

## **ENVIRONMENTAL AND SOCIAL ISSUES IN GEOTHERMAL IN EL SALVADOR**

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### **ABSTRACT**

Since the 90's, there has been a growing global tendency to apply policies, laws and regulations which can guarantee the protection of the environment and the improvement of the people's standard of living. The Central American countries have been influenced by this and somehow were forced to undertake it, as a requirement of the World Bank or IDB for funding approval on development projects.

LaGeo, S.A de C.V, in charge of the geothermal resources exploration and development in El Salvador, has created within its company's philosophy legal fulfillment and honest administration through the principal social responsibility policy and the respect to environment, safety and occupational health, commercialization and standard policies as added value for their stakeholders.

Environmental Management and Social Investment Plans are an integral part of geothermal projects having investment up to half million dollars per year. These include the reinjection strategy adopted as the primary brine disposal and the rehabilitation of unstable land through slope stability, terracing and strengthening the roadsides. During well test, barriers such as silencers, rock mufflers and fresh water injected steam outlets are installed to mitigate the noise level on communities, workers, etc. At the present, LaGeo is in the process of forming the Enterprise Management System (EMS) that includes all the social and environmental responsibilities, action initiated since the 90's when the geothermal industry started to expand. Although LaGeo is not responsible for the local community development in its area of operation, it is aware of the need of the community by making strategic alliances with local people concerning productive, educational and health facilities and human resource development projects. Projects in Ahuachapan and Berlin geothermal fields involve local communities in order to help in the unemployment crisis and the human resource development especially for the youth through computer training and sport events . Quality air, water and soil monitoring programme as part of the risk analysis on geothermal activities are included in the environmental management operation that guarantees the fulfillment LaGeo's company's policies.

## 1. INTRODUCTION

World wide tendencies including debates and conferences on the environment (Rio and Kyoto) have contributed to the search for legal framework and formal organizational structure to protect the environment and to improve the standard of living of the people, particularly in the developing countries. Furthermore, the meeting in Johannesburg 2002 at the World Summit for Sustainable Development (WSSD) brought energy issues to the centre of global debate (Fridleifsson, 2003). All of these international currents have driven the Central American region to create environmental and social responsibility policies within its organizational structures.

This paper provides an overview of El Salvador concerning the physical, social, economic and environmental aspects and the response of LaGeo to the changes and transitions in government policies in achieving geothermal resources sustainability in the country.

Legal entities such as Telecommunications and General Electrical Superintendence (SIGET) and the Ministry of Environment and Natural Resources (MARN) in El Salvador have formulated guidelines and procedures to ensure that geothermal projects fulfill the established laws and regulations, however, several conflicts have emerged between both institutions. These differences delayed the programmed activities of the developer, like LaGeo where the concession for Obrajuelo geothermal area is on stand by.

At present, after the oil crisis, interest arose from the Ministry of Economy of El Salvador concerning a real policy on renewable energy. Furthermore, the Central American Environmental Commission and Development (CCAD), consisting of institutions and interested groups are taking initiatives , together with LaGeo to be aware of the guidelines of the country's geothermal energy use.

## 2. OVERVIEW OF EL SALVADOR

### 2.1 Physical characteristics

EL Salvador is the smallest country in the Central American region and is strategically located, having connections with Europe, Asia and other countries of the world. It is bounded to the north by Honduras and to the west by Guatemala. The Gulf of Fonseca separates it from Nicaragua to the southeast and by the Pacific Ocean to the south.

The total area is about 21,000 km<sup>2</sup> consisting mostly of valleys and rugged mountains. To the north lie the Metapan and Chalatenango ranges, where the highest peak in the country, El Pital is located with 8,956 feet above sea level. On the other hand, the Santa Ana Volcano also known as Ilamatepec is the highest volcano with 7,749 feet above sea level and Izalco volcano with 6,135 feet.

The climate in El Salvador is tropical, with two different seasons: dry season from November until April and rainy season from May to October. Temperature varies with the elevation and shows few seasonal changes. Average temperature during the year is about 24° C and Normal Annual precipitation is 1800 mm. The country is divided to ten main basins having the Lempa River as the most important that extends almost half of the country and accounts for 68% of the hydraulic resources (Arevalo, 1998).

