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PLANS FOR GEOTHERMAL TRAINING IN CENTRAL AMÉRICA

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ABSTRACT

In the coming decades, actions to limit greenhouse gas emissions could affect patterns of energy use around the world and change the level and composition of energy related with carbon dioxide (CO2) emissions by energy source. The use of geothermal and other grid connected renewable energy sources continues to expand over the projections, increasing by 2.4% per year. (Energy Information Administration, 2006). Higher fossil fuel prices in the electric power sector, allow renewable energy sources to compete economically.

In order to have a diversified energy generation, the development education initiative that works to improve the conditions for learning and get the knowledge about new technologies, towards the search for alternative solutions, is considered a priority to train professionals and drive projects successfully.

The Government of Iceland, through the UNU-GTP will continue offering to Central America region, the six month courses, within the nine lines of training and the MSc Programme in geothermal science and engineering in cooperation with the University of Iceland. Short courses and workshops in geothermal development by 2006, will improve the conditions for learning and increase the cooperation between specialists in the field of sustainable use of geothermal resources. Long term goals are to assist in the establishment of formal training centers with former UNU fellows as main teachers in the region. (Fridlefisson, 2005).

1. INTRODUCTION

The technological, social and economic development in the world requires that the energy services are guaranteed in a context of sustainable development, being the use of alternative energy renewable resources a high-priority.

The world energy consumption is projected to increase by 71% from 2003 to 2030, with fossil fuels (oil, natural gas and coal) supplying much of the energy used worldwide, and oil remaining the dominant energy source. (DOE/EIA-0484). Since this will bring serious environmental consequences (increase of atmospheric pollution, emission of carbon dioxide (CO2) and other greenhouses gases, etc.), the use of renewable energy sources are becoming more economically competitive. Demand for energy services is growing fast, particularly in the developing countries with fast expanding economies. Central America growing energy demand is about 4.5% annually which means the new power needed is about 250 MW per year.

The global environment and development education initiative that works to improve the conditions for learning and get the knowledge about new technologies, towards the search for alternative solutions, is considered a priority to train professionals to drive projects successfully and integrate a specialized teamwork during the exploration, exploitation and development project stages, in order to have a diversified energy generation.

2. WORLD GEOTHERMAL TRAINING IN THE PAST

Since training in geothermal technology began in 1970, graduates have become the leading specialists in geothermal research in their countries, however there is a need to continue training professionals and create a new generation of scientists and engineers to build up the necessary human capacity.

During the last 25 years scientists and engineers have been trained through the main International Geothermal Training Centers in the world. The International School of Geothermics at Pisa, Italy, began in January 1970 and its training activity was financed by the National Research Council, the Italian Ministry of Foreign Affairs and sponsored by UNESCO (average 8 months course). The objective of this course was to prepare experts in geothermal exploration. The Kyushu University through its Geothermal Research Center at Fukuoka, was founded in September 1970 and financed by the Japan International Cooperation Agency (JICA), with a 4 month course. The Geothermal Institute of Auckland University, began in February 1979 and was sponsored by the United Nations Development Programme (UNDP) until the end of 1989. UNDP sponsorship began again in 1997 and financed by the New Zealand Ministry of Foreign Affairs and Trade (MFAT). With the Diploma in Geothermal Technology lasting 8 months, trainees could attend a 12 week intensive course in English prior to Diploma Course, as well as a one month course on computing. The Government of Iceland and the United Nations University (UNU) decided to establish the UNU Geothermal Training Programme (UNU-GTP) in Reykjavík, Iceland in 1978. Orkustofnun Office (the National Energy Authority of Iceland) became the host institution of the UNU-GTP. The aim of the Programme is to assist developing countries with significant geothermal potential to build up groups of specialists that cover most aspects of geothermal exploration and sustainable development.

The numbers of fellows who have attended international geothermal training courses during the last 25 years, especially the Latin American students are shown in the Table N° 1. They have contributed to carry out faster development in geothermal resource utilization in their respective countries. Unfortunately, most of these training courses are discontinued while some of them have been closed due a lack of funding to support the training opportunities through the international bilateral agencies or have been reduced the financing by governments. In 1992, after 322 geothermists attended the course in Pisa, Italy, it was suspended due to drastic cuts in government financing, but has occasionally held short courses in developing countries. The Training Course in Geothermal Energy at Kyushu University was closed in 2001 after 385 specialists were trained at this course. The Geothermal Institute of Auckland University, was closed in 2002 due to withdrawal of government financing, training 644 students. The Geothermal Training Programme of the United Nations University (UNU-GTP), has trained 359 scientists and engineers up to 2006 from 40 countries, being the only geothermal training institution which continues assisting developing countries to increase the human capacity building. (Fridleifsson, 2005).

