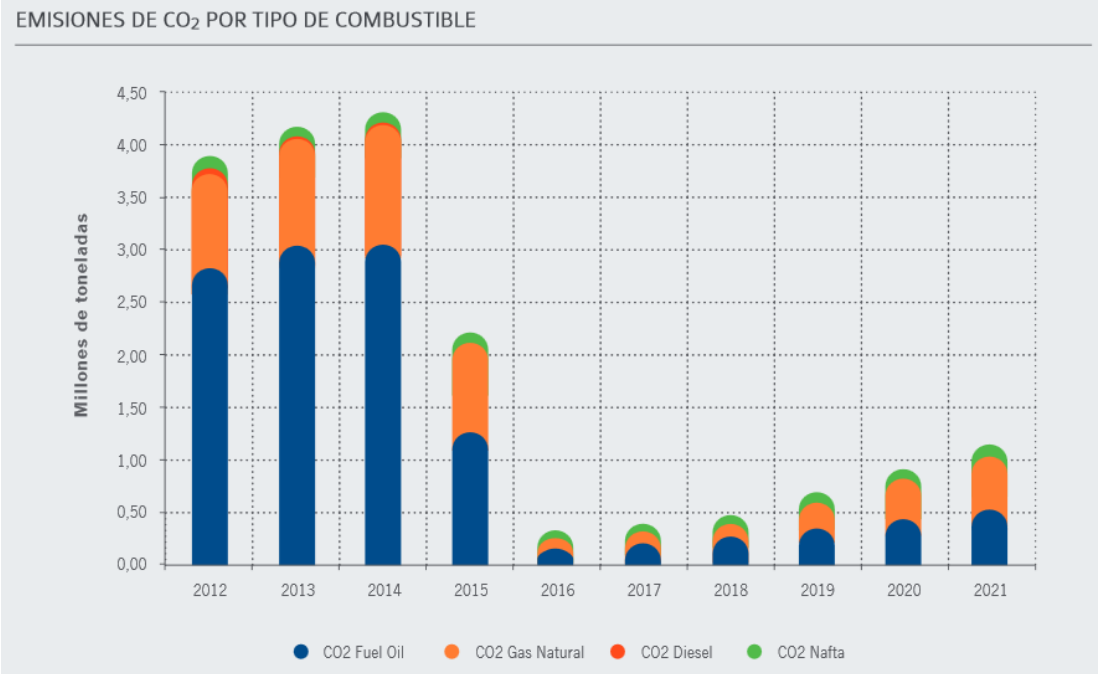
Xavier Castells states: "The proposal for the adoption of energy renewable sources nationwide, is born with the objective of substituting fossil fuel for alternative fuel in order to avoid the increase of environmentally harmful gas and thus avoid drastic climate change" (Castells, 2012, pág. 597).

> A key point to consider in the application process of renewable energy is to avoid the burning of fossil fuels. However the amount of investment and timimg to carry them out, must not be postponed because since the more the renovation processes of energy sources are delayed, the more the accumulation of greenhouse will continue, making them worse in the future (Castellanos, 2004, pág. 215).

The application of measuring techniques of climate changes for the energetic sector, mainly in the hydroelectric field, is a requirement to energy politics against pollution. It should be emphasized that the completion of the hydroelectric projects coming online in 2016, in the electrical system, the level of the consumption of diesel fuel will diminish.

The graphic on the following page illustrates the big quantities of CO2 annual emissions. These percentages are the result of the operation of thermoelectric power plants in the Ecuador. Nevertheless, through the transformation of the energy matrix, and with the adoption of new measures for electrical generation, the values around 0.34 million CO2 for 2016 could be reduced, bringing with it a positive benefit for economy and the environment. (Vásquez, 2012).

Graphic No. 3 CO2 emissions by fuel type



Source: Electrification Master Plan 2012 – 2021

Ecuador must lead the way pointing to cleaner energy sources, such as natural gas, thermal generation with bagasse, wind energy, asa well as nuclear and carbon plants.

Natural resources constitute a great assest to the country, from which fossil fuels produced by animals or bioenergy can be found, in addition to sun and rain which generate heat through soil and rain. Most of the Ecuador uses oil and natural gas as renewable energy.

Some types of energy that are produced by other countries are:

Biomass energy. - Energy production derived from plants through photosynthesis. Plants store solar energy in form of carbon contained in its own organic matter.

Solar energy. - Directly obtained from the sun, this is generated through radiation, becoming renewable and environmentally friendly energy. It is called green energy.

Wind energy. - Created by the wind, it is currently presented as a source of clean energy, important for energy development. Also, it doesn't generate pollution or contribute to the deterioration to the environment. The creation of this type of energy is obtained by a windmill.

Tidal energy. - Originated through tides, by water being captured from the sea at high tide. Stored in a bain or holding tank until it can be drained to produce eletric energy.

Hydroelectric Energy. - Obtained through the capture of water in reservoirs or swamps and it is unloaded through pipes, becoming kinetic energy, leading it to machine rooms, where it is transformed into electric energy. Also it may generate productive soil loss and faua because of the rise of the reservoirs, in addition to the decrease in water flows. The reservoirs, in addition to the decrease in water flows of creeks and water quality.

The construction of a dam can lead to environmental changes, alteration of the water flows, causing flooding, transformation of the fauna and flora, impact on the fishing, and population of the area. On several occasions, this situation represents a major cost than what benefits represent; therefore, an adequate evaluative process can lead to the right application of energy production.

Currently, a bigger electric generation project is being carried out with national interest, which seeks to adequately support the energy demand in the following years, reducing the fuel consumption and the reduction of carbon emissions, reforesting the areas affected by the construction and integrating schools to induce children to conservation, accomplishing the environmental management plan.

Through the identification of environmental and social costs of the project, the inhabitants of the flooded area are highlighted because of their vulnerability, thus resorting to involuntary displacement. These socio-environmental problems occur as a consequence of controlled and uncontrolled migration, causing health problems, public services depletion, and social conflict, among other types of negative impact. Because of its importance, these plains of rivers where the projects will be carried out, are sought prudently and under appropriate care and study in order to avoid such problems.

The hydroelectric projects represent great relevance to the contribution in the development of our society, based on the utilization of electric energy, moved by transportation networks and complex distribution. The resources that do not deplete and can permanently be required are called renewable energy, avoiding greenhouse gasses such as CO2, thus, at same time becoming a secure and unlimited alternative energy source.

Although positive aspects related to the utilization of energies exist, it is undeniable that the process of construction of hydroelectric power plants and their infrastructure cause environmental impact, which can be harmful to the community and to the surrounding animals. This could be avoided with the development of a correct evaluation, carrying it out carefully, it may also determine the decrease of the impacts presented during the execution of this work, because by the study of the

impact, it can be determined what consequences will be, and thus take action to avoid them.

“The generation of energy making use of water sources or in this case, the river flows, may trigger irreversible consequences caused by the construction of dams or reservoirs” (ENDESA SA, 2012).

Among the irreversible consequences ENDESA is considering are the following:

- Alteration of territory caused by the soil submergence.
- Natural cycle disorder due to changes that are presented in the area of construction of the dam or reservoir.
- Nutrients and sediments as silt and clay which depends of downstream are not transported properly.
- Decrease in the river flows.

Ana Portilla suggests that when applying an evaluation process “natural and social impacts that may signify the construction of a dam should be considered since they could allow the decrease of social spending and the environmental impact; therefore, when constructing a dam it is very important that possible impacts be evaluated in order to avoid or decrease them” (Portilla, 2014)

1.3 Energy demand preferential scenario

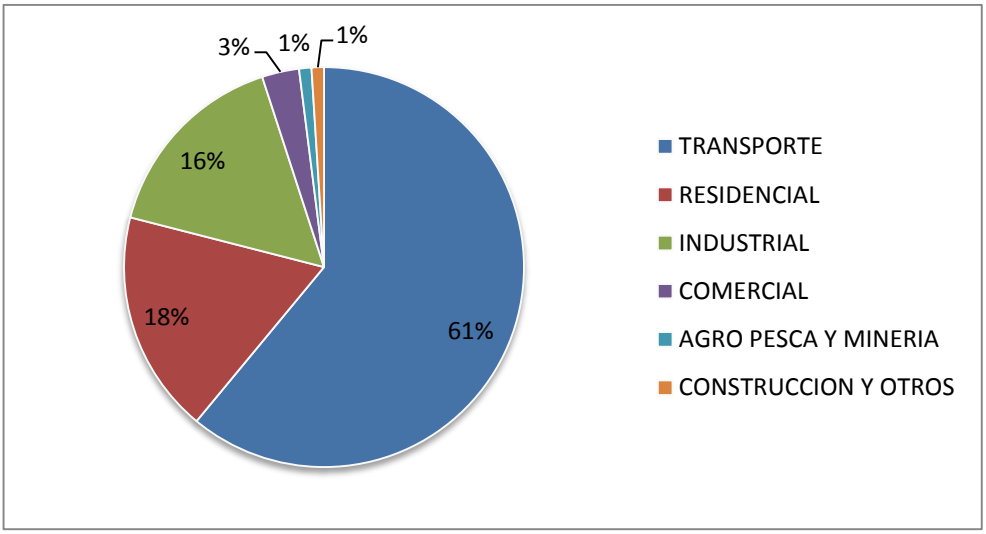
For the current energy demand, alternate but simple practices exist, such as the rational use of electrical devices which reduces electricity consumption, which in economic terms, will lead to save a great deal of money, as well as reducing environmental impact and thus streamlining the economy of the country.

