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UNITED NATIONS UNIVERSITY
GEOTHERMAL TRAINING PROGRAMME

LaGeo S.A. de C.V.

REGIONAL GEOTHERMAL TRAINING PROGRAMME AT THE UNIVERSITY OF EL SALVADOR

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ABSTRACT

Latin American and Caribbean countries have great geothermal potential located along the volcanic range from Mexico to Patagonia, most of them are leaning towards developing geothermal projects in order to reduce the dependency of the high cost of fossil fuels, protect the environment and to overcome some barriers like inexistent regulations, limited financial resources and limited experienced human resources to develop these kinds of projects.

The reduced training opportunities for young professionals around the world result in a limited knowledge on geothermal specialization. Furthermore, Latin American countries have been limited in their ability to attend some international courses due to the high cost of these courses as well as the living expenses that cannot be afforded by companies or governments with their own financial resources, and sometimes due to the limited language skills (mainly English) of the professionals.

In early 2002, LaGeo in El Salvador made the decision to have an alternative training opportunity for its own professionals who could not attend in a short period of time an international specialized geothermal course, having the former alumni as main lecturers, and organized a course called Diploma in Geothermal Science and Technology. A few years later, LaGeo began to look for international financial support and a partnership with a local university in order to share this specialized knowledge to a new generation of professionals, employed or not, in the geothermal industry. It led to the creation of the First Diploma Course with the partnership of the University of El Salvador.

1. INTRODUCTION

The global geothermal power market has been growing during the 20th century; it is currently fuelled by a number of factors: economic growth, especially in developing markets; the electrification of low-income and rural communities; and increasing concerns regarding energy security, measures against climate change and its potential impact on economic security. Additionally, the majority of the growth in the development of global geothermal resources occurs in countries with large, unexploited, conventional resources. As more countries recognize and understand the economic value of their geothermal resources, their development and utilization becomes a higher priority.

There is a need to create policies in order to support geothermal development in some countries; and the need to continue training and capacitating young professionals as specialized geothermal experts that should promote further development of the potential geothermal resources, which will help grow the economies and develop markets, as well as mitigate potential environmental impacts that cause by climate change.

2. POTENTIAL NEEDS OF LATIN AMERICA AND CARIBBEAN COUNTRIES

The Latin America region along the Pacific Coast has 4 of the 15 geothermal countries in the world that already have geothermal projects with a high temperature resource and are very efficient. They are considered part of the energy matrix in Central America as a base energy with low prices.

Other Latin American and Caribbean countries with no installed capacity have begun to undertake projects on developing their geothermal resources. In South America, Chile has a high geothermal potential due to its location with many volcanic centers in the Pacific Ring of Fire. This allowed them to begin exploration activities, inviting the private sector to elaborate their investment proposals. It is expected that Chile will become the first geothermal producer in South America at the end of 2014. Colombia is also conducting feasibility studies in the area surrounding the volcano Nevado del Ruiz. The project includes the completion of feasibility studies, environmental and financial aspects, exploration and production drilling; and adequate access to infrastructure, connection to the national transmission system, supply of equipment, plant construction and commercial operation.

Another important geothermal area in South America is found in Peru, with an estimated geothermal potential of 28.60 GW, located in the southern part of the country; the private sector will develop the exploration of geothermal resources to produce 10 GW by 2030. Bolivia, with a geothermal potential of 2.5 GW, including the Laguna Colorada area, located in the Andean region of Potosí (southwest), near the border with Chile. Ecuador seems to have geothermal energy as an option for the short term, with an estimated potential of 6 GW, the government holding CELEC EP has made prefeasibility studies of the geothermal projects of Chachimbiro, Chacana and Chalpatán, and also is working with ISAGEN from Colombia to develop prefeasibility studies of the Tufiño-Chiles–Cerro Negro Projects, located at the border.

The continuous reduction of gas production in Argentina during the last seven years, has promoted the search for renewable energy projects, in order to provide energy to a small miner complex and some touristic Andean towns. Argentina will install the first geothermal power plant which will be located in the unpopulated area at Valle del Cura and will contribute to the electrical system of the province of San Juan with 5 MW at an early stage.

