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GEOTHERMAL TRAINING PROGRAMME
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THIRTY YEARS OF GEOTHERMAL TRAINING IN ICELAND

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ABSTRACT

The first official statement on establishing a UNU geothermal institute in Iceland was made in 1975 when the United Nations University (UNU) had just been established. After a first proposal in 1976 and an international workshop in 1978, the Government of Iceland asked Orkustofnun - the National Energy Authority (NEA), to sign an Agreement on Association with the UNU and establish the UNU Geothermal Training Programme (UNU-GTP). The first two UNU Fellows from the Philippines arrived in Iceland in May 1979. Since then, the UNU-GTP has held annual six month courses for professionals from developing countries. Specialized training is offered in geological exploration, borehole geology, geophysical exploration, borehole geophysics, reservoir engineering, chemistry of thermal fluids, environmental studies, geothermal utilization, and drilling technology. The trademark of the UNU-GTP is to give university graduates engaged in geothermal work intensive on-the-job training in their chosen fields of specialization. The aim is to assist developing countries with significant geothermal potential in building up groups of specialists that cover most aspects of geothermal exploration and development. During 1979-2008, 402 scientists and engineers from 43 countries have completed the six month courses, and over 90 have received shorter training. A MSc programme in geothermal science and engineering was opened in 2000 in cooperation with the University of Iceland, and a PhD programme will be opened in 2008. Fifteen UNU MSc Fellows have completed their degree (July 2008). The UNU-GTP has also expanded its capacity building activities by annual workshops / short courses in geothermal development in selected countries in Africa (started in 2005), Central America (started in 2006), and in Asia (started in 2008). This is a contribution of the Government of Iceland towards the Millennium Development Goals of the UN. A second UNU training programme, the UNU Fisheries Training Programme (UNU-FTP), was established in Iceland in 1998, based on the experience of the UNU-GTP. Over 60 UNU Fellows from developing and transitional countries come annually to Iceland for specialized training at the UNU-GTP and UNU-FTP. In 2007, the Icelandic Government contributed about 4.3 million USD to the UNU activities in Iceland.

1. INTRODUCTION

The Charter of the United Nations University (UNU) was adopted by the UN General Assembly in 1973. The UNU commenced operations with headquarters in Tokyo in September 1975. Member countries of the UN were requested to support the establishment of the UNU. This could be in the form of contributions to the Endowment Fund of the UNU or through hosting individual research and

training programmes at UNU Associated Institutions. The Permanent Mission of Iceland to the UN supported the idea of establishing the UNU from the beginning, and considered in what way Iceland could best contribute to the work of the new university. The first official statement on establishing a UNU geothermal institute in Iceland was made by Ambassador Ingvi S. Ingvarsson in Tokyo at the Fourth Session of the UN Committee on Natural Resources in March 1975.

The Government of Iceland sent the first proposal on possible venues of cooperation to the UNU in Tokyo in January 1976. UNU Vice-Rector Walter Manshard and Dr. James M. Harrison visited Iceland in June 1976 for further discussions, and visited institutions which might become Associated Institutions of the UNU. Initially, training programmes for both geothermal energy and fisheries technology were considered. The UNU showed preference for geothermal energy to start with. It was considered whether the geothermal training centre should be hosted by the University of Iceland (UI) or Orkustofnun - the National Energy Authority (NEA), a government research institution with a large number of geothermal specialists, excellent laboratory facilities, drill rigs and logging equipment. After evaluating the available facilities, the UNU selected Orkustofnun.

A proposal to the UNU for the establishment of the Geothermal Training Programme in Iceland was adopted by the Government of Iceland in March 1978, and submitted to the UNU in Tokyo. The UNU convened an international workshop at Laugarvatn in Iceland in July 1978 to determine the need for the proposed training course and to ensure that it would not duplicate courses already available. There were representatives of four UN agencies and geothermal specialists from El Salvador, Germany, Hungary, Iceland, India, Italy, Japan, Kenya, New Zealand, Philippines and the USA. The workshop concluded: "After consideration of the existing courses and that proposed by Iceland, it is concluded that they cover reasonably well the diversity of general and specialized requirements for training at the professional level. The Iceland course is regarded as an important addition to the existing programmes. It is urged, especially by participants from recipient countries, that the Iceland training programme for individuals be as short and flexible as possible while still adequately improving the knowledge and the skills of trainees. It is felt that preference should be given to candidates from those developing countries where geothermal exploration or development is under way, and to those who already have some practical experience in their own discipline" (United Nations University, 1979).

A detailed account of the preparations for UNU activities in Iceland is given in the proceedings of the 20th Anniversary Workshop of the UNU-GTP (Fridleifsson, 1998). In October 1978, the Government of Iceland decided to ask Orkustofnun to sign an Agreement on Association with the UNU. The Agreement on the Status of Association was signed in Tokyo on 27th December 1978, and on 13th February 1979 in Reykjavik. The first two UNU Fellows from the Philippines arrived in Iceland in May 1979. As of the end of the 30th annual session in 2008, 402 scientists and engineers from 43 countries will have completed the six month courses. This paper describes the operations of the UNU-GTP through the 30 years, and looks at the prospects for the near future.

2. INSTITUTIONAL ENVIRONMENT AND ORGANIZATION

The UNU-GTP (www.unugtp.is) is operated at Orkustofnun (www.os.is), which has been an Associated Institution of the UNU since 1978. Orkustofnun is a government agency under the Ministry of Industry and Commerce. Its main responsibilities have been to advise the Government of Iceland on energy issues and related topics, and (until 2003) to carry out energy research and provide consulting services relating to energy development and utilization. Orkustofnun has an excellent library specializing in energy research and development (in particular geothermal and hydropower), with some 19,000 titles, subscriptions to 60 journals, and internet access to some 14,000 journals.

The Geoscience Division was separated from Orkustofnun in 2003 and a new public company established, ISOR - Iceland GeoSurvey (www.isor.is), with basically the same operations as the former Geoscience Division. Of the 90 staff members of ISOR in 2008, 20 have PhD qualifications. The

disciplines are represented as follows: 29 geologists, 18 geophysicists and reservoir physicists, 9 geochemists, 9 engineers, 3 geographers, 2 administrators, 10 technicians, 8 electricians and others. ISOR has chemical, geophysical, and petrological laboratories, and five logging trucks for geothermal wells. The integration, of the UNU Fellows with the specialists and the research atmosphere of ISOR, has continued as in the years previous to 2003. The UNU-GTP pays for the services of staff members of ISOR and Orkustofnun, respectively, in accordance with contracts. The UNU Fellows have full access to the research facilities and the multidisciplinary research environment of Orkustofnun and ISOR, which for over three decades have united been amongst the leading geothermal energy research institutions in the world.

The UNU-GTP also has a close cooperation with the University of Iceland (UI). Staff members of the Faculty of Science and the Faculty of Engineering have been amongst the key lecturers and supervisors of UNU Fellows in some subjects since the establishment of the UNU-GTP. A co-operation agreement was signed in 2000 between the UNU-GTP and the UI on MSc studies in geothermal science and engineering. This is designed for UNU Fellows who have already completed the traditional six month courses at the UNU-GTP, which constitute 25% of the MSc programme.