As the baseline scenario in the reduction of environmental impact, existing policies such as the objectives of penetration of renewable energies that have been designed by the International Energy Agency (AIE) and the (EU) European Union, which by the year 2020 are presenting the 20% of the final consumption and that 10% of the energy applied in transportation, depends on renewable source based energy and that CO2 emissions be 20% less than the ones produced by the 90's. (Galván, 2013)

On the other hand, the authors Sancho, Miro, and Gallardo, declare that "The focus towards the transportation sector supposes an improvement in 10% referring to the existing one in the year 2000, through the application of measures that improve management patterns and reduction of unnecessary transit" (Sancho, Miró, & Gallardo, 2006, pág. 109).

As it is indicated in the graph, (below) the transportation sector is one of the main energy consumers at a national level, around 61% of the total demand. It is necessary to apply measures that improve management patterns reducing the energetic consumption level. In this way, the other sectors like the residential one participate with 18%, the industrial one with 3%, agro fishing with 1% and mining and construction 1% as well. (Vásquez, 2012)

Graph 4 Consumption of Energy Nationally



Source: Electrification Master Plan Statistics 2012- 2021
Author: Ma. Gabriela Rodríguez C.

Arriving at a point where the generation of energetic processes is sustainable and efficient is the ideal to achieve, but this supposes going beyond demand and offer sectors.

According to the Electricity National Corporation (CNEL), in relation to demand sectors, in the edification sector, there would be rehabilitated around 500.000 houses until 2050, whose finality is to achieve 50% energy saving. In addition, the new houses will have a demand of 80% energy demand, less than the current demand, which will signify 465 saving until 2050.

In relation to offer measures, a bigger penetration of the renewable energy is considered, based on the available potential and the possible reduction of costs in contrast to the expected rise of fossil fuel cost.

"The final energy consumption development shows a tendency to rise; therefore, it is expected that in 2030 the consumption of final energy will reach 19% more than the one registered in 2009. This can be achieved through the increasing consumption of renewable energies and the decreasing oil participation" (Villalba, 2011, pág. 74).

Eduardo Gudynas when referring to the consumption of fuel for the energy generation, presents the possible following scenario for 2030:

> In the sustainable scenario, the consumption of fuel used for the generation of final energy for 2030, it is expected to have a reduction of 12% making reference to the year 2009. The processes that will improve efficiency apply to different sectors and the application of more efficient technology will allow 26% saving of the final energy consumption in 2030 in respect to the base scenario for electricity. Its participation in the final energy consumption would change, increasing from 21% in 2009 to 27% in the sustainable scenario in 2030. (Gudynas, 2010, pág. 208)

In this case, the difference in the evolution of consumption of primary and final energy is due to a greater efficiency in the energy system with sustainability factored in. "In transportation, both cases show reduction in the final consumption in 2030, which, in the case of the sustainable scenario, has great importance supposing 59%

less than in the year 2009. The reason for this reduction has to do with the insertion of electric vehicles, besides a change in the pattern of use and management of merchandise transportation" (Sancho, Miró, & Gallardo, 2006, pág. 216)

Due to environmental conservation policies and to the decrease in the dependence on hydrocarbons, there is an increase in the use of electric vehicle and implementation of electricity based trains. All this would lead to an increasing electric consumption, decreasing the oil consumption to half of 2009 levels.

The restrictions in CO_2 emissions in 2020 and 2030 make the participation of renewable energies in the system increase, reaching in 2020 70% of the generated electricity and 100% in 2030. (Lechon)

The massive increase of technologies for the generation of renewable energies has led to a fossil fuel consumption displacement, projecting the disappearance of carbon in the sustainable scenarios for 2020 and 2030 along with gas in 2030. This includes the disappearance of nuclear energy caused by the completion of current plants useful life, turning into a 100% scenario of renewable energy.

But every technological improvement and implementation process takes with it investment, since bigger investment will be produced around 2020, a moment in which most of the current plants will deplete their useful life. In this moment, countries need to invest in new renewable energies such as solar photovoltaic, thermal fossil, land and offshore wind, marine and core technologies of coal.

1.4 Hydroelectric Energy Offer

Rivers are important energy sources, although their uses have been reduced compared to the resource magnitude. Among works of bigger scope, the power plant in Paute should be mentioned. Other power plants which also accomplish a more efficient function, and as the emplaced on the rivers of turbines systems which act as compensators and are fully used in moments of bigger demand or in case of emergency.

In our country, emblematic projects which will change the energy matrix are promoted. “These projects advance in their construction, and accomplish the objective of the Ministry of Electricity and Renewable Energy and of the Government, guaranteeing the full coverage of the electric energy services in the country” (Alejos, 2011, pág. 96).

Ecuador promotes the change of the energy matrix in the country, moving forward to the construction of eight hydroelectric projects with the objectives established in the strategic plan of the Ministry of Electricity and Renewable Energy. (Ministerio de Electricidad y Energia Renovable, 2012).

Among some of the projects that can be mentioned are:

- The Coca Codo Sinclair, one of the most relevant projects, since it will increase the electric energy offer in 1500 MW.

- San Francisco mines, located in Pucara Canton and in Zaruma and Pasaje counties will contribute with 270 MW.

- Manduriacu, located in Quito city, Pichincha province and Cotacachi-Imbabura provinces will contribute with 60 MW.

- Mazar-Dudas, located in Azogues Canton, Cañar province; this hydroelectric will generate 20.82 MW.

- Toachi Pilaton. This hydroelectric Project is located in Pichincha, Santo Domingo de los Tsachilas and Cotopaxi provinces. It will generate 253 MW.

- Delsitanisagua, located in Zamora Chinchipe will generate 115 MW.

- Quijos, located in Napo province will generate 50 MW.

- Sopladora, hydroelectric Project located in Azuay province, Sevilla de Oro County, and Morona Santiago province, Santiago de Mendez County. It will generate 487 MW. (Ministry of Electricity and Renewable Energy)

In relation to the Environmental Management Plan and its right application, "The actions framed within the following programs: compensation and economic development, loan area, flora and fauna management, environmental training, and solid waste, are accomplished according to what was previewed, presenting a 21.67% improvement" (Coca Codo Sinclair, 2009, pág. 23)

According to the Ministry of Electricity and Renewable energy, with the culmination of these projects, electric energy will be guaranteed until 2021 in Ecuador; the hydroelectric projects that will finish its construction by 2016 will be a determining point so that Ecuador can reach self-sufficiency and become an energy exporter, transforming the energy matrix radically, and guaranteeing the country's provisions for the next nine years.

Currently, 62.7% of the country's electricity comes from water reservoirs ad 37.3% of the thermals. From 2016, 93% of the energy will be hydroelectric, according to the Ecuadorian Electric Corporation. (Ministerio de Electricidad y Energía Renovable, 2012).

These projects will help Ecuador move from 3770 MW to 6779 MW, in other words, an 80% rise until 2021, so the amount of energy to be produced to date, will be able to illuminate the equivalent of six thousand football stadiams, or six cities the size of Quito. "We will have so much energy that there will come a moment in which it will accumulate in a way that the country will start exporting electric services and not only primary goods to countries. (Correa, 2014)

"It doesn't only benefit the national economy, but also the environment since currently, the country spends approximately 1.100 million dollars annually in buying Diesel for thermic generation, and the hydroelectric process will save about eight thousand million CO_2 kilograms, which will reduce the use of approximately 80% diesel" (Correa, 2014).

Ecuador leads the Andean energy integration process which will be able to export clean energy to countries like Colombia, Peru, Chile and Bolivia since they suffer problems related to generation of electricity, being the possible buyers of energy to be exported by Ecuador. (Diario el Comercio, 2014).

CHAPTER TWO

2. Transformation planning of the energy matrix.

The energy matrix is described as the energy available in a definite place in different productive processes and it is a planning method of the energy sector and the adequate use of available energy that has generated great demand nationally.

In recent years, the worldwide consumption of energy, has more than doubled due to the increasing industrial growth and transportation, due to social and economic conditions, with an approxiate 70% increase. This has occurred even though 1.6 million lack electricity and another $ 2.5 million resort to wood or biomass for energy needs. (Global Environment Facility, 2009, pág. 16)

Ecuador has been a raw material provider, making Ecuador unable to compete in international markets. Stood for being a row material provider, making the Ecuadorian economy unable to compete in the international markets. Therefore, the Ecuadorian government needs to change to generate more added value to services and products, which will transform the product matrix, improving living conditions, thus creating a more fair and equal society.

Under this context, it will be necessary to achieve a whole transformation of the productive matrix by working to integrate the different systems that compound it. The most important one being the energy matrix.

The energy matrix reaffirms the characteristics of the country, demonstrating 90% national production of the total energetic offer that is concentrated in a 96% in raw oil and natural gas, remaining renewable energy relegated in 4% (hydroelectric and biomass) of the national production. (Samaniego, 2014)

The energetic social and environmental sustainable policies should consider the current energy matrix as much as the energetic production distribution, so the improvements in life quality can reach the whole world population, without risking the planet's human life survival.