The reduced training opportunities restrict young professional candidates the access to a specialized training around the world. They must wait for a fellowship at the only available Geothermal Training Programme at the United Nations University, UNU-GTP in Reykjavík, Iceland. Learning came from candidates who have been trained before and have carried out learning on the job. On the other hand, for developing countries the high cost of the course and living expenses cannot be afforded by companies or governments with their own financial resources.

TABLE 1. Student population at international geothermal training courses (1)

Institution/Country	Opened	Closed*	Total Students Trained	Latin American Students	Ref.
International School of Geothermics Pisa, Italy	Jan, 1970	1992	322	117	2
Kyushu University, Geothermal Research Center. Fukuoka, Japan	Sep, 1970	2001	385	120	2
Geothermal Institute of Auckland University. New Zealand	Feb, 1979	2002	644	103	2
Geothermal Training Programme of the United Nations University (UNU-GTP) Reykjavík, Iceland	Mar,1979		359	48	3
Total			**1710**	**388**	

* Closed o have reduced their opportunities of sponsorship to developing countries. Most of them have discontinued the main courses.
(1): Simiyu, Silas M and Mwangi, Martin N., 2005 ; (2): Hochstein, 2005; (3): Fridleifsson, 2004

3. CENTRAL AMERICA GEOTHERMAL TRAINING IN ICELAND

The Central America student population who has attended the international training courses in Iceland, above mentioned, represents about 14% of the whole trained population in the world, contributing to the expansion of the geothermal installed generating capacity using renewable resources.

Table 2 presents the current geothermal energy generation (GWh/y) and its contribution to each Central America country, related with geothermal human capacity expansion and the contribution of United Nations University, Geothermal Training Program (UNU-GTP) to the date.

TABLE 2. Student population in Iceland and Geothermal Energy Generation in Central America (1)

Country	Number of Fellows	Geothermal Energy Generation 2005 GWh/y	% Injections to National Electricity
Guatemala	3	146	2.0%
El Salvador	22	982*	20.2%
Honduras	2	0	0.0%
Nicaragua	6	223	8.3%
Costa Rica	15	1,148	14.0%
Total	**48**	**2,499**	

*To 2007 will increase to 1,348 GWh/y and will represent 25.9% inyections to national electricity.
(1) Fridleifsson, Ingvar B., 2005

4. GEOTHERMAL TRAINING IN EL SALVADOR

Geothermal industry requires making accurate decisions, which will need well-trained professionals. It is important to have an integrated multidisciplinary high skilled teamwork, with an up to date knowledge and trained young professionals as the next generation and have the acquired knowledge as part of the company's main values.
In order to have an alternative to increase the training opportunities and share the geothermal knowledge into the company, LaGeo El Salvador with the specialized fellows as main lecturers have organized an internal geothermal course called "Diploma in Geothermal Science and Technology" (DICITEG), which began in 2002. The first level was imparted to all the employees of the company and the other three levels to employees who wanted to learn more about geothermal specialized topics.

The main scope for the internal Diploma course, was to comply to the following objectives:

- Being an option of training internal professionals
- Promote and improve the core competencies
- Develop the employees' academic level
- Promote alternative training opportunities
- Share the knowledge of geothermal development
- Opportunity to create a regional geothermal training program in the future

This Diploma course has been structured and developed according to the specialty and requirements obtained from the different areas and the participants' needs. The Diploma syllabus contains the topics shown on Table 3.

After implementing this program, at present, we have trained about 274 employees at Level I and 30 employees at Level III, including our employees in San Jacinto Tizate Project located in Leon, Nicaragua, having the opportunity to invite some teachers and students from University of Leon to take the basic course.

Due to the success and enthusiasm transmitted into the company, LaGeo looked for an agreement with a local University trying to share this specialized knowledge to a new generation of professionals, working or not, in the renewable energy matters through the Renewable Energy Master Degree. Unfortunately after working together for more than a year, the University made a marketing research and they concluded that there were not enough market for geothermal issues and the career would not be feasible in the near future, due to high costs of bringing some specialists to teach to the country, expensive laboratory equipment, and there were not enough people interested and working in those areas.

However there are still some bilateral agreements with local Universities, such as exchanging some databases, sharing research results and exchanging experiences between both parties related with new alternative sources of renewable energy.