The UNU-GTP has four permanent staff members (employed by Orkustofnun), but lecturers and support staff are hired from ISOR, the UI, and other agencies/companies. Every year, about 50 staff members of these institutions render services to the UNU-GTP under contracts. This allows the flexibility required to provide highly specialized training in the nine fields of specialization offered. Dr. Ingvar Birgir Fridleifsson is the founding Director of the UNU-GTP, and has served as Director except for four training sessions, in 1981 when Dr. Hjalti Franzson served as Director, and in 1986-1988 when Dr. Jon Steinar Gudmundsson served as Director. Mr. Ludvik S. Georgsson has been the Deputy Director of the UNU-GTP since 1990.

The UNU-GTP is academically governed by a Studies Board, which is composed of experts (from ISOR, UI and Hitaveita Sudurnesja (HS)) responsible for each of the specialized courses. The UNU-GTP Director is the chairman of the Studies Board. Other members of the Studies Board are Dr. Hjalti Franzson (Borehole Geology), Mr. Knutur Arnason (Geophysical Exploration), Mr. Benedikt Steingrímsson (Borehole Geophysics), Dr. Gudni Axelsson (Reservoir Engineering), Dr. Halldor Armannsson (Environmental Studies), and Mr. Sverrir Thorhallsson (Drilling Technology), all from ISOR; Professor Stefan Arnorsson (Chemistry of Thermal Fluids), and Professor Pall Valdimarsson (Geothermal Utilization) from UI, and Dr. Gudmundur Omar Fridleifsson (Geological Exploration) from HS. Professor Stefan Arnorsson has been a member of the Studies Board from its establishment in 1979. The Studies Board does not have many formal meetings per year, but serves a very important role in setting the academic standards for the training and in designing training schedules for each UNU Fellow. The great devotion and unselfish work of members of the Studies Board (with very low payment) through the years is gratefully acknowledged.

3. CONTACT WITH UNU HEADQUARTERS

The agreement between Orkustofnun and the UNU on the Status of Association initially signed in 1978 was renewed first at three year intervals and later at five year intervals. The agreement, which has been modified through the years, sets out the framework for the cooperation between Orkustofnun and the UNU. Through the years, the operational contact has been between the UNU-GTP Director and senior staff members at UNU headquarters in Tokyo. The main contact persons have been Dr. Walter Shearer (Senior Programme Officer 1979-1983), Dr. Aly Nazerali (Secretary of the UNU Committee on Training 1983-1985), Dr. Abraham Besrat (Training and Fellowship Officer and later Vice Rector 1986-1998), Mrs. Wilma James (Administrative/Training Assistant 1998-present), and Mr. Max Bond (Executive Officer in the Office of the Rector 1997-present).

The bulk of the cooperative work has been the selection of UNU Fellows for training, which involves site visits to the various countries, personal interviews with candidates (undertaken by UNU-GTP), the screening of applications, and the award of UNU Fellowships (undertaken jointly by the UNU and UNU-GTP). In the early days, all reports had to go by mail and short messages by telex. With the telefax in the mid 1980s and later the e-mail, communication became much faster and easier. The cooperation has been very good through the years. Particular mention should be made of Dr. Abraham Besrat, who from 1986 to his untimely death in 2002 gave great support to the UNU-GTP, and was a key person in the establishment of the UNU Fisheries Training Programme (UNU-FTP (www.unuftp.is)) in Iceland in 1998, which was modelled on the experience of the UNU-GTP.

The UNU-GTP Director participated in meetings at UNU headquarters in Tokyo in 1979, 1980, 1981, and 1982. After that, visits to UNU headquarters became more sporadic (1987, 1991, but annually from 1995), and the operations were handled mostly through correspondence. Several key persons from UNU headquarters have visited the UNU operations in Iceland through the years, including UNU Senior Adviser and former UNU Vice-Rector Walter Manshard (1980), UNU Programme Director Maurice Levy (1982), UNU Rector Gurgulino de Souza (1991, 1997), Dr. Abraham Besrat (1994, 1996, 1997, 1998), UNU Consultant Prof. Leon Gordenker (1998), and UNU Rector Hans van Ginkel (1998, 2003). The UNU-GTP was also honoured by the visits of UN Secretary General Perez de Cuellar in 1983, UN Assistant Secretary General Margaret J. Anstee in 1985, and UN Under-Secretary General Mr. Nitin Desai in 2000.

Since 1998, at the invitation of Rector Hans van Ginkel, the UNU-GTP Director has attended the annual meetings of the UNU Council and participated in the Conference of Directors (CONDIR) of the UNU (twice per year) representing the two UNU programmes in Iceland (UNU-GTP and UNU-FTP). In the Agreement on the status of Association between the UNU and Orkustofnun signed in 2006 it says in Article 9: “The Director shall act as the focal point for the UNU Training Programmes in Iceland. He shall participate in the Conference of Directors of UNU Research and Training Centres and Programmes held periodically by UNU, as well as the sessions of the UNU Governing Council”. A CONDIR meeting was held in Iceland for the first time in April 2003.

4. SPECIALIZED TRAINING

The trademark of the UNU-GTP is to give university graduates 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. The training is tailor-made for the individual and the needs of his institution/country. All participants are selected by private interviews during site visits to the countries concerned where UNU-GTP representatives visit geothermal fields, research institutions and energy utilities. Participants are selected for training in the specialized fields that are considered most relevant to promote geothermal development in the respective country. The candidates must have a university degree in science or engineering, a minimum of one year practical experience in geothermal work, speak English fluently, have a permanent position at an energy agency/utility, research institution, or university, and be under 40 years.

The approximate time schedule of the six month specialized courses is shown in Table 1. All participants attend an introductory lecture course (5 weeks, three lectures per day) which aims to provide background knowledge on most aspects of geothermal energy resources and technology, and to generate an appreciation for the interrelationship between the various disciplines necessary in geothermal projects from the initial exploration to the stages of implementation and utilization. Participants have to take two written tests during the introductory lecture course. The introductory course is followed by lectures and practical training in the respective specialized fields (7 weeks), and the execution of a research project (12 weeks) which is concluded with an extensive research project report. Excursions (2 weeks) are also arranged to the main geothermal fields under exploration and utilization in Iceland. Seminars are held and case histories studied on each of the fields.

TABLE 1: Approximate time schedule for the six month specialized courses at UNU-GTP

UNU GEOTHERMAL TRAINING PROGRAMME IN ICELAND

Week	Geological Exploration	Borehole Geology	Geophysical Exploration	Borehole Geophysics	Reservoir Engineering	Environmental Studies	Chemistry of Thermal Fluids	Geothermal Utilization	Drilling Technology
1	Lecture course on all main aspects of geothermal energy exploration and utilization, practicals and short field excursions								
2									
3									
4									
5									
6	Field geology	Drilling	Resistivity methods	Course on well logging and reservoir engineering including:		EIA Project planning	Sampling of fluids and gas		Drilling equipment
7	Maps and photos	Petrological logging	Thermal methods	Logging and well testing practises	Logging and well testing practises	Chemistry Physics	Scaling and corrosion	Heat transfer and fluid flow	Drilling procedures
8	Structure analysis	Alteration	Magnetics	Reservoir physics	Reservoir simulation	Biology Monitoring	Analytical methods	Thermodynamics	Well design Safety
9	Hydrogeology	Mineralogy	Gravity	Tracer tests	Computer programs	Revegetation	Geothermometers	Control systems	Management
10						Health and safety			Rig operations
11	Excursion to the main geothermal fields of Iceland								
12									
13	Field work in deeply eroded strata	Aquifers Modelling	Data processing techniques	Logging methods	Responses to exploitation	Gas dispersion and abatement	Water rock interaction	Design of plants and systems	Cementing Completion
14			Data evaluation						
15	Project and report	Project and report	Project and report	Project and report	Project and report	Project and report	Project and report	Project and report	Project and report
16									
17									
18									
19									
20									
21									
22									
23									
24									
25									
26									

The main emphasis of the training is to provide the participants 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 (Table 1). Each participant is meant to follow only one line of training, but within each line there is considerable flexibility. A detailed description can be found on the home page of the UNU-GTP (www.unugtp.is).