The change in the energy matrix is a challenge that means "changing what we produce and how we produce it." It is important to stop hanging on the exportation of primary goods; adding value to local products and diversifying the consumers, in other words:

- To increase the national production through the participation of renewable energies, with the execution of hydroelectric projects contemplated in the Electrification Master Plan. The utilization of other renewable energies are added such as: geothermic, biomass, wind and solar.

- To reduce as possible, all importations derived from oil with the construction of the "Refinería Del Pacífico" (RDP) in Aromo-Manta, which will guarantee the provision of products derived from oil for the domestic consumption and thus, generate surplus.

Raw oil is a low added value product, so its utilization is proposed as an input in the new refinery that will help change the current exportations profile from oil products to higher added value products.

President Rafael Correa declared that after 2016, Ecuador will stop consuming blended gas in the homes in order to pass to electric stoves, due to the plan that 93% of energy will be hydroelectric. In this order it is expected to increase the levels of access and the expansion of telephone and internet services. Finally, there will be work done in the transportation sector, seeking efficiency and efficacy from the system.

"Transportation also has environmental implications in cities in which the high traffic volume generate problems of traffic jam and environmental pollution, being urgent in its attention" (El Comercio, 2014)

2.1 Critical Factors of the renewable energy adoption

Through a general context of the renewable energy adoption, there is the influence of several factors that determine the viability and benefit of technological use. This point analyzes the expectation for macro, for which it should consider technical, social, environmental and economic factors as critical to the implementation of renewable energy sources.

In order to release a diagnostic about the competitiveness of the certain technology in the energy sector, the cost is taken as an important fact since technologies that have competitive cost in respect to the traditional ones of the electric sector, will have greater feasibility and probability of being adopted, using cost data from the last Intergovernmental Panel information about the climate change (IPCC) corresponding to cost ranges.

These cost ranges are used since in America Latina lacks approximate renewable source technology data since they offer a scheme of the countries with different renewable energies and technologies.

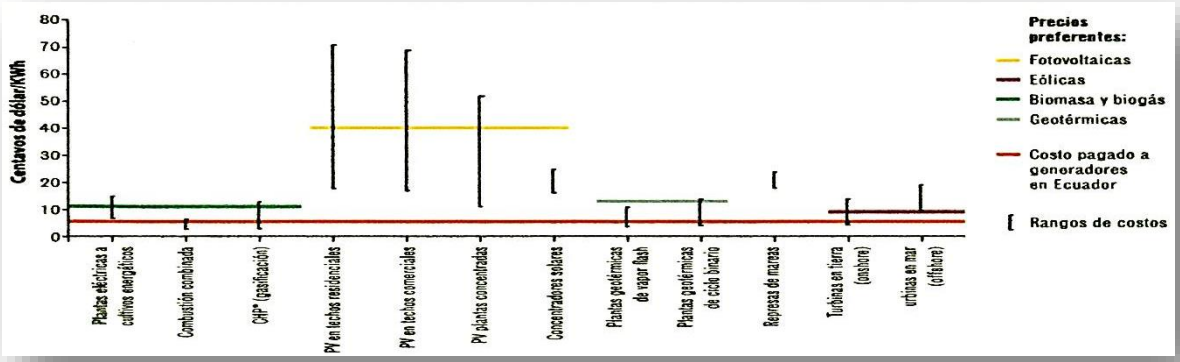
Four types of technology show global medium cost ranges smaller than the cost recognized to the electricity generation in Ecuador, such as the following:

- Bioenergy for the electricity and heat generation (*Combined Heat and Power* CHP);

- Geothermic energy with condensing flash plant technology and binary cycle plants.

The following graphic contemplates preferential prices according to the different technologies with cost ranges below these roofs that turn into economically viable energies for Ecuador.

Graphic N° 5 International Media Costs and Prices of Renewable Energy



Source: Bruckner et al., Conelec 2009 y 2011 b.

This would be focused in the socioeconomic aspect, dimensioning a sustained long term rise, allowing the reduction of poverty found in 61.3% of the population and 31.9% with extreme poverty, due to the income inequality.

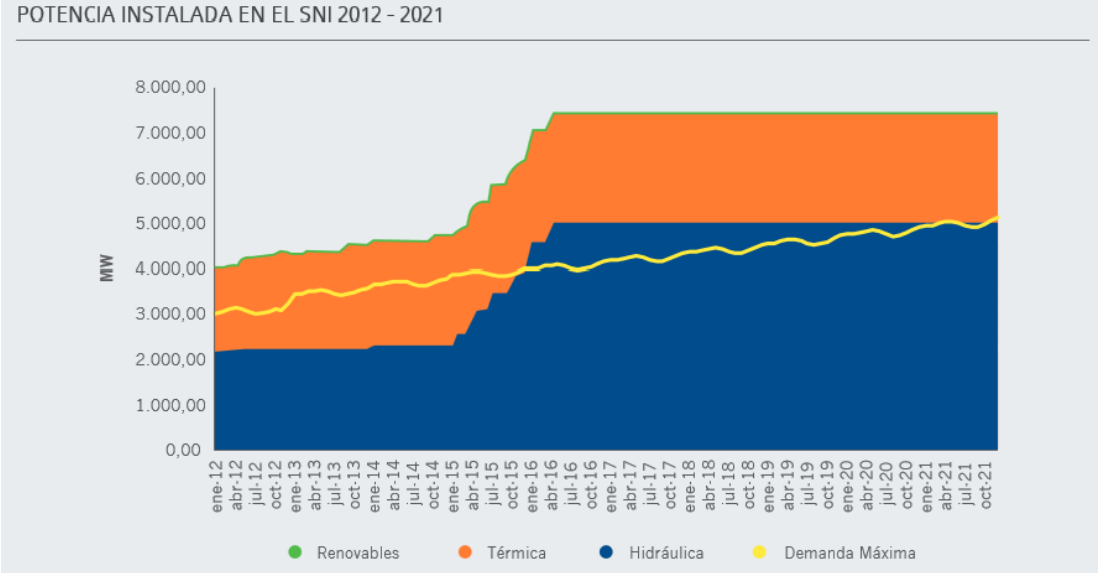
Because of the rise that Ecuador has had regarding the energetic consumption, a problem of demand arises and it seeks to cover it with renewable energy and the need of transforming the sources of energy optimizing its consumption; therefore, with the current energy sources that the country has, the following critical and concerning factors may be found:

- Pollution
- Waste generation, such as radioactive waste.
- The chemical alteration of the atmosphere and its following climate change with consequences such as the greenhouse gas emission, essentially carbon dioxide, resulting from the burn of fossil fuel.

In this way, it can be highlighted that the current fossil fuel availability is limited, resulting in an important rise of the oil price. Also, the energy consumption arises in a continuous way with an approximate 50% worldwide between 2007 and 2030; therefore, with the need of preserving the environment and securing a sustainable development, the use of clean or renewable energy sources is enhanced.

The hydroelectric projects entry results are important since it can diminish the participation of thermoelectric generation in the energy matrix. According to the 2012-2021 electrification master plan, the power to be installed with the projects in execution will "reach an increase of 7472 MW in 2021 from which 5037 MW will be hydroelectric, 2348 MW thermoelectric and 86 MW non-conventional generation" as shown in the following graphic. (Vásquez, 2012)

Graphic No. 6 Electric Power Installed at the SIN 2012-2021



Source: Electrification Master Plan 2012 – 2021

2.2 Determination of incidential factors in the energy matrix transformation advance and explanation from its current situation.

The previewed rise in the emissions of greenhouse gas is the reference scenario which estimates that by the end of this century the concentration of such gas will duplicate in the atmosphere; this will lead to a rise in the medium planet's temperature by six degrees Celsius.

Considering that the product matrix is based specifically on natural resources whose provision would threaten the economic and political provision of the country, the study of the environmental impact would be fundamental in the energy production sustainability in development projects.

Such studies would be necessary for the diversification of the matrix and moderating hydrocarbon resources since they have negative impact on the environment, so is the utilization of hydroelectrics and its dependence on climate phenomena, producing a significant environmental impact in the local ecosystem where they are installed.

The energy transformation is based in the main renewable energy source promise, being vulnerable to climatic changes in the caudal for the hydroelectric generation since the energy matrix depends upon the hydroelectric one, and Ecuador is a main electricity source. In this way, the transformation of the energy matrix in our country requires policies, planning and structured instruments that have configured a central matrix in oil and hydroelectricity.

The government performs functions in order to improve efficiencies, so fundamental organs have the politic responsibility through institutions to promote energy efficiency oriented in science and technology to serve the country and thus approach the world with a current perception of the primary source production and exportation, starting a transformation road with equity based in the technological impact.

According to data collected from the Electricity National Congress (CONECEL), in Ecuador, the primary energy demand has risen from 43 to 86 Mbep between 1985 and 2008, or 2.9 annually, being the strongest rate of Andean countries. The

Ecuadorian energy matrix depends 90% on oil based-energy, some that come from cane-based products. Studies have shown that national consumption of energy sources come from cane 1.2%, wood 1.2%, natural gas 4% and oil 90% becoming the biggest source of energy generation with 50 % consumed by transportation.