The tectonic activities and volcanism of the region have provided El Salvador with abundant geothermal activities where ten geothermal areas have been identified. Five of these areas are considered as high temperature geothermal fields (180-300°C) mostly lying on the northern flanks of young volcanoes. The Ahuachapan and Berlin geothermal fields are the developed ones and San Vicente, at present, is with deep drilling activities (Rivas, 2000).

## 2.2 General Social, Cultural and Economics Characteristics

Since the peace treaty in 1991, El Salvador has experienced social, economic and cultural transformations marked by the external and internal policies, which affected directly the total society. The globalization phenomenon brought advantages and disadvantages for the Salvadoran economy, which caused inequalities and social outbreak.

Great efforts have been made in terms of democratization process, promoting civil protection, free election, privatization process and, free trade agreement, but there were no positive results with regard to the national economy due to lack of political concern.

Delinquency and acts of corruption are serious barriers for foreign and national investment. Extreme poverty, unemployment and scarce educational and health programmes continue to be a challenge for the society. In addition, Salvadoran illegal immigrants to the USA have become an international problem, where in 1970, the total Salvadoran immigrants were 16,000 and at the present, there are more than 2 million people located in different states (LPG news).

The economy of El Salvador is supported by family remittance from other countries, which could surpass \$ 3.280 million in 2006 equivalent to 18% IGP PIB. Monthly average remittance is \$300, greater than the Salvadoran minimum salary. However, there lacks efficient financial administration as consumption is higher.

Different studies indicate the main factors for the migration of Salvadorans:

- Difficult economic situation
- New lifestyle in US
- Recurrent natural disasters (earthquakes, landslides, hurricanes)
- Citizen's insecurity (robberies, gangs, crimes and murders )

Government plans consider to recover the national economy with the Free Trade Agreement, tourism, foreign industrial investment, but not by focusing on human development plans.

## 2.3 Potential environmental problems

The situation of the environmental management in El Salvador has changed during the past few years. The environmental problems are now more severe than in the past, due to the growing population, land disorder and significant changes in the economic aspects.

The potential environmental problems in El Salvador are the following:

- Only 0.3% of the territory has been declared as protected area.
- The country has one of the highest rates of annual deforestation of the world, 4.56%.
- A high percentage of primary forests has disappeared throughout the years causing poor water quality by soil erosion.
- According to the National Service of Territorial Studies (SNET), more than 90% of the rivers are contaminated with excrements, toxic pesticides, spills and poor hygiene practices of the people.
- High population density in San Salvador metropolitan area, which contributes to the increase in the urban environmental problems: air pollution by transportation and factory gas emission, water pollution by industries and solid waste materials.
- Internal interest and conflict on landfill management for domestic wastes have caused diseases in the society.

### **3. ENVIRONMENTAL LEGAL AND INSTITUTIONAL FRAMEWORK**

#### **3.1 Environmental directive institutions**

On December 1989, the presidents of the Central American region signed the Agreement for the Central American Environmental Commission and Development (CCAD), whose primary target is to contribute to the sustainable development of the region, strengthening the cooperation and integration formation for the environmental management. This institution arose from free and sovereign will of the presidents of Central American, which in 1993, formed the Central American Integration System (SICA) endorsed by the United Nations General Assembly

In 1997, the Ministry of Environment and Natural Resources of El Salvador (MARN) was created as a governing institution and focused on the Agreements, Conventions and Protocols by the United Nations. The vision of this institution is “to direct an effective environmental management through policies and norms and facilitate the sustainable development for Salvadoran society.”

The environmental law in El Salvador was made official in 1998, while the national environment policy and benefits of natural resources (water, air, biodiversity, etc) were declared official in 2000. All of these became instruments for the public sector to rely on a legal frame for environmental management.

As a regional integrated organization, the CCAD has formulated an environmental plan for the next 5 years (2005-2010) in the Central American region, which will incorporate the application and fulfillment of the environmental legislation as a high-priority objective.