Most of the teaching is done by tutorials and practical work where the teacher works with two or three trainees and use is made of available textbooks and articles in journals as appropriate. In some instances, however, text material and manuals have been made for the training. Some of the teaching material has been published in reports, and is available from the UNU-GTP. UNU Fellows have in many cases used teaching material from the UNU-GTP to train colleagues in their own institutions.

A significant part of the practical training is done in connection with the research projects of the Fellows. In many cases, the participants bring with them data from geothermal projects in their home countries. The project topic is always selected with respect to the conditions of the home country of the participant. All project reports are published by the UNU-GTP. Since 1994, the reports have been published in the annual book "Geothermal Training in Iceland" (edited by Ludvik S. Georgsson, international publishing code (ISBN 9979-68). Copies can be obtained upon request. The books are mailed regularly to former UNU Fellows, universities and leading geothermal research institutions in over 50 countries. The titles of the research reports from 1979-2007 are listed in the home page of the UNU-GTP (www.unugtp.is). Abstracts of reports since 1988 and the complete reports since 1999 are also available on the home page.

On many occasions, UNU Fellows from a given country (e.g. Costa Rica, El Salvador, Kenya, Philippines) conduct multidisciplinary research (geology, geophysics, chemistry, reservoir engineering, environmental impact studies) over several years on data from the same area in their home countries under supervision of Icelandic specialists. All of the countries mentioned above obtain 15-22% of their electricity from geothermal steam.

Table 2 lists the countries of origin of the participants who have completed the six month training during 1979-2008, and their specialized courses. Figure 1 shows the same on a world map. The largest groups have come from China (70), Kenya (42), Philippines (31), El Salvador (27), Ethiopia (26), and Indonesia (24). Sixteen other countries have sent 5-19 participants.

TABLE 2: Fellows of the UNU Geothermal Training Programme in Iceland 1979-2008

FELLOWS OF THE UNU GEOTHERMAL TRAINING PROGRAMME IN ICELAND 1979-2008										
Country	Geological exploration	Borehole geology	Geophysical exploration	Borehole geophysics	Reservoir engineering	Chemistry of therm. fluids	Environmen. studies	Geothermal utilization	Drilling technology	Total
Albania								1		1
Algeria	1					1		1		3
Azerbaijan							1			1
Bulgaria				1	2	2				5
Burundi	1									1
China		3	1	2	24	14	9	15	2	70
Costa Rica	2	2	2		2	2	2	3		15
Djibouti		2			1					3
Egypt		1		1	1	1				4
El Salvador	1	1	2	2	5	4	3	5	4	27
Eritrea	2		2		2	2				6
Ethiopia		3	4	1	5	4	1	6	2	26
Georgia								1		1
Greece			1					2		3
Guatemala		1			1	1				3
Honduras		1	1							2
Indonesia		5	3		5	1	2	5	1	24
Iran	1	3	1	1	1	1	3	7	1	19
Jordan	1			1	1	2		1		6
Kenya	1	4	10		6	7	7	3	4	42
Latvia								1		1
Lithuania					1			1		2
Macedonia						1				1
Mexico	1		1	1	2					5
Mongolia	1		1		1	1		4		8
Nepal						1		1		2
Nicaragua					3	3	1			7
Pakistan	1	1			1	1				4
Philippines		4	5	4	9	6		3		31
Poland		1		1	5	1		6		14
Romania						1		4		5
Russia	1				2	5	1			9
Rwanda								1		1
Serbia				1	1	1				3
Slovakia				1	1					2
Tanzania	3					1				4
Thailand		1		2		1		1		5
Tunisia					1			5		6
Turkey		1			1	4	1	3		10
Uganda	4	1	1		1	3	1			11
Ukraine					2					2
Vietnam	1		1		1	1			1	5
Yemen	1					1				2
Total	23	35	36	21	86	74	32	80	15	402

Regular contact is held with former UNU Fellows by sending them the UNU-GTP yearbook and an annual newsletter. The majority of the Fellows keep in contact with the UNU-GTP and each other through correspondence. This has become much easier lately as more than 250 former UNU Fellows (out of 402 graduates) are listed in the e-mail directory of the UNU-GTP. An updated directory is sent out 1-2 times per year to all alumni of the Programme.

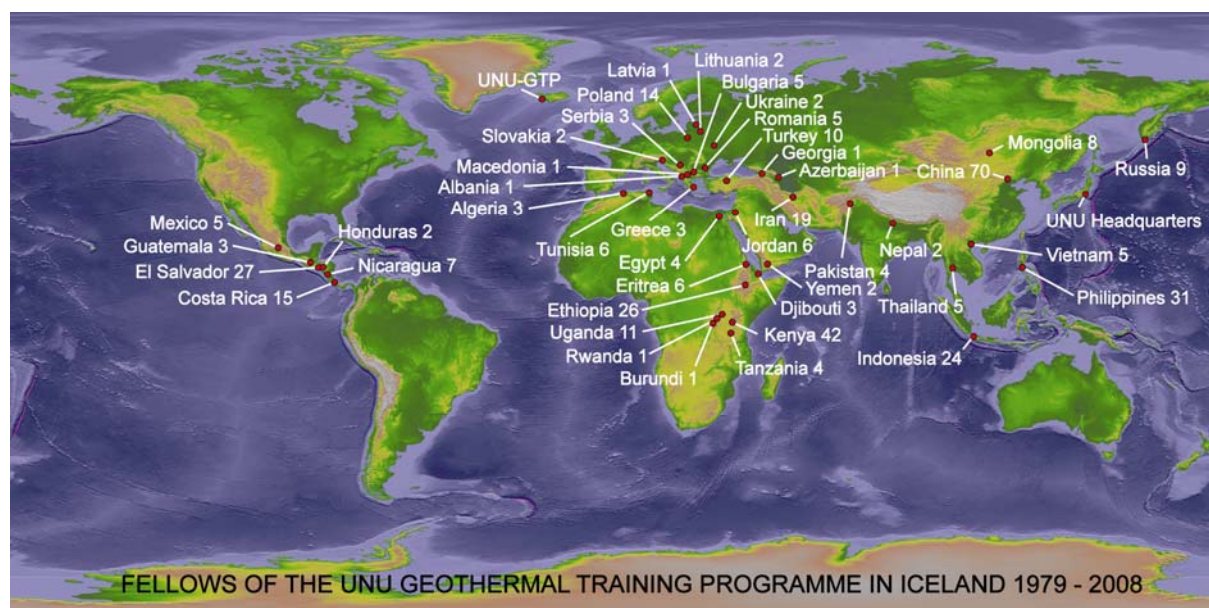


FIGURE 1: Geographical distribution of UNU Fellows completing six month courses 1979-

5. SELECTION OF PARTICIPANTS AND SITE VISITS

Candidates for participation in the specialized training must have a university degree in science or engineering, a minimum of one year practical experience in geothermal work, speak English fluently, be less than 40 years of age, and have a permanent position dealing with geothermal energy at an energy company/utility, research institution, or university in their home country.