In the Caribbean, Dominica, Nevis & St. Kitts and Montserrat are running their own geothermal projects at a low scale; however, each one will have a high impact on their own economies. The most recent and significant progress in this area is located in Dominica with the drilling of 3 wells during 2012 (Maynard-Date, 2012; George, 2012).

Figure 1 shows countries which have started earlier than others in Latin America, developing geothermal projects, such as Mexico in 1959, and Costa Rica and El Salvador during the 70's. This region represents 14% of the installed geothermal capacity in the world.

Due to the growing need in the Latin American and Caribbean countries in pursuing the use of geothermal at a larger extent and controlling the sustainable exploitation of their geothermal resources, the formation of a solid base of trained human resources is indispensable. However, capacitation of technical professionals will not alone help the purpose of promoting the utilization geothermal resources. There are three essential elements needed to produce the expected results: national determination, technical human capacity and financial resources; only the combination of these three elements will

work out. The high initial investment cost of geothermal projects, are the main obstacle to struggle in the industry development

FIGURE 1: Latin American and Caribbean countries with geothermal potential

In order to develop the capacity to apply the geothermal energy utilization, the courses are designed to the study of the geothermal systems at high, medium and low enthalpies and the techniques available for their management and exploitation.

Since Latin American and Caribbean countries still lack trained human resources to expand geothermal projects, there is a need to create a Regional Geothermal Training Center, to assist these countries to increase the human capacity building.

3. GROWING IDEAS DOWN TO EARTH

Central America was selected as the region for the Second Millennium Series of Short Courses, and since 2006, El Salvador has been the top host of the specialized short courses on geothermal, with the cooperation and main sponsor, the United Nations University-Geothermal Training Program (UNU-GTP) of Iceland, being recognized throughout El Salvador with abundant experience in conducting these specialized geothermal courses in the region.

The UNU-GTP has been supporting the region through the training of many staff members of geothermal institutions in cooperation with LaGeo, which is responsible for geothermal development in El Salvador since the 1970's and having all the know-how necessary to be an active and strong partner in hosting these courses.

The short courses have covered topics ranging from surface exploration to development, field management and production monitoring. However, it can also be expected to cover a wider area to countries where geothermal resources have not been developed to the same extent.

With the aim of providing geothermal training in the region, the course makes another step forward, and in 2009 a cultural-scientific agreement between the Italian Cooperation, LaGeo, the University of El Salvador (UES), the National Commission of Science and Technology (CONACYT) and the University of Palermo of Italy was signed to run the "First Geothermal Diploma Course in 2010" in El Salvador, which included training in different geothermal areas and performing activities for technical and academic/research for the staff and students of the University of El Salvador (UES), and other public or private institutions which would require it. A total of 39 students were awarded with scholarships, including three students from Nicaragua.

The course was carried out with the support of the Italian Cooperation-Ministry of Foreign Affairs, involving the participation of lecturers from the Geosciences and Earth Resources of the National Research Council of Italy Institute (IGG-CNR), LaGeo Staff, the University of Palermo (UNIPA)-Italy and the University of El Salvador (UES). The technical support through the exchange of educational experts in some specific academic subjects, as well as economic aid for the acquisition of some laboratory equipment, and specialized books were provided with the support of this sponsorship. During the second edition of the Geothermal Diploma Course in 2012, of the 25 registered students, ten were awarded with scholarships, all of them from El Salvador and coming from a wide range of sectors: students, public and some private institutions, who were interested in being trained in the geothermal field.

After the second edition of the Geothermal Diploma Course, students who excelled were given a grant, sponsored by the project, to visit Italy. The aim of the visit is to gain a better understanding of the equipment and activities developed in Pisa and Naples of the National Research Council of Italy Institute (IGG-CNR), and exchange experiences between participants and members of that Institute. The project works were presented by the students in order to promote their technical professional development abroad.