In general terms, the country's energy is destined to either natural gas, electricity, or ceramic industry; likewise, oil to refineries whose products are used in transportation, industry and domestic consumption.

Currently, the energy policy has suggested variations in the energy matrix which raises that oil and hydroelectric continue being the two main energy sources in the country. Wind and photovoltaic enerty is gaining prominence in the country because when counting on this type of energy sources help diminish polluting gas emissions such as greenhouse among others. All this helps consolidate new work areas for surrounding communities, thus promoting technological development.

The months of increasing demand are October, November and December. Such months have the lowest caudal in the oriental hydroelectric range, originating power cuts and lack of provisions, same as in the year 2009. In order to avoid these events, the proposal is to change the matrix through the construction of more electric power plants in the occidental rage in order to fully satisfy the electricity demand, avoiding new power cuts.

CHAPTER THREE

3. The Coca Codo Sinclair Project

3.1 Background

The relevant results are the already disappearing Ecuadorian Institution of Electricity (INECEL) since 1970 in the search of satisfying the increasing electric energy demand of Ecuador and taking advantage of the enormous hydroelectric potential that exists. By identifying excellent characteristics and opportunities for the hydroelectric exploitation in the Napo river basin and concretely in its affluent Quijos and Coca, space in which the geographic accident called "Codo Sinclair" is located.

In the subsequent years, the potential of "CodoSinclair" has become the most important hydroelectric project of the referred hydrographic basin, and one of the most attractive for the development of our country. In this way, the state, through organizations created to administrate in an appropriate way the electric sector, has encouraged several technical and financial feasibility studies with the purpose of guaranteeing its viability for implementation and exploitation.

Currently, the Coca Codo Sinclair is one of the emblematic projects undertaken by the Ecuadorian government, being found in the middle of an execution stage. This promising project will have an installed capacity of 1500 MW and currently is being built by the Chinese company *Sinohydro* with 1979 million dollar investment, financed 15% by the national government and 85% with a Chinese government loan.

Under this context, it is important to state that "February 7, 2008, before Dr. Remigio Poveda Vargas, Notary Seventeenth Quit County, the Thermoelectric Generation Pichincha Company, TERMOPICHINCHA S.A., represented by its executive chief,

Engineer Juan Carlos Lopez Benalcazar and on the other hand the Argentinian Energy Company S.A. ENARSA, represented by its president, Engineer Ezequiel Espinosa, constituted the Hydroelectric Coca Codo Sinclair Company COCASINCLAIR" (Obando, 2012)

Later, on September 17, 2009, through a "Share Purchase Agreement", the company ENARSA proceeds to yield, sell, and transfer to the Ecuadorian Electric Corporation (CELEC), in the same way the actions of the Argentinian company.

Finally, on May 26, 2010, President Rafael Correa Delgado, transforms the hydroelectric company Coca Codo Sinclair S.A. in the Hydroelectric Strategic Public Company Coca Codo Sinclair EP which has the power to "exercise as a legal entity under public law, with own equity endowed with budgetary, financial, economical, and administrative autonomy, located in the Metropolitan District of Quito, Pichincha Province" (Consejo Nacional de Electricidad, 2008).

3.2 Characteristics of the project.

The hydroelectric Coca Codo Sinclair Project, considered as the most important of the country is located in Napo and Sucumbíos provinces in the north oriental part and it consists of the Coca river waters. Once the station starts operations it will become the greatest hydroelectric project in the country, with 1500 MW potency installed.

ASTC, along with other consultory firms that participated in the development of designs at an advanced level of that included, complementary works, dams, balance chimneys, power plants, access roads, hydromechanics equipment, electro mechanic, civil works and substations, and the transmission line study.

"In the same way, the study execution was done, field research, ecologic study and environmental impact, were conducted to determine costs and budgets, works programming, construction methodology and financial evaluation of the project. It is strategic that all named areas are appropriately coordinated for the right project operation" (Global Environment Facility, 2009).

3.2.1 Physical characteristics of the Project:

Concrete dam (height):	38.1m
Main Landfill length:	110.0 m
Auxiliary Landfill length:	66.0 m
Maximum Capacity:	20.000 m3/s
Driving tunnel:	24, 9 km (63.50 m3/s)
Compensation reservoir:	Rockfill dam (maximum height): 53, 50 m Reservoir Total Volume: 812.103 m3 Useful Volume: 530 .103 m3
Penstock:	Caudal de diseño: 80,25 m3/s Tramo en hormigón: 1.418,70 m de longitud por 4,50 m de diámetro. Tramo Blindado: 425 m de longitud por 4,2 m diámetro.
Machine house:	Number of Groups: 3 Pelton Net fall: 609 m Installed Potency: 432 MW Tailrace tunnel: 643, 30 m long by 5, 80 m diameter. Transmission Line: 150 km (230 KW) (Coca Codo Sinclair, 2009)

3.2.2 Importance of the Project against the new energy matrix.

Ecuador is an outstanding country because of its richness of natural resources that include considerable mineral and oil reserves.

The extraction and exportation of crude have marked the development of Ecuador in the last four decades and the earnings that have been generated by industry have been the main source of income due to its high performance for the energy production. However, oil is a non-renewable source and the sites for exploitation are each time more reduced, provoking a great environmental damage; for this reason, the Ecuadorian government has decided to invest in energy sources that are renewable to counteract the mentioned aspects.

In Ecuador, the main financing source for the fiscal cash comes from oil exportation, in addition to the electric energy generated for the population. This represents a high cost and creates external dependence. For this reason, hydroelectric projects are the most suitable ones for the generation of electric energy, since through them the energetic demand will be supplied in the country, thus exporting energy to other countries.

Rivers are hydraulic renewable sources that do not affect the environment negatively besides generating electricity at a low cost for the population, leaving aside thermoelectric power plants that use fossil fuel that is dangerous for the community and the environment.

The chart below shows the geographic location of the various project areas which help us have a better understanding of how the project would be established.

CHART N° 1

Location of the Project – Infrastructure works

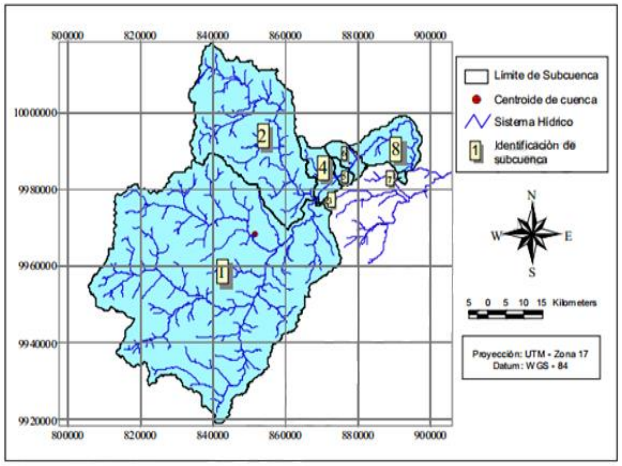
Project location in the study area

INFRASTRUCTURE WORK OR INSTALLATION	INFRASTRUCTURE WORK OR INSTALLATION			GEOGRAPHICAL LOCATION (1)	
	PROVINCE	CANTON	PARISH	EAST	NORTH
Work of Uptake	Napo	El Chaco	Gonzalo Díaz de Pineda	201000	9978000
Adduction Tunnel	Napo	El Chaco	Gonzalo Díaz de Pineda	I: 201500 F: 224500	I: 9978000 F:
Compensation Reservoir	Napo	El Chaco	Gonzalo Díaz de Pineda	224500	9984800
Pressure Pipes	Napo	El Chaco	Gonzalo Díaz de Pineda	I: 224500 F: 226700	I: 9984800 F:
Machines House	Napo	El Chaco	Gonzalo Díaz de Pineda	226700	9984800
Machines House way	Sucumbíos	Gonzalo Pizarro	El Reventador /Gonzalo Pizarro	I: 228000 F: 226700	I: 996700 F: 9984800
Compensating reservoir way	Sucumbíos / Napo	Gonzalo Pizarro / El Chaco	El Reventador /Gonzalo Díaz de Pineda	I: 228400 F: 224500	I: 9994800 F:

Source: Definitely Environmental Impact Study (Coca Codo Sinclair Project)

Graphic N° 7

Location of the studied basin and sub basins division.



Source: Definitely Environmental Impact Study (Coca Codo Sinclair Project)

This graphic helps us have a better view of how the basin and project flows are distributed.

The vison that the Coca Codo Sinclair central has is to be recognized by 2018 as the leader Public Company in the generation of hydroelectric energy with the application of new techniques for the right gestation of whole development, energy, and social projects, making it sustainable from the environmental point of view.