Much care is taken in selecting the participants. Site visits are conducted by representatives of the UNU-GTP to the countries requesting training. The potential role of geothermal energy within the energy plans of the respective country is assessed, and an evaluation made of the institutional capacities in the field of geothermal research and utilization. Based on this, the training needs of the country are assessed and recipient institutions selected. The directors of the selected institutions are invited to nominate candidates for training in the specialized fields that are considered most relevant to promote geothermal development in the respective country. All qualified candidates are interviewed personally. Training starts in late April and ends in October each year. Nominations (including the curriculum vitae of the candidates) must be received in Reykjavik before September 1 each year for participation in training starting the following year.

The site visits have played a very significant part in the work and in the success of the UNU-GTP. Since 1979, a total of 172 site visits have been conducted to countries requesting training, or an average of almost 6 site visits per year. The visits have been made by the permanent staff of the UNU-GTP (70%), and members of the Studies Board and other geothermal specialists mostly from Orkustofnun/ISOR. The UNU-GTP Director or the Deputy-Director normally undertakes the first site visit to a given country. In addition to visiting geothermal fields, research institutions, and interviewing candidates, the UNU-GTP representatives commonly participate in local or national/regional geothermal energy conferences/seminars, and in some cases give lectures or lecture series at selected institutions and universities. Indeed, many site visits are planned to coincide with regional conferences and seminars. In some cases, members of the Studies Board and other specialists from ISOR spend a few extra days in a given country/continent to make site visits for the UNU-GTP when they are travelling to conferences or on consultancy missions. In this way, the travel cost can be shared. In connection with the site visits, meetings are held with the UNU-GTP alumni in each country/region as practicable.

The site visits are very valuable for the quality of the training. The private interviews with candidates are aimed to secure the quality of the selected Fellows. During the 30 years of the UNU-GTP, only seven UNU Fellows (out of 409) have been unable to complete the six months of training, mostly for medical reasons. The visits to institutions and geothermal fields aim to tailor the training to the needs of the country and the institutions from which the candidates come. The site visits have, without doubt, contributed very significantly to the successful transfer of technology from Iceland to the recipient countries. A wealth of information and practical experience has been gathered and shared between the various countries participating in the UNU-GTP activities. The site visits have contributed significantly to make the UNU-GTP an international centre of learning.

Participants from developing countries and some CEE countries (not EU members) normally receive scholarships financed by the Government of Iceland and the UNU that cover international travel, tuition fees and per diem in Iceland. The UNDP, the International Atomic Energy Agency (IAEA), the Icelandic International Development Agency (ICEIDA) and other bilateral aid agencies have also financed fellowships for several trainees through the years. With the entrance of some of the CEE countries into the European Union (EU) in 2004, countries previously eligible for UNU Fellowships (Estonia, Latvia, Lithuania, Poland, and Slovakia) are not eligible any more. Qualified participants from industrialized countries (including EU) can be accepted for UNU-GTP training if they have similar scholarships from their own countries.

6. MSc AND PHD PROGRAMME

Since 2000, twenty seven former UNU Fellows (from Djibouti 1, China 1, El Salvador 2, Eritrea 1, Ethiopia 2, Indonesia 3, Iran 3, Jordania 1, Kenya 8, Mongolia 2, Philippines 2, and Uganda 1) have been admitted to an MSc programme in geothermal science and engineering in cooperation with the University of Iceland (UI). Many of our trainees have already completed their MSc or PhD degrees when they come to Iceland, but several excellent students who have only BSc degrees have made requests to come again to Iceland for a higher academic degree. Their six months in the UNU-GTP fulfill 25% of their MSc programme credit requirements. The aim of establishing the MSc programme in cooperation with the UI was to go a step further in assisting selected countries in building up their specialist groups and to increase their geothermal research capacity.

The first UNU Fellow to attend the MSc programme in geothermal engineering was Mr. Muthafar Emeish from Jordan (UNU Fellow 1999). He graduated in 2001. A total of fifteen scientists and engineers have completed their MSc thesis during 2001-2008 (by July 2008). Seven have come from Kenya (graduated in 2002, 2004, 2006, 2007, 2008), two from Iran (2005 and 2008), and one from each of China (2008), Djibouti (2008), Jordan (2001), Mongolia (2005), Philippines (2008), and Uganda (2005). The MSc theses have been published in the UNU-GTP publication series, and can be obtained from the UNU-GTP webpage (www.unugtp.is). All of the MSc Fellows have been on UNU-GTP Fellowships funded by the Government of Iceland.

The first four former UNU Fellows have been admitted to commence PhD studies at the University of Iceland in the academic year 2008-2009. Two are on UNU-GTP Fellowships (both from Kenya) and two (from Djibouti and Iran) are funded by other sources.

7. BUILDING OF SPECIALIST GROUPS AND EVALUATION

The aim of the UNU-GTP is to concentrate its training efforts to assist in building up groups of specialists in the geothermal departments of selected countries with significant geothermal potential. Priority for training is given to candidates from carefully selected institutions from developing countries and Central and Eastern European countries where geothermal exploration and development is already under way. The limiting factor is, in some cases, the availability of sufficiently qualified staff in the recipient institutions. The fact that participants must speak English fluently has, for example, hampered participation from certain parts of the world such as Latin America.

Figure 2 shows the number of Fellows completing the six month specialized training per year during 1979-2008 and the active MSc students per year. The number of Fellows has gradually increased, mostly controlled by available financing. There have always been waiting lists of qualified candidates. In the last few years, 18-22 UNU Fellows have graduated after six month courses each year, but the number of MSc Fellows conducting their studies has risen steadily from 4-5 to 16 in a year.

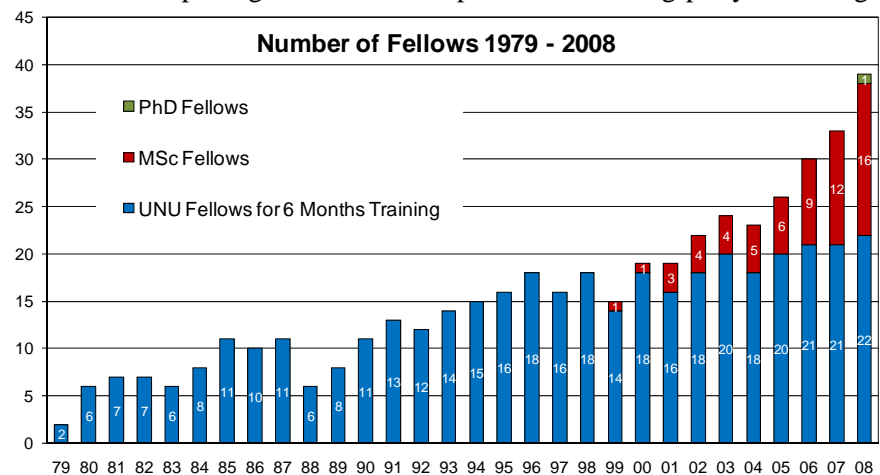


FIGURE 2: Number of UNU Fellows completing six month specialized courses and studying for MSc 1979-2008

Table 3 shows how the leading recipient countries have sent professionals for specialized training in most of the courses offered. Relatively few experts have been trained in geological exploration and drilling technology, as these subjects are generally mastered in the home countries.