#### **3.2 Electrical Sector**

In 1998, the Telecommunications and General Electrical Superintendence (SIGET) became the official entity for power generation, transmission, distribution and trade electrical energy activities, which included provisions for public, private and mixed sectors.

From the Electricity Law and Regulation, for concession permit, in Art. 8. Chapter II, it states that those entities interested in electric energy generation studies and development using hydraulic or geothermal resources, for national or public use, should submit an application and request established by SIGET. Furthermore, in Art. 13, it states that any party interested in obtaining a guarantee for hydraulic or geothermal resources exploitation should submit a written request to SIGET, including the environmental impact assessment, previously approved by the national authority that allows a systematic assessment of the project's environmental effects and their mitigation during construction, operation and abandon stages.

On the other hand, the Ministry of Economy is working on incentives for renewable energy projects. The first draft revision was already carried out that includes tax discounts, rent deduction and other electrical projects. However, these incentives are only applicable to power generation less than 5 MWe.

LaGeo always complies with all the legal aspects and initiates the work program after the permit is granted.., Taxes and other legal commitments are properly covered during operation of geothermal power plants. Environmental audits are usually undertaken with no negative results.

## **4. ORGANIZATION OF GEOTHERMAL MANAGEMENT OF LAGEO**

### **4.1 Company Profile**

LaGeo is a company dedicated to electrical energy generation based on geothermal resources. It started in 1999 as a private institution after being part of the Comisión Hidroeléctrica del Río Lempa (CEL).

The company created its vision, mission, and corporate values. Adapting the main social responsibility policy, the respect to the environment, safety and occupational health, commercialization and quality policies, guidelines for geothermal development were written to allow long-term sustainability accepted by the society. This will help improve the quality of life of shareholders, clients, workers and neighbouring communities.

### **4.2 Environmental Evaluation Process for Geothermal Projects**

Within LaGeo's policy, fulfilling legal requirements for any activity, work or project are always considered. According to environmental law, the permit for geothermal power generation projects require at least five steps, starting from filling out the form on general, technical and environmental aspects of the project (as part of the screening), followed by the field inspection of MARN technical personnel on the location of the project. The authorities by then decide if EIA is necessary, and if so it will be published in a local newspaper for three times as a call for stakeholders' comments during a 10-day period.

After the MARN technical analysis, LaGeo is notified for the next requirement of environmental fulfillment guarantee for the mitigation measures as an Environmental Management Plan (EMP). MARN by then grants the Environmental Permit for the project execution including programmed audits. The permit expires at the end of the activities. However, for the operation and maintenance of the power plant, other permits maybe necessary.

The main objective of LaGeo's Environmental Management Policy (EMP) is to ensure the proper environmental control aspects and the improvement of performance of the power generation process, taking into account the environmental aspects.

### **4.3 Environmental Management and Monitoring Plan**

LaGeo has supported the environmental management in a systematic manner and with great commitment. Within the organizational structure, the Environmental Unit is in charge of promoting, developing and implementing the MARN guidelines in geothermal projects. The main activities are to have the proper permits for concession, pre-feasibility, feasibility, construction and geothermal power plant operation.. Every stage includes water, air and soil quality control, awareness and environmental education, mitigation measures, plan fulfilment and action to be taken to correct the non predicted impacts.

In addition, the risk analysis process including all workers, contractors and subcontractors is required as an important tool to comply with the environment, safety and occupational health policies of the company.

In El Salvador, the geothermal areas are located in rugged terrains, near or within coffee or cane plantations, near rural communities and in unstable areas with erosion, landslides or seismic activities which are all taken into consideration by LaGeo to avoid the negative effects on the environment, neighboring communities and its facilities. Table 1. shows the types of important environmental

impacts and mitigation measures implemented in El Salvador geothermal fields: Ahuachapan, Berlin Extended Projects and San Vicente deep exploration drilling.