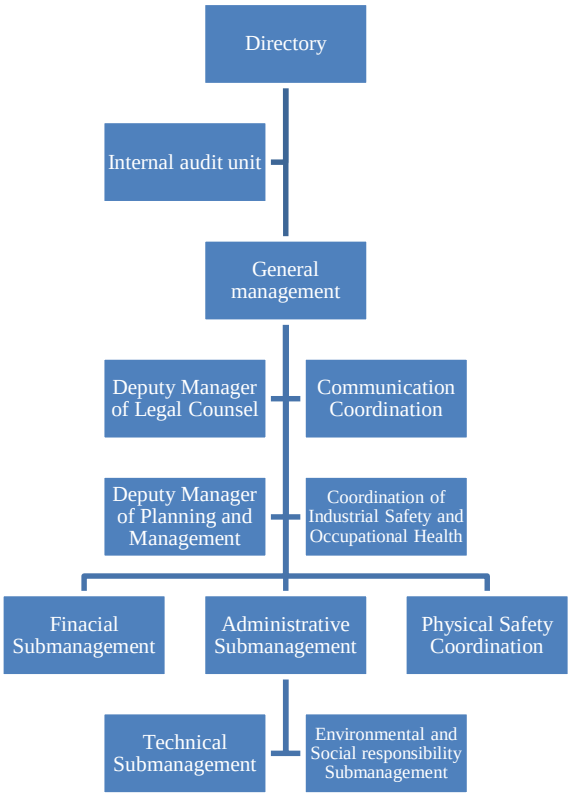
The mission through this mega Project is to contribute to the sovereignty and the change in the Ecuadorian energy and productive matrix through the construction and operation in the year 2016 of the hydroelectric central, besides various complementary projects which with the help of a technical gestation model, business, environmental, added to social responsibility, human talent, innovation, research and development, so it can improve the inhabitants of the project zone lifestyle, mainly to social and economic development of the country. (Coca Codo Sinclair, 2009)

The objectives of this company are intended to be accomplished through a specialized group of work that is qualified and skilled, which will be organized in

different strategic areas. The way the staff and departments are developed, helps achieve a greater result in the project.

3.2.3 Organization Chart

Graphic N° 8 Organizational Project



Source: Final Environmental Impact Study (Coca Codo Sinclair Project).

3.2.4 Coca Codo Sinclair PC Company Objectives

- To ensure strategic position for the long term.

- To maintain a regime that allows timely operation and a good central maintenance.

- To establish support policies for the development of the electric sector which are being enhanced by the National Government through its respective Ministry and other institutions.

- To increase, through plant construction, the infrastructure of hydroelectric national generation.

- To strengthen administrative and commercial gestation of the company is it can offer the population quality service. (Coca Codo Sinclair, 2009)

3.3 Project viability and versatility

The company, along with the Ecuadorian government had established on March 27th, 2009, the construction of the hydroelectric central to Sinohydro Corporation (Chinese company constituted in Ecuador). This project is built under the EPC mode which establishes that design, engineering, manufacturing permissions, construction and installation, commissioning, safe, and punctual completion of the required works for the execution of the project, are the contractor's responsibility.

Within what is budgeted, there has been considered the amount of 1,980 million dollars according to the agreement whose purpose is to avoid the double taxation between Ecuador and China in order to make withholding for international payments that are made by the constructor to his matrix house, affiliates and subsidiaries constitute tax credit for them.

Considering these aspects and under tax detailed conditions, the total Budget for the EPC contract totals 2,161 million dollars according to the auditing company Deloitte. (Deloitte and Touche, 2011)

To consider the economic benefit of the present hydroelectric project investment, the following costs are taken into account which will be reflected in the cash flow:

- Construction costs (civil works, equipment and transmission line) and other costs (including engineering, administration and fiscalization) so Coca Codo Sinclair works can be made.

- Costs that are generated by equipment replacement concept permanent after 30 years of useful life and;

- Annual operation and maintenance plant costs.

The deadline for the construction of the mega hydroelectric work is assumed to be distributed in the 5 years agreement according to the established chronogram for investment, taking as a starting point the construction of the plant on July 1, 2001, but by chronogram effects 2010 has been taken as a reference.

The benefits presented along with the hydroelectric construction are considered according to the good benefit thereof, establishing that the production starts from the sixth tear, taking as a referential starting point the year 2015 and being effective such execution process on July the first, 2014 during the next fifty years, which is the useful life assumed for the plant.

To determine the economic parameters, a discount rate equal to 6% is assumed, and considering the actual cost of the installed cost (1500 MW) which, in dollars is 1353 dollars per kW; therefore, the cost of the energy will be 0.0171 dollars per kw/h. In the same way, the project's net benefit costs are 1448,8 million dollars and the relationship benefit/cost is 1, 93 resulting in an Internal Return Rate (TIR) equals to 12, 20%. (Ulloa, 2011)

Establishing the direct benefits for the Ecuadorian Government, the execution of the hydroelectric Coca Codo Sinclair project is considered a high national priority, the production of 1500 mw will generate a savings of 2.5 million dollars per day. Up to date there have been used in the consumption of Diesel for the thermic power plants that generate energy for the country.

In other words, with this sole project the energetic need of approximately 36% of the population would be supplied, which leads to the reduction in the production costs and thus to the decrease of electric fees that the population should pay for the service. In this way, this project pretends to reduce the energy dependence with cleaner and more efficient energy alternatives.

The energy sufficiency that the commissioning will cause will allow the creation of more work fields thus lowering unemployment. From the environmental point of view, use of the thermic power plants and the production processes at Coca Codo Sinclair start, the CO2 emissions will be reduced in 4 million tons annually, and will decrease the Diesel importation level in 533 million gallons annually. (Consejo Nacional de Electricidad, 2012)

CHAPTER FOUR

1. Economic opportunities Ecuador would have in the international energy market.

Energy is considered a fundamental element to achieve a whole nation´s development since the appropriate management and control of this source leads to sustained growth, thus improving the life quality of its inhabitants.

For this reason, the government sees as meaningful and strategic to carry out great projects and the construction of infrastructures, investing in research, development, and human talent; because these are ways to attract big transformations, and at the same time, opportunities that establish productive chains positioning us in front of the international community as a promising, rentable country, capable of creating important international relations.

In this way, the Coca Codo Sinclair project seeks the link to achieve commercial opportunities with other countries, since many nations look forward to achieve sustainable economies. With the increasing energy demand and the situation of struggle on climate change, they see themselves forced to face new challenges at micro and macro levels. In order to achieve this, it is fundamental to make investments in the energy sector.

Since we offer something they need, because hydroelectric energy is fundamental; it is more efficient and less polluting. It will be a mutual benefit because it will allow energy demand between 42% and 62% nationally, along with the demand from neighboring countries, thus improving the electric sector's competitive edge.

4.1 Main economic international relations with the Project.

Ecuador is characterized for being one of the countries that more electric energy has imported, causing 2009 to resort to the energy rationing due to the deficit of the

balance. The policies of the energy matrix have achieved the modifying of this situation providing an investment of 4,362 million dollars; only in 2012, achieved 2% of the thermoelectrical generation, and in the last six years, the hydroelectric energy rose from 46% to 65% projecting an extent of 93% in 2016. (Gonzales)

In the last years, the energy has gained importance in the international relations, mainly because many countries worked to achieve sustainable economies and seek better alternatives to control climate change. In the same way, because of the rise of the population, it implies a rise in the world commerce that demands more energy for the industrial and technological processes; and finally, because of the decrease in the oil price due to an overoffer of countries belonging to OPEP.

Since we are gaining participation in the world market and the interest of some countries to invest in projects like this one, it seems appropiate to strengthen international relations and to create an enabling environment for business, as this is a way to get many benefits that will improve the strategic sectors of a nation.

Relations between Ecuador and Chile

During the last years, Chile and Ecuador have come to some agreements that have led to the current conservation and cooperation in the different socio-economical fields: education, science, technology, health, tourism, justice, defense, social security, mining, energy, among others.

Agreements such as these, political consultation mechanisms, economic agreements for the establishment of an expanded trade between Chile and Ecuador have lead to cooperation in different socio-economic fields. These are overseen by the Chilean-Ecuadorian Special Commission on matters relating to the law of the sea, cultural Joint Committee Convention promotion and Reciprocal Protection of Investments, etc. (Ministerio de Relaciones Exteriores de Chile)

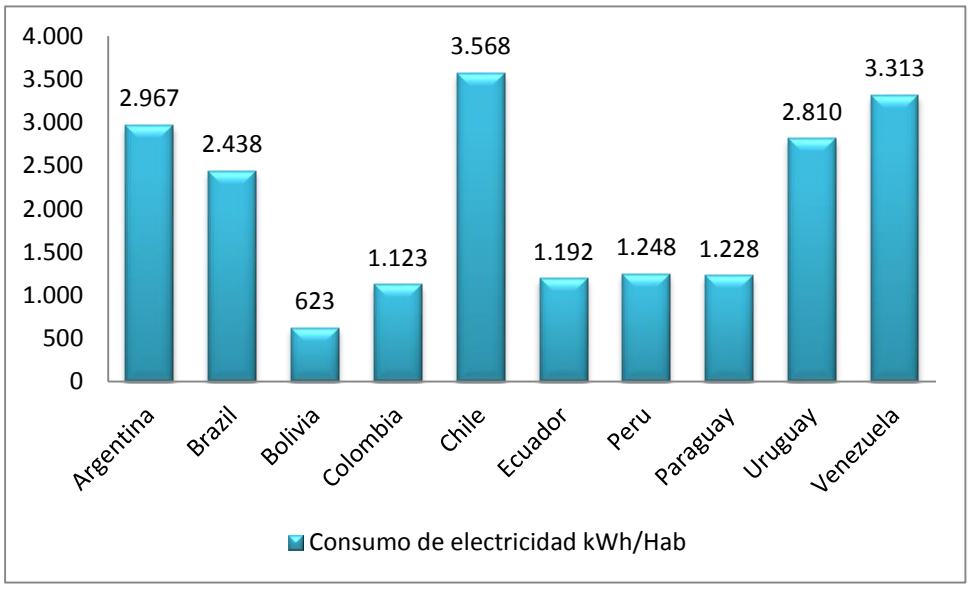
It is important to highlight that this association maintains almost a free-commerce zone, since almost 49% of the commerce with Chile is moving duty-free, so Ecuador has also been able to position new products in the Chilean market. These economic

and commercial relations have been consolidated thanks to the ACE-68 agreement that allows balance between markets.