TABLE 3: Number of Fellows from the five leading countries and chosen specializations 1979-2008

	China	Kenya	Philippines	El Salvador	Ethiopia
Geological Exploration		1		1	
Borehole Geology	3	4	4	1	3
Geophysical Exploration	1	10	5	2	4
Borehole Geophysics	2		4	2	1
Reservoir Engineering	24	6	9	5	5
Chemistry of Fluids	14	7	6	4	4
Environmental Studies	9	7		3	1
Geothermal Utilization	15	3	3	5	6
Drilling Technology	2	4		4	2
Total	70	42	31	27	26

The UNU-GTP has twice been evaluated as a part of the UNU system. In 1996, a detailed account was given within an assessment report on UNU training and fellowship activities (United Nations University, 1996). In 1998, a brief description was given in a report on the 20-year review and evaluation of the UNU (United Nations University, 1998). Both evaluations were very favourable to the UNU-GTP.

Internal assessment of the training has, in the past, mainly taken the form of interviews with former trainees and their directors during site visits. Meetings are also arranged in connection with international geothermal conferences. Some changes have been made in the detailed contents of some of the specialized courses, based on the feedback from the trainees and their institutions. During the training, questionnaires (anonymous answers) are also used to obtain the opinion of the Fellows on the content of the lectures and the performance of the lecturers. Since 2004, questionnaires have been used to seek the opinion of the Fellows on individual phases of the training and research activities as well as their opinion on the general support and guidance from UNU-GTP staff, working conditions at the UNU-GTP office, the attitude and support of staff of Orkustofnun and ISOR, arrangements of accommodation, and daily allowance.

At the International Geothermal Conference held to celebrate the 25th anniversary of the UNU-GTP, former UNU Fellows presented papers on the contribution of UNU-GTP training to geothermal development in Africa, Asia, Central America, Central and Eastern Europe, and China (Mwangi, 2003; Benito and Reyes, 2003; Barrios, 2003; Kepinska, 2003; Zhao et al., 2003, respectively; the papers can be obtained at www.unugtp.is under *Special Events / 25th Anniversary*). These papers give valuable assessments on the UNU-GTP from the point of view of the respective regions. Similar papers will be given at the 30th Anniversary Workshop in August 2008.

Generally speaking, the effort to have the training tailor-made to the abilities of the individual and the needs of the recipient country/institution seems to have been very successful. The number of fully qualified applicants each year is normally much greater than the number of scholarships available. All the participants are selected after private interviews by UNU-GTP staff, and on the recommendation of the recipient institutions. It is, therefore, not surprising that many of the former trainees have become the leading specialists in their countries in their given fields. Our records indicate that about 80% of all our trainees have continued working in the geothermal sector for five years or more.

In many countries in Africa, Asia, Central America and Central and Eastern Europe, UNU-GTP graduates are among the leading specialists in geothermal research and development. They have been very successful, and have contributed significantly to energy development in their parts of the world.

8. TEACHING MATERIAL

Most of the teaching is done by tutorials and practical work where the teacher works with two or three trainees, and use is made of available textbooks and articles in journals as appropriate. In some instances, however, a special effort has been made to compile text material and manuals as teaching material for the training. Most of this work has been done by the regular teachers of the UNU-GTP. Some texts have also been written by visiting scholars from other countries. Some of the teaching materials has been published in reports, and are available upon request.

One guest lecturer with an international reputation is invited every year as a UNU Visiting Lecturer to give a lecture series and to lead discussions with the trainees. The UNU Visiting Lecturers have stayed from about one week to two months in Reykjavik. Table 4 shows the UNU Visiting Lecturers 1979-2008. Many of the lectures of the UNU Visiting Lecturers have been published by the UNU-GTP, and are listed by author in the publication list of the UNU-GTP (www.unugtp.is). Copies of the publications are available on request.

TABLE 4: UNU Visiting Lecturers 1979-2008

1979	Donald E. White	USA	1994	Ladislaus Rybach	Switzerland
1980	Christopher Armstead	UK	1995	Gudmundur Bodvarsson	USA
1981	Derek H. Freeston	New Zealand	1996	John Lund	USA
1982	Stanley H. Ward	USA	1997	Toshihiro Uchida	Japan
1983	Patrick Browne	New Zealand	1998	Agnes Reyes <i>UNU Fellow 1979</i>	Philippines/ NZ
1984	Enrico Barbier	Italy	1999	Mike Wright	USA
1985	Bernardo Tolentino	Philippines	2000	Trevor Hunt	New Zealand
1986	Russel James	New Zealand	2001	Hilel Legmann	Israel
1987	Robert Harrison	UK	2002	Karsten Pruess	USA
1988	Robert O. Fournier	USA	2003	Beata Kepinska <i>UNU Fellow 1994</i>	Poland
1989	Peter Ottlik	Hungary	2004	Peter Seibt	Germany
1990	Andre Menjoz	France	2005	Martin Mwangi <i>UNU Fellow 1982</i>	Kenya
1991	Wang Ji-yang	P.R. China	2006	Hagen Hole	New Zealand
1992	Patrick Muffler	USA	2007	José Antonio Rodriguez	El Salvador
1993	Zosimo F. Sarmiento <i>UNU Fellow 1980</i>	Philippines	2008	Kun Wang <i>UNU Fellow 1998</i>	P.R. China

9. SHORT COURSES AND UN MILLENNIUM DEVELOPMENT GOALS

The Government of Iceland has secured core funding for the UNU-GTP to expand its capacity building activities by annual short courses/workshops in geothermal development in selected countries in Africa (started in 2005), Central America (started 2006), and in Asia (started in 2008). The announcement on this was made at the International Conference for Renewable Energies held in Bonn (Germany) 1-4 June 2004. This is a contribution of the Government of Iceland towards the Millennium Development Goals of UN.

The courses/workshops are set up in cooperation with the energy agencies/utilities and earth science institutions responsible for the exploration, development and operation of geothermal facilities in the respective countries/regions. A part of the objective of the workshops/short courses is to increase cooperation between specialists in the field of sustainable use of geothermal resources. The courses may in the future develop into sustainable regional geothermal training centres.