The lecturers came from the parties involved during the previous editions of the Geothermal Diploma Course, and their contribution is presented in Figure 2.

4. THE REGIONAL GEOTHERMAL TRAINING PROGRAMME PROJECT

In order to support Latin American and Caribbean countries to increase the human capacity building, and after looking for more funding for this purpose from some international cooperation agencies, in 2012, the Inter-American Development Bank (IDB) in co-finance with the Nordic Development Fund (NDF), granted more than two million US Dollars, through the National Energy Council (Consejo

Nacional de Energía - CNE) as the main executing organization to assist El Salvador in consolidating the Regional Geothermal Training Center for Latin American and Caribbean countries. In September 2012, an agreement between the Government of El Salvador and the Inter-American Development Bank was signed. Besides that, the institutions involved in this project, that is, CNE, UES and LaGeo signed an agreement with the aim to work together "to make El Salvador become the main venue of the regional geothermal professional development, through a sustainable training project diploma course, that guarantees an accurate investigation and training in the geothermal fields, throughout the efficient execution of the Operation Plan of the Technical Cooperation of the IDB, to support the Regional Geothermal Training Programme for the Latin American and Caribbean countries".

The specific objectives of the Project are to:

- Establish the academic and administrative structure of the Specialized Geothermal Diploma Course of the UES, and adapt to the needs of developing the geothermal regional human capacity building.
- Enhance the capacity of CNE and UES to develop the sustainable geothermal training in El Salvador.
- Increase the regional geothermal expertise through the technical and financial support, in order to develop three diploma courses in 2013-2015 with an updated structure of the curricula and scholarships.

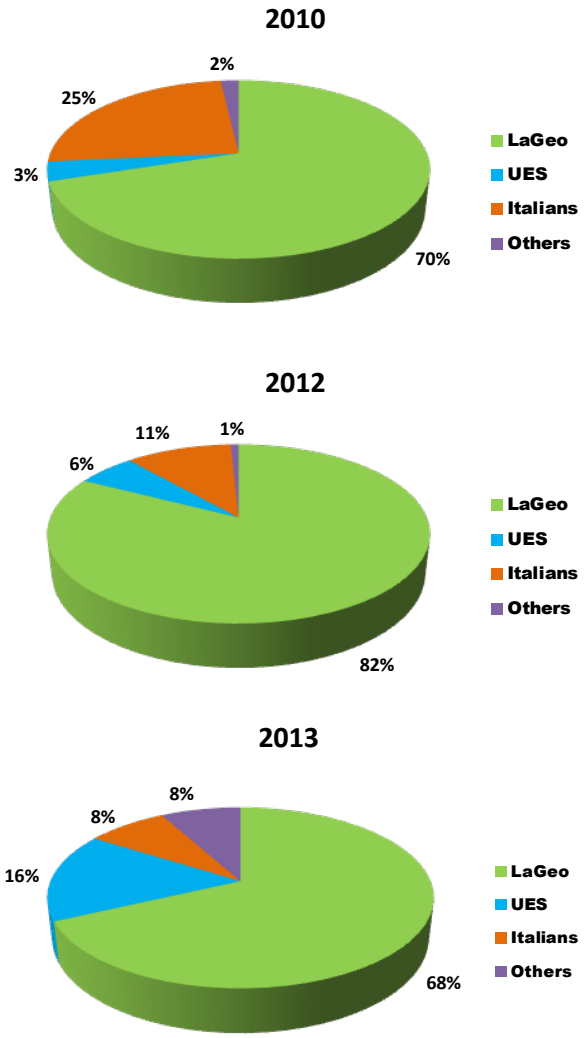

FIGURE 2. Contribution of the different categories of lecturers to the previous courses Source 2010 and 2012: UNU-GTP (Haraldsson et al., 2013)

In order to achieve the objectives mentioned above, the project was divided into three components such as follows:

a) **Component I: Review and analysis of the Geothermal Diploma Course at the University of El Salvador.**

The main objective of this component was to review and evaluate the past 2010 and 2012 Geothermal Diploma Courses at the University of El Salvador and identify the different aspects to improve on based on the academic and administrative points of view.