TABLE 1: Interaction matrix between natural factor and geothermal activities. Brief summary from Environmental Impact Assessment (EIA) documents in El Salvador Geothermal Projects (2000-2005)

NATURAL FACTOR	SIGNIFICANT IMPACT	MITIGATION MEASURES
Physical	<p>Land surface disturbance (erosion caused by rain or wind after civil works)</p> <p>Landscape alteration</p> <p>Increase on noise level</p> <p>Alteration in Natural drainages</p> <p>Domestic and industrial solid wastes</p>	<p>Rehabilitation through slopes stability, terraces, roadsides.</p> <p>Reforestation and architectonic designs of facilities</p> <p>Barriers in the source (silencers, rock muffler and fresh water injected steam outlet)</p> <p>Dam structures, peripheral drainages, roadsides, canals</p> <p>Debris' final deposition on legal sites, landfill, or reuse /recycling of woods, ferric materials, empty packings, etc.</p>
Chemistry	<p>Nuisance odor by air emission during power plant operation or test well discharge</p> <p>Brine, oil or water mix with drilling mud spills</p>	<p>NCG's exhaust in cooling towers, fresh water injected steam outlet silencers with monitoring H<sub>2</sub>S and CO<sub>2</sub> levels.</p> <p>Re-injection is adopted as the primary disposal method for brine. Analysis of trace elements in brine, soil and surface water bodies</p>
Biological	<p>Deforestation or elimination of dense areas</p> <p>Wildlife temporary migration</p>	<p>Establishment of zone for native species and rapid growing vegetation</p> <p>Employee awareness, education to wildlife conservation</p>
Social, Economical and cultural	<p>Family displacement</p> <p>Heavy equipment transport causing heavy traffic, secondary transmission lines breaking on local roads and vicinity</p> <p>Interference on local roads by pipelines network</p>	<p>Adequate economic and other land compensation assuring a better quality of life</p> <p>Adequate control of traffic through the transport procedures (include local authorities' communication)</p> <p>Loops or small bridge construction on the pipes and communities</p>

LaGeo's EMP has been developed conforming the EIA and includes the continuous improvement within the environment and social responsibility policies aiming at the geothermal development environmental performance.

#### **4.4 Social Projection in El Salvador's Geothermal Projects**

Public involvement in the decision making for any on going project is an inherent condition according to the environmental law. LaGeo, conscious of its role of being a "responsible neighbour", has created a Social Projection Area (APS) to promote and contribute to the local development along with the local government and other institutions (GOs, NGOs, civil society) within the area of influence of the existing Ahuachapán and Berlín geothermal power plants..

##### **4.4.1 Socioeconomic conditions of the geothermal fields' neighbouring communities**

As mentioned before, the geothermal development is located in rural areas where most of the population is living in worst conditions and have limited opportunities on their economic and human progress. Socioeconomic studies in EIA confirm that 3 out of 5 of family members migrate to USA searching for new opportunities even if they face the risks to cross the border illegally.

Economic conditions such as low income (\$6/d) for a labourer or tenant farmer and scarce permanent jobs are of the same category . Among public services with limited opportunities for institutional attention are health, education and water and electricity services. High index of delinquency are found mainly in Ahuachapán geothermal field surroundings..

The criteria established by LaGeo to support the local economic development within its zone of influence are the following:

- Contribution only for institutions legally established
- Communities and municipalities with high-priority projects or clearly defined within a strategic local development plan
- Must be justified actions through the positive impact-cost analysis correlated with the APS transversal axes such are Health, Education, Culture and Sports
- Company's resources available
- Maximum of only 40% of the total project amount is available for local projects and the rest to be covered by other organization confederates
- Appropriate interest justified to guarantee the sustainability of geothermal power stations in its operations

For social projects, execution of the fund approval is endorsed by MoU, internal cooperation agreements and LaGeo's suitable procedures.

##### **4.4.2 Social issues**

LaGeo's social projection programme is based on 3 actions towards the human development capabilities, productive and economic areas and infrastructure. Table 2, shows us the achievements from January to June, 2006, within the Ahuachapán and Berlín geothermal fields.