Despite the mentioned facts, Chile has shown a lack of energy resources since they cannot count on sufficient energy; therefore, they have to import it. According to the Chilean Ministry of Foreign Affairs, Fernando Schmidt stated that "its energy production is based on hydroelectricity which depends on two main factors: one of them is a problem since its precipitation rate cannot be controlled, and the other one is the different groups opposition for the construction of large hydroelectric power plants" (Arauz F. H., 2011)

These problems go hand in hand with the consumption of electricity. Through data collected from the World Bank, the following information was determined:

Graphic No. 9 Electricity consumption kWh / hab



Electric Energy consumption per capita (kWh/inhab) 2011
Created by: Ma. Gabriela Rodríguez C.
Source: El Banco Mundial

In relation to the electricity consumption per capita for the year 2011, it can be seen that Chile is a big consumer with a value of 3.568 (kwh/inhab), followed by Venezuela, with 3.313 (kwh/inhab), then comes Argentina with 2.967 (kwh/inhhab) and Uruguay with 2.810 (kwh/inhab). It can be seen that Uruguay, despite being a small country consumes more than Brazil that has a value of 2.48 followed by

Paraguay with 1.128 (kwh/inhab), Peru with 1248 (kwh/inhab), Colombia with 1.123(kwh/inhab) and Ecuador with 1.192 (kwh/inhab). (El Banco Mundial, 2014)

Under this context, it can be determined that Chile is a good country which can negotiate energy since they have a high value of electricity consumption and Ecuador could cover that demand exporting energy from Coca Codo Sinclair. Likewise, Venezuela would be the next country convenient to sell energy to.

This could be achieved through the following means: Ecuador takes the lead in the UN initiative and the Chilean government "Sustainable Energy for all (SE4ALL)" in this forum of sustainable energy for all, our country has been seen committed to the accomplishment of the objectives for these projects as follows: a) to assure the universal access to modern warranty energy services, b) to double the world improvement rate in the set of energy sources, and c) to duplicate the renewable energy fee. Through hydroelectric projects, the rural electrification and the energy efficiency has been promoted making the country stand out in the region. (Bittium Energy , 2014)

This intervention has contributed to give capacity to the V Binational Interministerial Chilean-Ecuadorian Reunion of July, 2014, where the energy ministry Maximo Pacheco in representation of Chile and the electricity ministry and renewable energy Esteban Albornos representing Ecuador has been able to admit a joint statement on electric cooperation and commercialization, which lays the foundations for a better bilateral future agreement for the buying and selling of energy long term. (Gobierno de Chile, 2014)

The agreement notes aspects over which work should be done through various work groups in order to achieve an appropriate electric integration. In addition, through mechanisms, to identify opportunities that help harness a good use of renewable energies and that future agreements count on technical assistance, technology delivery, constant capacitation, and application of studies. In the same way, to promote the construction of more infrastructures that allows the energy exchange. To be in constant communication among nations in terms of information of their electric

systems, holding continuous meetings to keep track of the advance in the projects that are carried out through work teams and designed commissions. (Gobierno de Chile, 2014)

In the same way, Ecuador and Chile are looking to have better electricity integration, thanks to the Andean Electric Interconnection System (SINEA), an initiative through which can ease the transmission of energy among Colombia, Peru, Chile, and Bolivia. This corridor will be a 500 KV wiring that could be executed once the operating hydroelectric projects are finished. (Gobierno Nacional de la Republica del Ecuador, 2014)

It is necessary to highlight that both nations feel satisfaction with this event since it is a promising agreement of mutual profit. Ecuador feels confident in providing Chile with energy based on projections that show electric surplus between 2017 and 2020; therefore, it is a fact that the Coca Codo Sinclair project will be the first one in exporting this energy to Chile through this electric net.

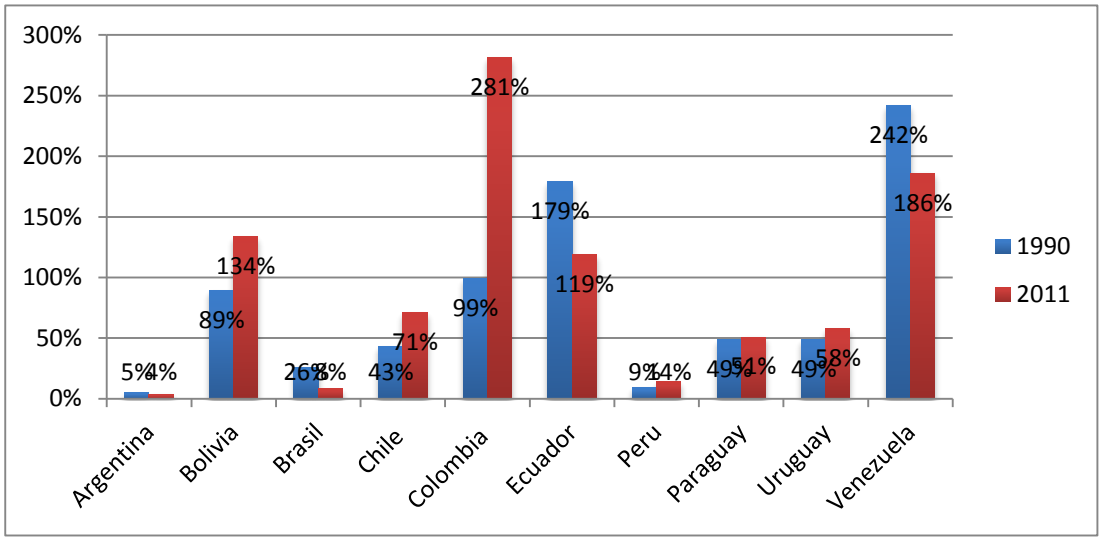
Relations between Ecuador and Colombia

For many years, Ecuador and Colombia have maintained a tight relationship due to their dependence on the energy market, which has led them to create commercial, political, diplomatic and cultural links. These situations help Ecuador and Colombia grow together creating mutual support in the development of each one of the states within the international system.

However, this dependence along with a bad negotiation by their representatives have brought problems and inefficiency to our competitivity since Colombia has sold Ecuador high cost energy for years when the cost should have been lower. "According to the figures reported by the Electricity National Council (CONELEC), from 2002 to 2007, Ecuadorians have paid almost 500 million dollars to Colombia for energy at an annual average cost of $8, 69 for each kw/H while in that same period, the sale of energy to Colombia totaled approximately 8 million dollars to an annual average cost of 0,04 dollar cents per kw/h" (Pileggi)

After analyzing the importation of energy made in South American countries the following data could be found:

Graphic No. 10 Energy Importation



Percentage of energy use
Created by: Ma. Gabriela Rodríguez C.
Fuente: El banco Mundial

The country that imports the most is Colombia with 281%, percentage of total imports with an estimated cost of $53.5 trillion. This result is being argued because of that country's high consumption in transportation and Venezuela with 186%, with high consumption in the industry sector which shows that they would be potential buyers of Ecuador's energy. (El Banco Mundial, 2014)

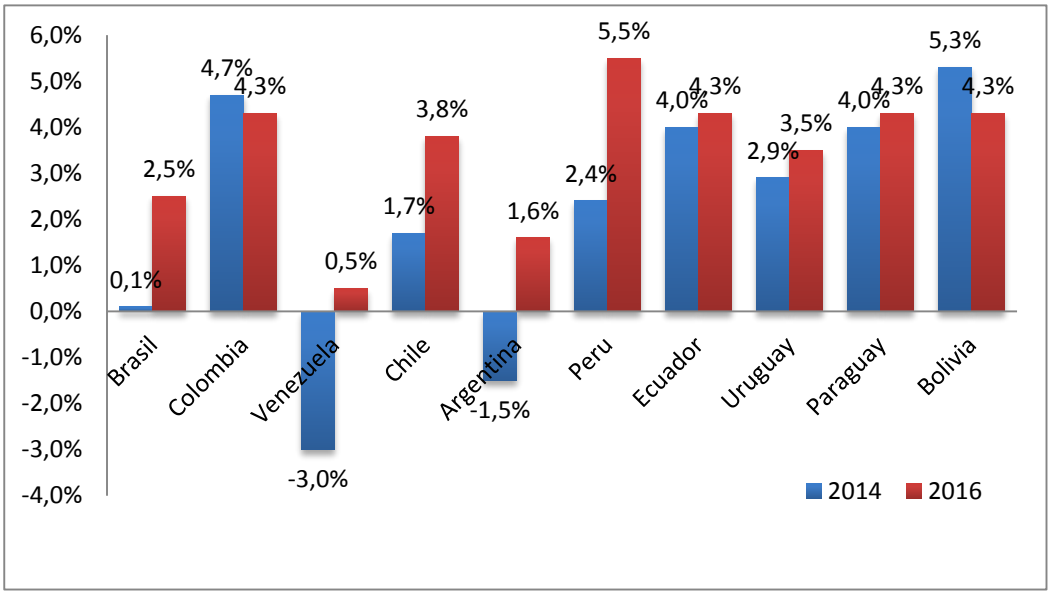
Ecuador could be exporting energy to Colombia with the energy corridor, especially in rainy seasons, being able to help in those emergency situations and at the same time maintain interconnection.

