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Geothermal Center of Excellence in El Salvador

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ABSTRACT

El Salvador is one of the pioneering countries in geothermal energy in Latin America. Gifted with favorable geological conditions, efforts to utilize geothermal resources for power supply in El Salvador date back to 1950s, when Executive Hydroelectric Commission of the Lempa River (CEL) took the leadership on geothermal development. Currently, LaGeo, a subsidiary company of CEL created in 1999, operates the two existing geothermal power plants with total installed capacity of 204 MW, which accounts for 24% of the national electricity market.

With its extensive geothermal history, El Salvador - LaGeo employs many experts working in the field. The vast technical, scientific and managerial capacities have been shared through various courses and workshops to young professionals from El Salvador, Latin America and the Caribbean in cooperation with the Geothermal Training Programme of the United Nations University (UNU-GTP).

In addition, the five-month Geothermal Diploma Course for Latin America has greatly contributed to make El Salvador a reference country as a center of excellence for geothermal energy in the region. This academic project resulted from an important cooperation agreement signed in 2016 by LaGeo and UNU-GTP to jointly implement a study programme carried out by Salvadoran and Icelandic experts.

To date, a total of 689 professionals from Bolivia, Chile, Colombia, Costa Rica, Dominica, Ecuador, Guatemala, Honduras, Mexico, Montserrat, Nevis, Nicaragua, Peru, San Vincent and El Salvador have taken part in the geothermal short courses and the Geothermal Diploma Course imparted in El Salvador.

This report describes the academic project and its positive results and future activities.

1. INTRODUCTION

In 2006, UNU-GTP and LaGeo decided to jointly organize, finance and implement a series of Short Courses held in El Salvador, intended for Latin America and Caribbean geothermal professionals. The series, usually referred to as the UN Millennium Short Courses, started with a Workshop for Decision Makers in 2006 and has since been continued with short courses on various topics in geothermal, on almost annual basis, with Short Course III on Geothermal Reservoir Characterization: Well Logging, Well Testing and Chemical Analysis given in September of 2018, in support of the UN Sustainable Development Goals.

In 2013-2015 a project for implementing a Diploma Course aimed for Latin American countries was developed in El Salvador, given at the University of El Salvador (UES) with the majority of teaching carried out by staff members of LaGeo. This Diploma Course was financed by the Inter-American Development Bank (IDB) and Nordic Development Fund (NDF), through a three-year commitment agreed upon in 2012. UNU-GTP had a monitoring role in the project.

To maintain opportunities for geothermal professionals in Latin America for obtaining quality education on the geothermal disciplines in Spanish, a Memo on Cooperation (MoC) was signed between LaGeo and UNU-GTP on April 25th of 2016, with the objective of strengthening human geothermal capacity in the region, through training and professional development in geoscience, engineering and management, to promote geothermal development in the region. As a product of this MoC a renovated series of five-month Diploma Courses was born under the name of Geothermal Diploma Course for Latin America, whose first to third editions were carried out successfully in 2016, 2017 and 2018, with funding coming from NDF and the Icelandic Ministry for Foreign Affairs through its Directorate for International Development Cooperation (MFA-ICEIDA), overall oversight of the project was carried out by UNU-GTP, local management and administration, in addition to the majority of teaching was carried out by staff members of LaGeo and academic support came from UES.

On May, 2019 an extension of the MoC was signed to guarantee the continuity of the Diploma Course for at least two more years. In this occasion funding of the project comes from MFA-ICEIDA and UNU-GTP.

From 2016 to 2018 USD 474,647 have been invested to carry out this training and it is expected that in 2019 cost of the implementation will be USD 216,935.

2. STRUCTURE OF THE DIPLOMA COURSE

2.1 Students

The Diploma Course is targeted toward Latin American countries, with special attention to those with geothermal resources with feasible potential for exploitation, such as: Argentina, Bolivia, Chile, Colombia, Costa Rica, Ecuador, El Salvador, Guatemala,

Honduras, Mexico, Nicaragua, and Peru. Countries with lower income and less trained professionals are prioritized during the candidates' selection, if the applicant pool allows it, as a way to encourage and support geothermal development in those countries.

Professionals with a BSc degree in geology, geophysics, physics, geochemistry, chemistry, engineering (mechanical, chemical, civil, industrial, electrical, other), environmental science or other degrees deemed sufficient by the Academic Committee may be selected for the course. Professionals with proven experience in geothermal may also apply, as well as university students who have completed all course requirements and are engaged in thesis work.