The first workshop in Africa (*“Workshop for Decision Makers on Geothermal Projects and their Management”*) was held in Kenya in November 2005 with 35 participants (including lecturers) from Eritrea, Ethiopia, Kenya, Tanzania and Uganda, as well as Iceland and the Philippines. The second event in Africa was held in Kenya in November 2006 (*“Short course on surface exploration for geothermal resources”*). The purpose was to give “a state of the art” overview of the possibilities and status of surface geothermal exploration in East Africa. Twenty three trainees from Djibouti, Eritrea, Ethiopia, Tanzania, Uganda, and 10 from the host country (Kenya) took part in the course. Participation was by invitation only. The lectures and demonstrations were in the hands of four Icelanders (UNU-GTP and ISOR), 12 former UNU Fellows from KenGen and one from each of Eritrea, Ethiopia, and Uganda, as well as a senior official from Djibouti and Tanzania. The third annual event in Africa (*“Short Course II on Surface Exploration for Geothermal Resources”*) was held at Lake Bogoria and Lake Naivasha, Kenya, November 2-17, 2007. The basis of the course was the same as in 2006, but it was extended with additional lectures and a week of field work, which was entirely handled by KenGen staff, while the lecturers from Iceland were involved in the rest of the course. In all, 30 trainees were invited and 25 lecturers took care of the teaching, the majority from Kenya, adding to that 5 Icelanders and one from most of the neighbouring E-African countries. The Workshop in 2005 and the Short Courses in 2006 and 2007 were co-hosted by the UNU-GTP and KenGen.

The first workshop in Central America (*“Workshop for Decision Makers on Geothermal Projects in Central America”*) was held in San Salvador 26 November to 2 December 2006. It was co-hosted by UNU-GTP and LaGeo S.A. de C.V. in El Salvador. The fifty participants came mainly from the four countries of Central America active in geothermal development, i.e. Costa Rica, El Salvador, Guatemala and Nicaragua. Lecturers came from the Central American countries as well as Iceland, Italy, Kenya, Mexico, Philippines and the USA. Among them were 9 former UNU Fellows. The aim of the workshop was to give high level decision makers from the energy and environmental ministries, leading geothermal agencies, and electric utilities in the region an overview of some of the key issues of geothermal development, with a special focus on environmental issues. The second event in Central America (*“Short Course on Geothermal Development in Central America”*) was held in El Salvador in November 2007, and dealt with geothermal development in Central America with special focus on resource assessment and environmental management, including lectures, debates and practical exercises. There were 61 participants, including 45 trainees from Costa Rica, El Salvador, Guatemala, Honduras, Mexico, and Nicaragua. The lecturers/instructors came from Costa Rica, El Salvador, Iceland, Kenya, Nicaragua, and the Philippines. The Workshop and the Short Course were co-hosted by UNU-GTP and LaGeo S.A, de C.V. in El Salvador.

The first event in Asia (*“Workshop for Decision Makers on Direct Use of Geothermal Resources in Asia”*) was held in Tianjin 11-18 May, 2008. High ranking decision makers and leading geothermal experts were invited from the Peoples Republic of China as well as from Asian countries with significant geothermal resources, including plans and markets for space heating (replacement for coal). The criteria for a country to be invited was a) that there is a need for space heating for at least a few months of the year, and b) that there are known geothermal resources near densely populated areas (towns, villages). Participants came from China, India, Iran, Jordan, Mongolia, the Democratic Peoples Republic of Korea, and the Republic of Korea. In addition, lecturers came from Iceland, Germany, Japan, Poland and Switzerland. There were 118 participants on the first day (including speakers). The Workshop was co-hosted by the UNU-GTP, the Tianjin Bureau of Land, Resources and Real Estate Management, and the Tianjin Bureau of Geology and Mineral Exploration and Development.

Reports of the annual Millennium Workshops/Short Courses of the UNU-GTP can be seen on our webpage www.unugtp.is.

10. INTERNATIONAL COOPERATION

One of the roles of the UNU-GTP, according to the Agreement on the Status of Association with the UNU, is to “develop and maintain communication among developing countries and arrange, as necessary and appropriate, conferences, seminars, workshops and panels which would further the dissemination and application of practical knowledge” in geothermal energy. This has been fulfilled partly by direct cooperation with the UNU-GTP alumni and their institutions, and partly through active participation in international geothermal conferences, workshops, and seminars. The UNU-GTP has contributed to the organization of many international meetings such as the *1985 International Symposium on Geothermal Energy* (US Geothermal Resources Council, Hawaii 1985); *UN Workshop on the Development and Exploitation of Geothermal Energy in Developing Countries* (with UN/DTCD in Reykjavik 1986); the *World Geothermal Congress 1995* (International Geothermal Association, Italy 1995); the *World Geothermal Congress 2000* (International Geothermal Association, Japan 2000); and the *World Geothermal Congress 2005* (International Geothermal Association, Turkey 2005).

Former UNU Fellows have also been active with their colleagues in some countries in arranging regional and international conferences/workshops such as the annual *PNOC-EDC Geothermal Conference* in the Philippines; the *European Summer School on Direct Applications of Geothermal Energy* (sponsored by the European Commission and the International Geothermal Association, at Oradea University, Romania 2001); the *International Scientific Conference on Geothermal Energy in Underground Mines* (Poland in 2001); the *2002 International Symposium on Geothermal at the 2008 Olympics in Beijing*; the *KenGen Geothermal Conference* in Kenya 2002, which was expanded in 2003 under the title *2003 Eastern Africa Market Acceleration Conference*, and their follow-up the *African Rift Geothermal Conferences*, with *ARGeo C-1* held in Ethiopia in 2006, and *ARGeo C-2* due to be held in Uganda in late 2008.

The UNU-GTP has been very active within the International Geothermal Association (IGA), with the Director serving as Chairman of the European Branch of IGA 1992-1995, and as IGA President 1995-1998. Many former UNU Fellows are active members in the respective national geothermal associations (e.g. in Costa Rica, El Salvador, Ethiopia, Indonesia, Philippines, Poland, Romania, Slovakia and Turkey) which are affiliated with the IGA, and six (from El Salvador, Ethiopia, Kenya, Poland, Romania and Uganda) are members of the present Board of Directors of IGA.

The most memorable participation of UNU Fellows in the international arena was the World Geothermal Congress 2005 in Turkey (WGC 2005). The Congress is organized every five years by the IGA, this time with the Turkish Geothermal Association as a co-convenor. There were over 1300 participants from 80 countries. The UNU-GTP was very well represented. In all, 141 papers (20% of all papers) were authored or co-authored by 104 former UNU Fellows from 26 developing and transitional countries. The papers were divided between 23 of the 24 technical sessions of the conference. The level of activity of the UNU Fellows in the international geothermal community is well reflected in the fact that a third of the 318 graduates of the UNU-GTP from 1979-2004 were authors of refereed papers at the congress. The papers are accessible on www.unugtp.is.

Seventy seven former UNU Fellows from 25 countries attended the congress in Turkey (Figure 3). Most of them received travel fellowships funded by the UNU-GTP in Iceland and the UNU Centre in Japan. Sixty one UNU Fellows attended the WGC 2000 in Japan (out of 227 graduates at that time) and 35 the WGC 1995 in Italy (out of 161 graduates). The UNU-GTP policy to support the participation of former UNU Fellows in the WGC every five years has made it possible for a large number of professionals from all continents to share their research results and experience with the international geothermal community. Their enthusiasm and hard work gives them the opportunity to keep up with new technical developments as well as the pleasure of meeting friends and colleagues from various parts of the world, reminisce about the past, and plan for the future. These are the pillars of the network of UNU-GTP Fellows worldwide.