Relations between Ecuador y Peru

With the purpose of improving the use of energy, Ecuador, and Peru have agreed to work together in energy arena. The revelant points related to the implementation of cooperation agreements, are oil and gas reserves valuation studies, electrical

interconnection issues, identifying mining activity zones, and to stop fuel smuggling,. (Expreso, 2014)

Graphic No. 11 Internal Raw Product



Raw Internal product forecast (PIB) for 2016
Created by: Ma. Gabriela Rodríguez C.
Source: El Banco Mundial

Based on the PIB, it can be seen that Peru forecasts a 5.5 % increase for 2016 in relation to the rest of the countries. Another potential possible client would be Chile with a 3.8% increase which shows that they also have economic capacity. It is convenient to maintain relations with these kindsof countries since their markets, goods, and services are going well. (El Banco Mundial, 2014)

Peru has agreed on special systems with Ecuador in order to be able to sell energy in a mutual way. This mainly happened after the government supplied energy temporally; therefore, Peru bega buying Ecuador energy in 2011. Both governments are interested in improving bilateral relationships.

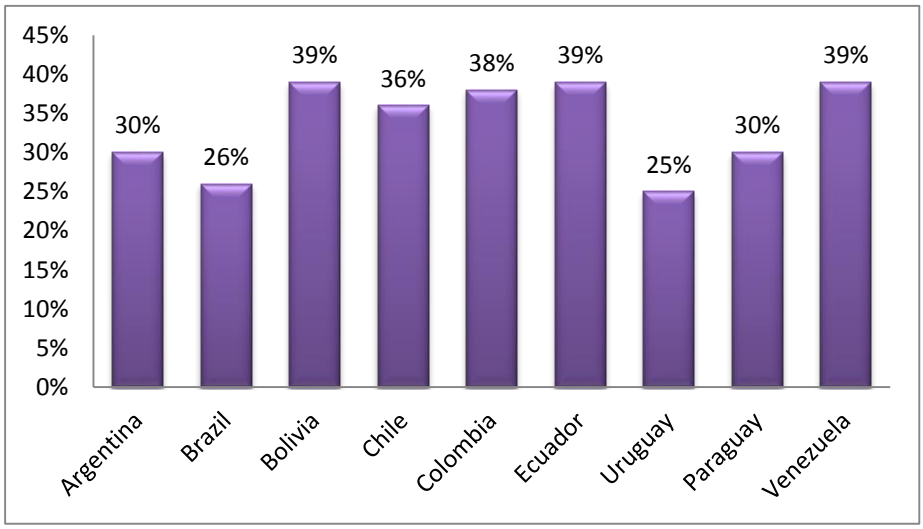
Once the Coca Codo Sinclair Project is launched, it will be able to export energy to Peru same as Colombia. This will soon be a reality since an agreement about the construction of a new electric interconnection that will have better capacity around 500.000 Volts was signed between these two countries. At the same time, it will be complemented with the Ecuadorian transmission system 500 KV that will be built in

Ecuador to achieve a better transfer and electric integration with other countries of the region. (Gobierno de la Republica del Ecuador, 2014)

Relations between Ecuador and Venezuela

Recently, both countries have strengthened ties in political terms as well as in commercial terms, and Venezuela has become a possible client for exporting energy from Coca Codo Sinclair to them as shown on the following chart:

Graphic No. 12 Industrial Growth



PIB percentage in 2012
Created by: Ma. Gabriela Rodríguez C.
Source: El Banco Mundial

According to World Bank data, an important development indicator, such as the industrial growth, between 2000 and 2012 Venezuela, Bolivia, and Ecuador grew 39%, being the highest percentages in South America, followed by Colombia with 38% and Chile with 36%. This shows that these countries will be potential clients since if they have had industrial growth, they will need more energy. Therefore, Ecuador could be selling them these goods so they can improve their productivity. (El Banco Mundial, 2014)

In the same way, previous chapters showed important information demonstrating that Venezuela is a potential buyer of Ecuador's excess capacity of energy production. For instance, they are big energy consumers with 3.098 (KWH/inhab). It also

explains that it is a big net energy importer, with 186%, besides being a high consumer in the industrial sector and having great access to electricity.

There are four bilateral cooperation agreements that are the link for negotiation between these two countries signed in 2012 in Caracas between Nicolas Maduro and Ricardo Patiño with the purpose of strengthening the oil exchange and at the same time, creating better commercial agreements and energetic projects. Therefore, Ecuador has good chance to sell energy from Coca Codo Sinclair plant to Venezuela.

4.2 Investment opportunities for the development of a good living.

The redistribution of the national resources has generated a positive change, and proof of that is that extreme poverty has decreased by 9.4% in Ecuador. This has been accomplished thanks to better policies and decisions that the government has made, seeking an efficient way so that other countries can invest in Ecuador.

The Coca Codo Sinclair is considered to be an ecologically clean Project since it will significantly reduce the use of fossil fuel and generates little negative impact over the environment. It is important to mention that the hydroelectrical policies focus its on education of society, citizen participation, and genre equality, participation and inclusion.

In addition, licenses that certify the strict adherence to international environmental rules such as the caring of the hydrolic basins, taking advantage of the forests, authorizing archeological research and the encouraging of sustainable activities in the zone will be sought,

This monumental work will produce energy, but will also lead to the progress of the zone usher in a whole social concept of the human development, creating for its inhabitants a better life, respecting the environment and improving Ecuador.

Taking care of the hydrographic basins

One of the main aspects for the development of hydroelectric dams are constructs that are completely transformed due to water accumulation, causing environmental impact and imbalances the surrounding watershed. Taking this into account, the Coca Codo Sinclair project is a collection system, which would prevent the construction of a dam instead replacing it with a water reservoir project that would send water through the turbines, after which the water is returned without polluting the Coca river.

Special logging

It is well known that many companies haven't been given the right use to trees they cut when constructing in populated areas. The Coca Codo Sinclair project takes care of its surrounding fauna and flora. In addition, the trees that to be cut, will be fully used and for each 100 trees cut, 110 new ones will be planted.

It is essential that among the entities responsible for the accomplishing of the environmental standards, that the national water secretariat SENAGUA will guarantee a correct environmental management plan. In this way, this ensures a good management of the project, covering all the process and avoiding alterations. (Marco Salgado, 2012)

Permission for archeological research

Agreements have been signed regarding the need for archeological research and economic support for the project since the company is located in a mountainous area in the middle of the jungle. (Coca Codo Sinclair, 2009)

It should be emphasized that the Company has the corresponding mining permissions in order to use appropriate material to implement this mega project's construction, which go hand in hand in hand with an environmental management plan.

Jobs

There are almost 5000 Ecuadorians among technical, administrative and non-qualified labor staff who currently work in the different construction fields in the hydroelectrical power plant. This work has generated 15.000 indirect jobs, which undoubtedly has boosted the local economy of the family and community; 60% workers come from Napo and Sucumbios provinces, 20% from other provinces and 20% are Chinese workers according to the project's website. (Gobierno Nacional de la Republica del Ecuador).

The Company SINOHYDRO pays its workers salaries higher than the charts established by the Ministry of Labor Relations, and its qualified technical staff receives payments according to their profession, experience, and performance. It also recognizes payment for overtime, plus all legal benefits.

Impact in the communities close to Coca Codo Sinclair

The commitment of the national government is to generate quality hydroelectric energy efficiently with minimum environmental impact in the process and also create low costs in order to enhance the development of the country and the welfare of the population. Implanting such project causes impact among the inhabitants; so, this project seeks to insure harmony between it and the inhabitants of the zones.

The corporation SINOHYDRO signed an agreement with the local government of El Chaco for the donation of work beneficial to San Luis community located next to the company camp.

Among the benefits that the parish will receive, are a bus, classrooms and physical and sanitary infrastructure for the progress of El Chaco and Gonzalo Pizarro communities. Additionally, motorcycles will be sent to the integral farms program with these works the parishes and communities will renew their physiognomy but it will mostly improve their health since the wastewater treatment plant will contribute to the improvement of the river quality water of all the nearby populations.

A big part of the works are found in San Luis, the installation of pipes for potable water, trash containers, playground reparation and maintenance, and a solid waste management plan with extension project for the whole population.

It should be emphasized that $250.000 were invested in the construction of sidewalks in Gonzalo Dias de Pineda parish and $152.592 were used in the construction of a sewerage sanitary system, treatment plant in Brazil Neighborhood, among other works done.