To perform the activities of Component I, the United Nations University-Geothermal Training Program from Iceland, was hired to carry out the study, finishing the Final Report in March 2013. The outcomes obtained from this report were key inputs to implementing Component III and improve some issues for the 2013 Diploma Course.

b) **Component II: Preparation of a Sustainable Development Plan for the Regional Geothermal Training with the University of El Salvador.**

This component will analyze the future regional geothermal training demand and assure its self-sustainability, with emphasis on the academic and financial analysis and the scholarship structure.

After the bidding process this Component has been carried out by the International Geothermal Centre (GZB) and International Geothermal Association Service Company (IGA Service GmbH), who's experience in these kinds of projects and expected outcomes are going to enrich the future of Geothermal Diploma Course.

c) **Component III: Support to the attainment of the Regional Geothermal Training Courses from 2013 through 2015.**

This component is focused to support the execution of the training courses between 2013 and 2015. The expenses corresponding to the administration, lecturers and scholarships will be supported by this project. The Geothermal Diploma Course is offering thirty scholarships to local students in El Salvador and at the same time, thirty scholarships to geothermal experts from Latin America and the Caribbean countries; priority will be given to participants from countries with geothermal potential.

5. NEXT STEPS OF THE DIPLOMA COURSE

The 2013 Geothermal Diploma Course was reviewed based on the recommendations for the future/guidelines for improvement stated in Chapter 7 of the Final Report written by the UNU-GTP, as a result of the evaluation of Component I. The recommendations touched upon the academic quality and structure of the course, including the amount of time to be spent on different modules/subjects and time of the day for lecturing. Three scenarios were presented, each with a different emphasis and structure, including recommendations on facilities, library and laboratory access, etc., as key input to define the content of the 2013 Edition.

The Third Geothermal Diploma Course was held from August to November 2013, and was the first one that was reflective of the key outcomes of the Component I of the IDB Project. It was the first time that it was open to the Latin American and Caribbean countries that have some geothermal potential and need to prepare technical human capacity to develop geothermal projects. It was held with an evening schedule with internship at LaGeo in the morning, in order to have on-the-job training.

This Edition of the Course registered 25 students from seven Latin American countries: Guatemala (2), Peru (2), Ecuador (1), Argentina (1), Honduras (1); Nicaragua (2), Chile (1) and 15 from El Salvador (Figure 3). As part of the Component III, 10 foreign and 10 local students were awarded with scholarships including: tuition, daily per-diem, transportation, accommodation and other expenses during the Diploma Course.

The 2014 Edition of the Geothermal Diploma Course will cover the areas shown in Table 1.

The next edition of the Geothermal Diploma Course is intended to begin in June 2014, scholarships are available under the same scheme as the 2013 Edition. Students interested in applying to this Programme can get more information at: www.geotermia.edu.sv or send an email to: jarevalo@geotermia.edu.sv or jgarcia@cne.gob.sv.

The aim of the Geothermal Diploma Course is to be an alternative to increasing the capacity building and transfer of technology as key issues in the sustainable development of geothermal resources of the Latin American and Caribbean countries with a self-sustainable course in the long term.

FIGURE 3: Participants of the third Diploma Course

TABLE 1: Structure of the 2014 Edition of the Geothermal Diploma Course

Module	Area	Theoretical hours	Practical hours	Field visit	Lab
I	Geothermal Energy General Concepts	31	12	1	
II	Geological Exploration	32	19	1	4
III	Geochemistry Exploration	31	16	1	
IV	Geophysical Exploration	34	26	2	
V	Geothermal Drilling	25	6	1	
VI	Reservoir Engineering	39	24	1	1
VII	Geothermal Power Plants and Utilization of Low and Medium Enthalpy	30	6	1	
VIII	Environmental and Social Management of Geothermal Projects	26	11	1	
X	Project Work				

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