FIGURE 3: UNU Fellows with UNU-GTP staff and Studies Board at the WGC 2005 in Turkey; a third of the 318 UNU Fellows graduating 1979-2004 were authors of papers at the congress

Through the years, the Director of the UNU-GTP has frequently been asked to represent geothermal energy in international working groups and at conferences, as the UNU-GTP is the most active UN centre dealing with geothermal energy at present. The most recent example is *the IPCC Scoping Meeting on Renewable Energy Sources* (in Lübeck, Germany, January 2008) where the Director was a keynote speaker and gave a paper entitled “*The possible role and contribution of geothermal energy to the mitigation of climate change*” (Fridleifsson et al., 2008). Similar papers were given on the other renewable energy sources (biomass, hydro, solar, tidal and wind energy). This is one of many expert meetings organized by the IPCC (International Panel on Climate Change) in preparation for the renewal of the Kyoto protocol.

11. UNU-FTP AND OTHER UNU ACTIVITIES IN ICELAND

The UNU Fisheries Training Programme (UNU-FTP) started operating in Iceland in 1998 on the basis of an Agreement on Cooperation between the UNU, the Government of Iceland, and the Marine Research Institute. The training methods and mode of selection of participants is based on the experience of the UNU-GTP. Six specialized courses are offered: Quality Management of Fish Handling and Processing; Fisheries Policy and Planning; Marine and Inland Waters Resources Assessment and Monitoring; Fishing Technology; Management of Fisheries Companies and Marketing; and Aquatic Environmental Assessment and Monitoring. Under the able leadership of Dr. Tumi Tomasson, the Director, the UNU-FTP (www.unuftp.is) has in ten years grown in size similar to the UNU-GTP. A total of 167 Fellows from 30 countries have graduated from during 1998-2008 after six months training. MSc and PhD studies have been taken up in cooperation with the University of Iceland. The UNU-FTP has held a number of short courses in Africa, Asia, and the Caribbean.

A third specialized training programme, the Land Restoration Training Programme (LRTP), is in a three year pilot phase in Iceland (starting in 2007). The new training programme is built on the same concept as the UNU-GTP and the UNU-FTP. A seven week programme was operated in 2007, and the first six Fellows came for six months specialized training in April 2008. Once fully developed, the LRTP may offer six specializations: Land Degradation and Global Environmental Change; Remote Sensing and GIS; Assessment and Monitoring of Degraded Land; Restoration Project Planning and Implementation, Sustainable Land Management; and Capacity Development and Institutional Change. The LRTP is financed by the Icelandic Foreign Ministry. The implementing agencies are the Agricultural University of Iceland and the Icelandic Soil Conservation Service. The preparations are made in close cooperation with the UNU. The programme may become a formal UNU programme after the trial period.

12. FINANCING OF UNU ACTIVITIES IN ICELAND

During 1979-1982, the financing of the UNU-GTP was shared equally by the UNU and the Government of Iceland. Since then, the Government of Iceland has carried the lion's share of the annual financing. Through the years, international agencies such as UNDP, IAEA, and bilateral aid agencies have occasionally financed Fellowships. These have both been for six months and shorter training periods. Fellowships awarded by UNU/Iceland have almost entirely been for six months training. The Government of Iceland has been very supportive of UNU activities in Iceland through the years (Figure 4). The contribution to the UNU-GTP in 2007 was 2.4 million USD and 1.9 million USD to the UNU-FTP.

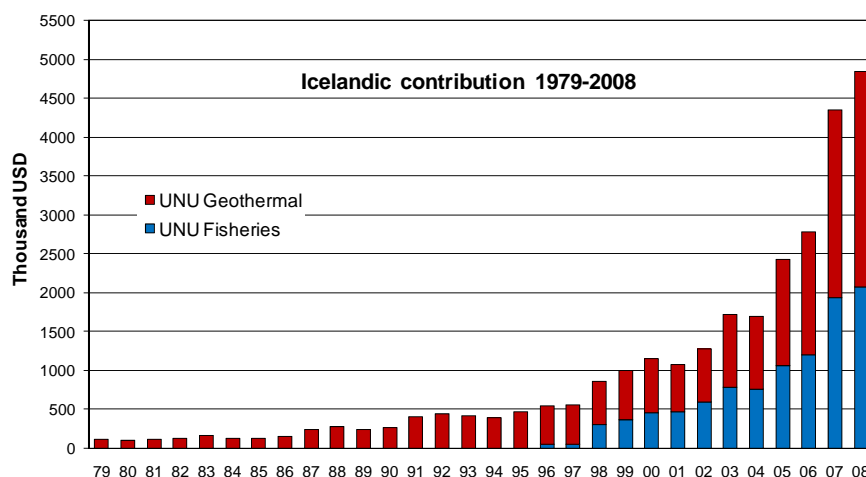


FIGURE 4: Annual contribution of the Government of Iceland to the UNU programmes in Iceland (UNU-GTP and UNU-FTP) in 1979-2008 in thousands USD

The Government of Iceland contributes a higher amount annually to the UNU than any other institution within the UN system. It is no coincidence that the two UNU programmes, UNU-GTP and UNU-FTP, are hosted in Iceland. Both of these specialities are of national importance. The technically highly developed and sustainable use of the fisheries resources, and the renewable energy resources (geothermal and hydropower) have been instrumental in bringing Iceland from the category of developing countries in the early 1960s, to the ranks of the ten countries with the highest BNP/capita since the 1980s. Iceland is willing to share its experience with the developing and transitional countries. The Government considers the UNU a most suitable venue for channelling a considerable part of its multilateral development aid. The feedback from the recipient countries has been very favourable. It is commonly stated in public debate in Iceland that the research and training activities in cooperation with the UNU are the most effective development aid undertaken by Iceland.

13. FUTURE PROSPECTS

Looking back over 30 years of operations certainly gives cause for reflection on whether an international school is on the right track, and where that track should lead in the years to come. The UNU-GTP was established in the shadow of the oil crisis, when many nations were looking for new and renewable energy sources in order to reduce their dependence on hydrocarbons, in particular oil with its rapidly escalating prices. At the beginning of the new century the situation is somewhat similar in that the international community is looking towards the new and renewable energy sources as an alternative for the hydrocarbons (especially coal and oil), not only because of the high fuel prices but also in order to reduce the emissions of greenhouse gases. Thus, there are two very important reasons for increasing the development of renewable energy sources on the global scale.

The total world electricity production from renewables in 2005 was 3,188 TWh. By far the largest contribution (89%) came from hydropower, but 5.7% from biomass, 3.3% from wind, 1.8% from geothermal, and 0.2% from solar energy (WEC, 2007).

Figure 5 shows the fourteen countries with the highest percentage share of geothermal energy in their national electricity production. Special attention is drawn to the fact that El Salvador, Kenya, Philippines, Costa Rica, Nicaragua, and Indonesia are among the top nine countries with 6-22% of their electricity coming from geothermal. This clearly demonstrates how significant geothermal energy can be in the electricity production of countries and regions rich in high-temperature fields which are associated

with volcanic activity. Kenya is the first country in Africa to utilize its rich geothermal resources and will in the foreseeable future be able to produce most of its electricity with hydropower and geothermal energy. Several other countries in the East African Rift Valley may follow suit, and the same applies to countries in Central America. Indonesia is probably the world's richest country in geothermal resources and can in the future replace a considerable part of its fossil fuelled electricity by geothermal energy. The UNU-GTP is very proud of how many UNU Fellows stand behind these impressive figures on electricity production. Many of the leading geothermal experts of El Salvador, Kenya, Philippines, Costa Rica and Indonesia are graduates of the UNU-GTP.