On the other hand, the work will benefit the whole country with a lower electric fee which will allow electric self-sufficiency. It will considerably reduce carbon dioxide emissions generated by the utilization of hydrocarbons

It is estimated that Ecuador will consume 533 million less imported Diesel gallons in the year, same with energy from neighboring countries. This will avoid gas pollution that they would produce, investing in social development projects. (Coca Codo Sinclair, 2009)

It tries to guarantee that all Ecuadorians can benefit from these projects and transformations that the government is working on. In addition, it tries to distribute the richness that will be prudently and equally generated with the project in order to avoid creating inequality between social and economic groups, always ensuring security of the lands, working with nature in the search of new reserves since the current ones are disappearing. In short to take Ecuador toward a better level of development.

Conclusions

At the end of this research, it could be noted that Ecuador, in its search for achieving integral development chooses the transformation of the different strategic sectors in order to maximize its productivity. Within the sectors to be transformed, the energy matrix results are fundamental, so it can accomplish economic and human progress, not depend on fossil fuels which release large quantities of CO_2 provoking

environmental, economic, and social damage and opting for renewable energy sources such as the hydroelectric energy.

Through this transformation, Ecuador will be presented to the international community as a profitable country, rich in natural resources and diversity, with extraordinary human talent, capable of strengthening commercial, political, or social ties with other countries.

Along the first chapter, it can be concluded that by describing the current energy situation, it is essential to reiterate that the rise in energy demand is given by a population increase. Such population increases will continue to occur in all the targeted nations.

Ecuador, as a producer of oil which is a primary resource that has generated plenty of investment and advance in the country, but at the same time, its exploitation has generated loss of its value and due to the impact that it produces. For that reason, the change in the energy matrix arises as a strategy to stop depending on oil to produce energy.

Within the Ecuadorian electric sector, there are important factors to analyze such as how to improve the energy distribution, since a current problem is the loss produced at the distribution of energy to each city due to the lack of appropriate control.

Ecuador opts for renewable energies since along the years, men have provoked pollution and as a consequence, climate changes have left irreversible damage. Despite alternative energies are not economic, it is important to use and develop resources that we already have, since Ecuador has the potential to count on river flows.

The participation of renewable energies in the energy matrix, through the application of appropriate technologies and the right measures will allow Ecuador to save in Diesel since thermoelectric generator would be discontinued and with such savings, it will be able to invest in social matters such as: health, education, and environment,

strengthening with it the idea that government promotes a good living for the country.

In relation to chapter two, by analyzing the government's proposal on the diversification of the energy matrix of Ecuador, it can be concluded that Ecuador is highly dependent on hydrocarbons, and that is the reason the government’s proposal is to renew all sources of electric generation in order to satisfy the energy national demand at a low cost, without affecting its economy.

Ecuador has planned to change its primary exporting model to manufacture better quality products and thus promote better development of the country. In order to accomplish this plan, the energy matrix should be transformed and one of the ways to do that is through hydroelectric projects.

Many economic, social, and environmental aspects are considered, in addition to high tech studies that determine the viability of these projects. Possible damage and environmental impact caused by installation of the projects are also considered, due to its dependence on climate phenomena for their performance.

In respect to chapter three, regarding the project Coca Codo Sinclair, it is concluded that since the decade of the 70´s opportunities for the hydroelectric exploitation were identified, which uses Coca river water located in Napo and Sucumbios provinces.

After many years and many negotiations, this idea was shaped, becoming a reality after various negotiations, being financed mainly by the Chinese company Sinohydro.

This Project is valued at $2.5 million, and it will have a capacity of 1500 MW and it is divided into five sections such as: work catchment, headrace tunnel, compensation reservoir, pressure pipes, and machines house.

This project will make Ecuador save up to $2.5 million daily and it will reduce the importation of fuel, being able to cover an energy demand of 36%. It should be mentioned that its purpose is to contribute to the transformation of the energy and

productive matrix which contributes to the economic and social development of the country.

The Coca River will provide the hydroelectric plant with 222 mt3 per flow second, which will be fully used to transfer it into electric energy, flow which will be obtained through the development of catchment work. This structure is taken directly at the river shore without constructing a big dam, causing minimum environmental impact.

Finally, in Chapter four, in order to identify potential investment opportunities for the commercialization of hydroelectric energy it is fundamental to state that the hydroelectric Coca Codo Sinclair project is the greatest in the history of the country and will provide 35% national energy demand, encouraging the positive presence of this type of works of great magnitude that will benefit the Ecuadorians as the exportation of energy is achieved.

The energy has taken relevance among international economic relations, since many countries bet on sustainable energies, and being able to stop, or at least to control climatic change. For that reason, Ecuador seeks to offer optimal energy to countries which need it so in this way, become electrically independent.

About the countries which have signed agreements or made negotiations on this project, there is the relation between Chile and Ecuador, where they have agreed on having a solid cooperation in different strategic areas, energy being the most important one since Chile is very interested in the Ecuadorian energy due to their lack of energy resources.

So this time, Ecuador worked along with the Chilean government in the SE4ALL "Sustainable Energy for all" after accomplishing the objectives for this initiative, seeking to dynamize investments which will promote transformation to energy systems worldwide, concluding in an agreement of cooperation for electric commercialization between both countries and improving integration.

Ecuador and Chile look toward having better electricity integration, thanks to the Electric Andean Interconnection (SINEA), energy corridor able to ease the transmission of energy between Colombia, Peru, Chile and Bolivia.

In the same way, relations with Colombia have improved since Ecuador had great dependence on the energy market for many years, strengthening commercial political ties, but this aspect has kept the country from getting more competitive since Colombia has sold it energy at high prices.

With the Coca Codo Sinclair, Ecuador will reach energy sovereignty when counting on its own energy, allowing economic savings and in the same way being able to sell them energy in emergency situations.

In respect to relations with Peru, agreements talk about systems to sell energy in a mutual way, subscribing an agreement to build a new electrical interconnection that will have better capacity and that will be complemented with the Ecuadorian transmission system to trespass energy among countries of the region.Besides, Peru forecasts a rise of 5.5% by 2016, for being a potential client after showing good economic development of the country.

Venezuela is another potential client since it has had 39% industrial growth in the last years, and this is an advantage because Ecuador could be selling them these goods to improve their productivity.

Institutions in charge related to the project, seek not only to generate cleaner energy, but to count on licenses that stick to environmental laws with the purpose of not affecting the flora and fauna of the land.

The Project has a captation system to avoid the construction of a dam, and in addition, the trees cut will be fully used and it will look for a right environmental management plan. It will have economic support for the archeological research as well as mining permission to use material for construction.

It is important to say that this work will provide the Ecuadorian community with jobs. In this work there are 5000 employees, among them: technical and administrative staff from which 60% come from Napo and Sucumbios provinces, the other 20% belong to other provinces and the final 20% are Chinese workers.

Nearby communities, such as El Chaco parish, will be benefited with works that sustain the development of the community such as high schools provided with classrooms, and sanitary and physical infrastructure. Same with the whole farms programs without leaving aside the installation of water pipes, parks maintenance, playground, among other works to improve the life of the citizens.

In the same way, it was invested in the remodeling of sidewalks and sewerage construction for the Gonzalo Dias de Pineda parish with the purpose of leasing the impact to the community in the construction process and also be able to generate better opportunities to achieve quality life.

Recommendations

Suitable sources of energy sources such as the hydroelectric should be adopted, since they are inexhaustible, although investment is high for its execution, the benefit obtained with its performance is even higher which justifies the high value of the investment.

The hydroelectric Project start up proposed by the current government has great advantage, since the importation of Diesel will be suppressed, making generation sources be 100% renewable.

The right design and organization of the projects is recommended to generate other investments in the social aspect, achieving local and regional development.

The sustainability is an important aspect to consider since its results are exceptional. Futhermore a safeguard team that can cover possible impact and damage in the social and environmental field should be made an intregal part of the plan.

The government should consider all social and environmental aspects resulting from making surveys, public consultation so it can see the participation of the indigenous population.

It should be considered to carry out an evaluation protocol on the sustainability of hydroelectric energy, as with other countries is essential in social and environmental terms, since it controls and measures the area's performance.

Another recommendation for this project is to achieve better investment and to have better development of the energy sector, it would generate better participation with the communities.

One aspect that we could take advantage of, would be the existing tourism in our country when trying to reconcile the project with tourism. We could achieve more commercial opportunities.

It is expected to satisfy the total demand of electric energy in the country with these projects, being the most relevant the Coca Codo Sinclair Project for its great capacity. Therefore, efforts should be focused on completing its execution.

It is important to be in continuous search for better strategies and technologies allowing Ecuador to develop innovative techniques of renewable energy generation, accomplishing a whole advance in various areas in the productive sector.

With the transformation and establishment of these projects and applying these successful strategies, Ecuador will be able to respond to the current and future energy demands of the country. In addition it will allow Ecuador to go from being an energy importer to being an energy exporter. The existing energy surplus, can be combined with oil surpluses , and thus, supply the constant need with the sale of electricity through electric channels via the support of Ecuadorian power plants. (Consejo Nacional de Electricidad, 2012).

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