TABLE 2. LAGEO LAST DATA OF SOCIAL PROJECTION JANUARY – JUNE 2006  
 Compiled from data in Table 1 in Enterprise Development and System Management 2006

SOCIAL PROJECTION AREA			
THEMATIC AREA	ACTIVITY	BENEFICIARIES COMMUNITIES	POPULATION
EDUCATION	Fellowship Programme Student's Packets English and computing Courses. (Ahuachapán and Berlín )	37	823
INFRASTRUCTURE	Improvement, extension or construction such as: street walls, bridges, roofs on schools and Health Units facilities. (Berlín)	18	29,000
HEALTH	Medical attention journey, fumigations and vaccinations. (Berlín)	45	4,600
SPORT AND CULTURE	School of football (Berlín)	6	220
PRODUCTIVE*	Tilapia fish farm, horticulture, garden and enterprise development. (Ahuachapán and Berlín)	10	370
ECONOMIC	Temporary jobs by project execution: Setup U-3, Pipeline network, drilling wells, Berlin Binary Cycle, Maintenance works, productive projects (Ahuachapán and Berlín)	29	5,000

\* The condenser water from cooling tower is used for fishponds and irrigation.

The results from Table 2, indicates that most social benefits are focused in Berlín Geothermal field surroundings, this is partly due to the geothermal development which caused severe environmental and social impacts in the 90's (during construction and O&M of 10 MWe back pressure units).

This allows Lageo to design a social plan to avoid discontented society taking into account their needs and keeping good relationship and communication with them.

On the other hand, most of the work opportunities are located in Alegría-Berlin Municipalities due to the expansion of the Berlín geothermal field to a 44 MWe power plant with ENEL (LaGeo's strategic partner) providing the foreign investment. Furthermore, the Binary Cycle and total reinjection projects and general maintenance works have provided local work, facilities, services, etc to their operations. With a total amount of US \$ 100,000, ENEL approved the funding of the Berlín Social Investment Plan (BSIP) linked with the Expansion of Berlin Geothermal Power Station Project. The BSIP is being carried out by the Social Projection Unit.



#### 4.4.3 Enterprise profits

Incentives included in the Environmental Law to motivate people and institutions to contribute to the protection of the environment and execute healthy, environmentally benign processes in the country, LaGeo, in 2002 won the national environmental award by enterprise effort. In 2003, the Ahuachapán Total reinjection project became a contender for the same prize in the category of waste water technology.

On May 25<sup>th</sup>, 2006, the third unit of the Berlin geothermal power plant was registered at the CDM Executive Office. The project in cooperation with the Netherlands Government, aims in generating emission reduction credits, starting in the year 2006 for a period of seven years. A percentage from income by the carbon bond sale will be used for social and environmental activities.

LaGeo is a founding member of the Enterprise Council for Sustainable Development (CEDES) that joins the main leaders of Salvadoran companies whose objective is to achieve sustainable development through the social responsible practices, eco- efficiency processes, environmental management system aided by the enterprise benchmarking and permanent training, creating a national technical committee to implement these guidelines.

### 5. DISCUSSION

At a national level, LaGeo is considered to be a successful company due to the accelerated economic progress in harmony with the social and environmental responsibilities. For almost ten years, that technical and human development in the company has played an important role, as can be seen from its mission and vision. From 10 MWe back pressure units installed in Berlín, approximately 100 MWe in operation will be available at the system network at the end on December 2006.

Although the back pressure units are now operating in San Jacinto Tizate geothermal power station, the Berlín Binary Cycle Plant will be available with the same 10 MWe by next year. Additionally, of the total capacity installed in Ahuachapán (90 MWe), 25 MWe will soon be possible with the Ahuachapán Optimization project. More new challenges will be faced by LaGeo if the Nicaragua concessions process surpasses the legal barriers.

El Salvador's social, economic, cultural and environmental problems including the Environmental Impact Assessment studies (EIA) in geothermal projects are important parts to take into account within the geothermal development national strategy of renewable energy for the future. But it will only be possible with the Social and Environmental Investment Plans to guarantee the sustainable development in their zones of influence..

The El Salvador Millennium Development Goals should be the key to take into account the social programmes in the future and could be a part of the social and economic outlines within the enterprise sector.

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