The potential role of geothermal energy is also significant on a global scale in the heating of houses and other direct use applications, thus reducing the dependence on polluting coal and oil. China is on top of the world list on direct use of geothermal energy for heating. A total of 70 UNU Fellows from 14 provinces, cities, and autonomous regions of China have completed the six month specialized training during 1981-2008. Many of the leading geothermal experts of China are graduates of the UNU-GTP (Zhao et al., 2003).

The UNU-GTP will continue to focus on specialized training and capacity building. New countries will be added, but care will be taken not to spread the efforts too thin. After 30 years of operations, experience strongly suggests that to make technology transfer successful and sustainable, it is necessary to build up a group of at least ten geothermal specialists in a given country. In addition, support will continue to former UNU Fellows in different countries/regions through the Internet and by site visits, workshops and seminars.

In the coming five years, about 20 UNU Fellows will be accepted each year for the six month courses in Iceland, 5-6 six former UNU Fellows will be admitted annually for MSc studies and 1-2 for PhD studies in cooperation with the University of Iceland. The series of annual workshops/courses in Africa, Asia, and Central America involve a significant expansion in the activities of the UNU-GTP, which is foreseen to continue. These courses may in the future develop into sustainable regional geothermal training centres. Requests for this have already come from Kenya and China.

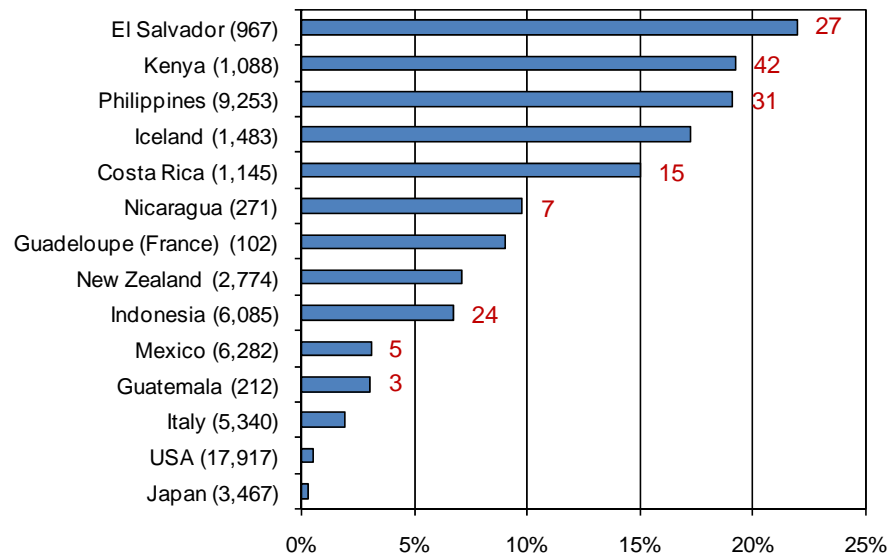


FIGURE 5: The fourteen countries with the highest % share of geothermal energy in their national electricity production (Fridleifsson, 2007). Numbers in parenthesis give the annual geothermal electricity production in GWh in 2004 (Bertani, 2005). The numbers of UNU-GTP graduates in each country are shown at the end of the columns

To meet the requests of the developing countries for expansion of the capacity building and degree oriented research, it will be necessary for the UNU-GTP to strengthen further its ties with the University of Iceland and ISOR, as well as with the geothermal industry. The excellent network of UNU Fellows in over thirty developing and transitional countries is of great value for the promotion and development of geothermal resources in the world. This rather unique network of the United Nations University needs to be nurtured and expanded further. To meet these tasks, the UNU-GTP has to be strengthened as an institution both in Iceland and within the UNU.

REFERENCES

- Barrios Martinez, L.A., 2003: Contribution of UNU-GTP training to geothermal development in Central America-Mexico. *Proceedings of the International Geothermal Conference on Multiple Integrated Uses of Geothermal Resources, Reykjavik, Geothermal Association of Iceland*, S2 11-21.
- Benito, F.A., and Reyes, A.N., 2003: Contribution of UNU-GTP training to geothermal development in Asian countries. *Proceedings of the International Geothermal Conference on Multiple Integrated Uses of Geothermal Resources, Reykjavik, Geothermal Association of Iceland*, S2, 22-31.
- Bertani, R., 2005: World geothermal power generation in the period 2001-2005. *Geothermics*, 34, 651-690.
- Fridleifsson, I.B., 1998: Twenty years of geothermal training in Iceland. *Proceedings of the 20th Anniversary Workshop, UNU-GTP, Reykjavik*, 1-13.
- Fridleifsson, I.B., 2003: Twenty five years of geothermal training in Iceland. *Proceedings of the International Geothermal Conference on Multiple Integrated Uses of Geothermal Resources, Reykjavik, Geothermal Association of Iceland*, P1 4-21.
- Fridleifsson, I.B., 2007: Geothermal energy and the Millennium Development Goals of the United Nations. *Proceedings of the European Geothermal Congress 2007, Unterhaching, Germany*.
- Fridleifsson, I.B., Bertani, R., Huenges, E., Lund, J.W., Ragnarsson, A., and Rybach, L., 2008: The possible role and contribution of geothermal energy to the mitigation of climate change. In: Hohmeyer, O., and Trittin T. (eds.), *Proceedings of the IPCC Scoping Meeting on Renewable Energy Sources, Luebeck, Germany*, 59-80.
- Kepinska, B., 2003: Contribution of UNU-GTP training to geothermal development in Central and Eastern European countries. *Proceedings of the International Geothermal Conference on Multiple Integrated Uses of Geothermal Resources, Reykjavik, Geothermal Association of Iceland*, S2, 40-51.
- Mwangi, M.N., 2003: Contribution of UNU-GTP training to geothermal development in Africa. *Proceedings of the International Geothermal Conference on Multiple Integrated Uses of Geothermal Resources, Reykjavik, Geothermal Association of Iceland*, S2, 1-10.
- United Nations University, 1979: *Training needs in geothermal energy*. United Nations University, Tokyo, report of the Workshop at Laugarvatn, Iceland, July 1978, NRR-3/UNUP-17.
- United Nations University, 1996: *Internal assessment report UNU training and fellowship activities*. United Nations University, November.
- United Nations University, 1998: *Report on the 20-year review and evaluation of the United Nations University*. UNU, report UNU/C/45/L.5, December.
- WEC, 2007: *2007 Survey of Energy Resources*. World Energy Council, 427-437 (available on www.worldenergy.org).
- Zhao, P., Wang, K., and Liu, J., 2003: Contribution of UNU-GTP training to geothermal development in China. *Proceedings of the International Geothermal Conference on Multiple Integrated Uses of Geothermal Resources, Reykjavik, Geothermal Association of Iceland*. S2, 32-39.