The selection of students as well as academic matters, such as structure of the study plan, are in charge of an Academic Committee comprised of a Main Representative and an Alternate Representative from LaGeo, UNU-GTP and UES.

Each year, the Diploma Course is opened to thirty (30) students. Ten (10) scholarships are granted to Latin American students, which include housing, food, health insurance and transportation (air and local). Ten (10) scholarships are granted to local students and there are ten (10) additional students may participate in the course covering expenses by their own means.

Since 2016 until 2019, one hundred nineteen (119) students have been trained (29 of them in 2019) coming from Argentina, Bolivia, Chile, Colombia, Ecuador, Honduras, Mexico, Nicaragua, Peru and El Salvador.

Table 1 below shows a summary of the students who have participated in the Diploma Course since 2019.

2.2 Lecturers

The majority of lecturers and student project supervisors have been employees of LaGeo due to the extensive expertise found within the company and each year, two (2) Icelandic lecturers from the UNU-GTP have also contributed for at least three lecture days each and, since 2018 they also have been project co-supervisors.

Figure 1 shows the percentage distribution of lecture hours imparted by LaGeo, UNU-GTP and international lecturers of the Short Course in 2018:

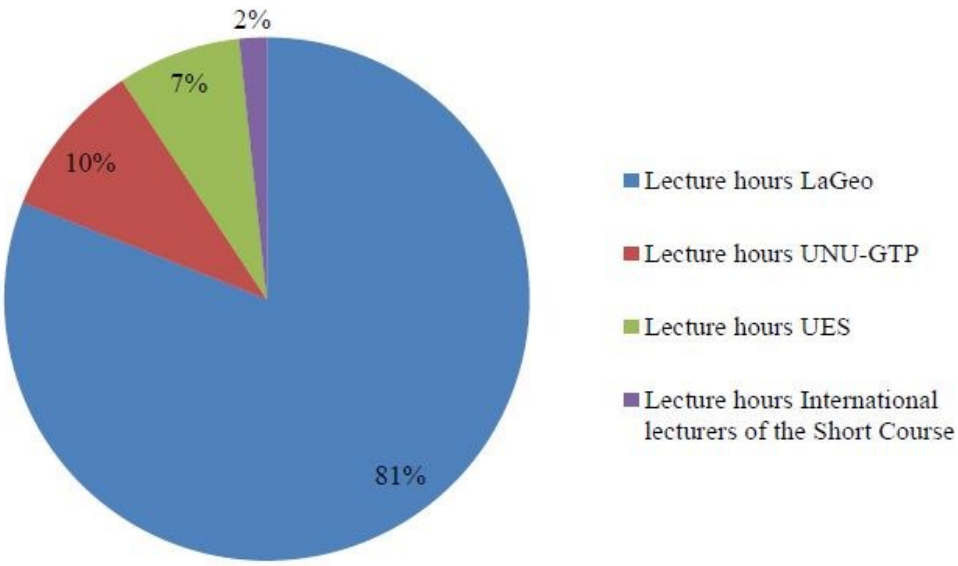

Figure 1: Percentage distribution of lecture hours imparted by LaGeo, UNU-GTP and international lecturers of the Short Course in 2018 (LaGeo and UNU-GTP, 2019).

2.3 Study Plan

The study plan and curriculum of the Diploma Course have been evolving through the years and in 2018 a new module on Energy Policy and Management of Geothermal Projects was added, in addition to a new topic on Energy and Social Issues on the previously existing Environmental and Social Management of Geothermal Projects module, taking into consideration suggestions to improve the course.

Table 2 shows the modules lectured in the Diploma Course.

Table 1: Summary of the students who have participated in the Diploma Course since 2016 (29 of them are currently studying the Diploma Course).