5. GEOTHERMAL TRAINING FOR CENTRAL AMERICA PROFESSIONALS IN THE FUTURE

The opening of the current internal Geothermal Science and Technology Diploma to the region could be the first step to have a Geothermal Training Center in Central America, however, it demands an international bilateral cooperation in order to finance the associated costs for the facilities and training in all phases of geothermal development from geothermal exploration to operation of geothermal power plants.

UNU-GTP Plans for Central America

The United Nations University UNU-GTP is thus, at present, the only international graduate school still offering specialized training in all the main fields of geothermal science and engineering. Candidates are nominated by the directors of the selected institutions for training in the specialized fields that are considered most relevant to promote geothermal development in the respective country. They are selected by personal interviews in their home country by UNU-GTP representatives, having at least the following requirements:

- A university degree in science or engineering
- Have a permanent position at energy company, dealing with geothermal energy at a public energy company/utility, research institution, or university in their home country
- A minimum of one year practical experience in geothermal work
- Speak English fluently
- Be under 40 years in age

The six months specialized training will continue annually with a target of 20 international fellows, with candidates who comply the above mentioned requirements. The main emphasis of the training is to provide the fellows with sufficient understanding and practical experience to permit the independent execution of projects within a selected discipline in their home countries. Nine specialized lines of training are offered, each participant is engaged in geothermal work intensive on-the-job training in their chosen fields of specialization. The trainees work side by side with geothermal professionals in Iceland. (Fridleifsson, 2005).

A MSc Programme in Geothermal Science and Engineering in cooperation with the University of Iceland began in 2000 at UNU-GTP and some UNU fellows who attended the six month course have been admitted to the date. The MSc Programme requires 18 month study. Admission to this programme complies with the same requirements for the six month training and the private interview with candidates, to secure the quality of the selected fellows.

Funded by the Government of Iceland as part of its contribution towards the United Nations Millennium Development Goals, short courses and workshops in geothermal development will be set up by the UNU-GTP by 2006 at Central America, in cooperation with the energy agencies/utilities and earth science institutions responsible for the exploration, development and operation of geothermal energy power stations and utilities in the respective countries. Short courses will also be conducted in selected countries in Africa and Asia in cooperation with the local organizations. The main objective is to increase cooperation between specialists in the respective countries in the field of sustainable use of geothermal resources. Teaching will be from UNU-GTP graduates and the regular teachers of the UNU-GTP. Longer term goals are to assist in the establishment of formal training centers with former UNU fellows as main teachers in the region and transfer the knowledge to a new generation of scientists and engineers to the future. (Fridleifsson, 2005).

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TABLE 3. "Geothermal Science and Technology Diploma"
Syllabus

Level	Content	Hours No.
I	**Introduction to Geothermal Energy**	
	▪ Basic Concepts of Geothermal Energy	8
	▪ Geothermal Power Plant Basic Operation	8
	▪ El Salvador Electric Law Frame	4
	▪ El Salvador Environmental Law Frame	4
	▪ Safety and Environmental Integrated System (Quality Control)	4
	▪ Budget Planning and Financial aspects	4
II	**Geothermal Resources**	
	▪ Geology of Geothermal System	24
	▪ Chemistry of Fluids	8
	▪ Geothermal Resources Assessments	8
	▪ Database Information System	8
	▪ Geothermal Exploration	24
	▪ Conceptual Models	8
	▪ Special Exploration	16
	▪ Risk Assessment	8
III	**Geothermal Engineering**	
	▪ Well drilling	16
	▪ Gathering System	8
	▪ Geothermal Project Development	8
	▪ Geothermal Power Plant Design	16
	▪ Chemical Evolution	8
	▪ Geothermal Projects and Financial Aspects	8
	▪ Well logging and field monitoring	8
	▪ Geothermal Power Plant Efficiency Analysis	8
	▪ Geothermal Fields Management	8
	▪ Reservoir Engineering	8
IV	**Geothermal Power Plants**	
	▪ Geothermal Power Plants Types	16
	▪ Thermal Conversion Efficency	4
	▪ Input and Auxiliary Equipment	4
	▪ Turbine, Condenser and Eyector	8
	▪ Auxiliary Equipment	8
	▪ Pumps and Cooling Towers	8
	▪ Generator and Auxiliary Equipment	8
	▪ Automatic Control and Instrumentation (DCS)	8
	▪ Substation and Transmision Lines	8
	▪ Power Generation Plant Operation	8
	▪ Electric Market Operation in Central America	4