	Argentina	**Bolivia**		**Chile**	**Colombia**	**Ecuador**		**Honduras**	**Mexico**		**Nicaragua**			**Peru**	**El Salvador**	
	CONICET	*ENDE*	*Ministry of Energy*	*Student*	*Student*	*CELEC EP*	*IGER*	*NUH*	*CFE*	*INEEL*	*ENEL*	*POLARIS*	*Ministry of Energy*	*INGEMMET*	*Student*	*LaGEO*
2016		1			2	1			2		1	2		1	10	10
2017	1	1	1	1	2	1			1		1			1	10	10
2018	1	1			1			1	3		2	2	1		10	8
2019	1			1	2		2			1	1	1		1	10	9
Sub-total	**3**	**4**		**2**	**7**	**4**		**1**	**7**		**11**			**3**	**77**	
TOTAL	**119**															

CONICET: National Scientific and Technical Research Council.

ENDE: National Electricity Company.

CELEC EP: Electricity Corporation of Ecuador.

IGER: Institute of Geological and Energy Research.

NUH: National University of Honduras.

CFE: Federal Electricity Commission.

INEEL: National Institute of Electricity and Clean Energy.

POLARIS: Polaris Energy Nicaragua.

INGEMMET: Geological Mining and Metallurgical Institute.

Table 2: Modules of the Diploma Course.

Module	Topic
I	General Concepts
II	Geothermal Geology
III	Geothermal Geochemistry
IV	Geothermal Geophysics
V	Integrated Conceptual Model
VI	Drilling
VII	Geothermal Reservoir Engineering
	UNU-GTP / LaGeo Short Course
VIII	Geothermal Plants. Low and Medium Enthalpy Applications
IX	Environmental and Social Management of Geothermal Projects
X	Energy policy and management of Geothermal Projects
XI	Final Project

3. EVALUATION OF THE COURSE AND EXPECTED RESULTS

Since 2016 students have been asked to answer an evaluation of course components.

In 2018 the survey was answered by 26 students and most of them qualified as "very good" or "excellent" the acquired knowledge in all the modules of the Diploma Course (LaGeo and UNU-GTP, 2019).

Additionally, 92% of the students considered the time dedicated to practical work (practical class hours and laboratories) and field trips was enough to promote learning. All the students considered they learned new techniques during the final project and that the teaching methods used in the Diploma Course were appropriate to promote learning. They also expressed the Diploma Course reached their expectation and that they would recommend the course among their colleagues (LaGeo and UNU-GTP, 2019).

It is expected that with the implementation of the Diploma Course project the following results will be achieved:

1. The number of trained geothermal professionals in the Latin American region will increase.

2. All participants will be successfully provided with scientific, analytical and technical capacities that will allow them to contribute to an efficient and sustainable management of geothermal resources in harmony with the environment.

3. The Diploma Course graduates that work in a public or private geothermal company will get involved in scientific, engineering or management activities in the different phases of a geothermal project, from planning and exploration to utilization and management, depending on the country´s possibilities and development in geothermal.

4. Each year, at least 10 international students of the Diploma Course (5 female and 5 male) will return to their home countries in Latin America and will contribute to their geothermal institutions or universities and implement and share with others the acquired knowledge to achieve geothermal development. Also, at least 10 Salvadoran students (5 female and 5 male) will continue to contribute to geothermal development and share the acquired knowledge in El Salvador.

5. Graduates from the Diploma Course will actively promote the development of geothermal in their countries and will be the key actors that generate scientific research of use for existing or future geothermal projects.

6. Graduates will continue to do scientific research related to geothermal.

4. UPCOMING ACTIVITIES

One of the next steps in the evolution of the Diploma Course is to ensure it is worth Master´s level academic credits. That is why; LaGeo will work towards this achievement through proposing the signature of Agreements on Cooperation with local universities that recognize the course in their MSc programs.

LaGeo will prioritize the approach to UES to guarantee that the Diploma Course is recognized as academic credits in the Master in Renewable Energy imparted by this university.

Also, LaGeo expects in a near future the Diploma Course can evolve into a Master´s Degree in Geothermal for the Latin American region.

5. CONCLUSION

The Geothermal Diploma Course is a postgraduate course funded by MFA-ICEIDA and UNU-GTP, with overall oversight of the project by UNU-GTP, local management and administration of the implementation of the project by LaGeo and academic support by UES.

Since 2016, one hundred nineteen (119) students coming from Latin American countries have been trained in this course given in Spanish and most of them have expressed their contentment and satisfaction with the course. This project allows young professionals of the region to be trained on geothermal in a country that has more than 40 years of experience and with collaboration of Icelander experts.

The course is a favorable way of geothermal training because students can be granted a fellowship and are able to learn about a geothermal environment similar to the one in their countries.

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