

TRANSFER OF GEOTHERMAL TECHNOLOGY AND CAPACITY BUILDING IN ASIA

Ingvar B. Fridleifsson
United Nations University
Geothermal Training Programme
Orkustofnun, National Energy Authority,
Grensasvegur 9
108 Reykjavik
ICELAND
ibf@os.is

ABSTRACT

The main goal of the UNU-GTP is capacity building in the sustainable use of geothermal energy resources. Nine specialized lines of training are offered (www.unugtp.is). The aim is to assist developing and transitional countries with significant geothermal potential to build up groups of specialists that cover most aspects of geothermal exploration and development. Since the foundation of UNU-GTP in 1979, 380 scientists and engineers from 41 countries have completed the annual six month courses. Of these, 44% (165) have come from 10 countries in Asia, 26% from Africa, 16% from Central and Eastern Europe, and 14% from Latin America. All participants are selected by private interviews during site visits to the countries concerned. They are trained in the specialized fields that are considered most relevant to promote geothermal development in the respective country.

The Government of Iceland has secured core funding for the UNU-GTP to expand its capacity building activities by annual workshops/short courses in geothermal development in selected countries in Africa (since 2005), Central America (since 2006), and in Asia (starting in May 2008). This is a contribution of the Government of Iceland towards the Millennium Development Goals of the United Nations. A part of the objective is to increase the cooperation between specialists in the respective countries/regions. The courses may in the future develop into sustainable regional geothermal training centres.

1. INTRODUCTION

The Government of Iceland and the United Nations University (UNU) decided in 1978 to establish the UNU Geothermal Training Programme (UNU-GTP). Orkustofnun (the National Energy Authority of Iceland, NEA) became the host institution of the UNU-GTP. 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 (www.os.is/unugtp/). The aim is to assist developing countries and transitional countries

with significant geothermal potential to build up groups of specialists that cover most aspects of geothermal exploration and sustainable development.

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/her 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 a public energy agency/utility, research institution, or university, and be under 40 years.

During 1979-2007, 380 scientists and engineers from 41 countries have completed the annual six month courses. Of these, 44% have come from countries in Asia, 26% from Africa, 16% from Central and Eastern Europe, and 14% from Latin America. There have been 62 women (16%). Over 80 professionals have received shorter training (2 weeks to 4 months). In 2000, an MSc programme in geothermal science and engineering was started in cooperation with the University of Iceland. Ten have graduated from the MSc programme and eleven are presently pursuing their MSc studies. 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. The UNU-GTP is (since 2003) the only international graduate school offering specialized training in all the main fields of geothermal science and engineering.

The UNU-GTP has four permanent staff members (employed by Orkustofnun), but lecturers and supervisors are hired from ISOR (Iceland GeoSurvey), the University of Iceland, 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 and individualistic training in the nine fields of specialization offered. Teaching and research supervision at the UNU-GTP has in the last few years been carried out by geothermal specialists of ISOR 50-60%, the University of Iceland 20-30%, and specialists at other institutions, energy utilities and consulting engineering offices 20%. The availability of top grade supervisors for the various specialized lines of studies offered is of vital importance to the UNU-GTP operations.

2. SPECIALIZED TRAINING

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, and some practical work) 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 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.

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).

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	Reservoir physics	Chemistry	Physics	Scaling and corrosion	Drilling procedures
8	Structure analysis	Alteration	Magnetics	Reservoir physics	Reservoir simulation	Biology Monitoring	Analytical methods	Heat transfer and fluid flow	Well design
9	Hydrogeology	Mineralogy	Gravity	Tracer tests	Computer programs	Revegetation	Thermodynamics	Control systems	Safety Management
10						Health and safety	Geothermometers		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 Data evaluation	Responses to exploitation	Gas dispersion and abatement	Water rock interaction	Design of plants and systems	Cementing Completion
14									
15									
16	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
17									
18									
19									
20									
21									
22									
23									
24									
25									
26									

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.

Table 2 lists the countries of origin of the participants who have completed the six month training during 1979-2007, and their specialized courses. Figure 1 shows the same on a world map. The largest groups have come from China (65), Kenya (41), Philippines (31), Ethiopia (25), El Salvador (25), and Indonesia (22). Fifteen other countries have sent 5-17 participants.

TABLE 2: Fellows of the UNU Geothermal Training Programme in Iceland 1979-2007

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	22	13	9	13	2	65
Costa Rica	2	2	2		2	2	2	2		14
Djibouti		1			1					2
Egypt		1		1	1	1				4
El Salvador	1	1	2	2	5	4	3	4	3	25
Eritrea	2		2			1				5
Ethiopia		3	4	1	5	3	1	6	2	25
Georgia								1		1
Greece			1					2		3
Guatemala		1			1	1				3
Honduras		1	1							2
Indonesia		5	3		5	1	1	5		22
Iran	1	3	1	1	1	1	3	7	1	19
Jordan	1			1	1	1		1		5
Kenya	1	4	9		6	7	7	3	4	41
Latvia								1		1
Lithuania					1			1		2
Macedonia						1				1
Mexico	1		1		2					4
Mongolia	1		1		1	1		4		8
Nepal						1		1		2
Nicaragua					3	2	1			6
Pakistan	1	1			1	1				4
Philippines		4	5	4	9	6		3		31
Poland				2	5	1		6		14
Romania						1		4		5
Russia	1				2	5	1			9
Serbia				1	1	1				3
Slovakia				1	1					2
Tanzania	2						1			3
Thailand		1		2		1		1		5
Tunisia					1			5		6
Turkey		1			1	4	1	3		10
Uganda	4	1	1		1	3				10
Ukraine					2					2
Vietnam	1		1		1	1			1	5
Total	21	33	35	21	84	68	30	75	13	380

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 some 250 former UNU Fellows (out of 380 graduates) are listed in the e-mail directory of the UNU-GTP. An updated directory is sent out twice per year to all alumni of the Programme.

3. 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 if possible, speak English fluently, be less than 40 years in 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 late October each year. Nominations (including the curriculum vitae of the candidates) must be received in Reykjavik before 1st September each year for participation in training starting the following year.

4. M.SC. PROGRAMME

Since 2000, 21 former UNU Fellows have been admitted to MSc studies in geothermal science and engineering in cooperation with the University of Iceland (UI). Several 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 fulfil 25% of their MSc programme credit requirements. The aim of establishing the MSc programme in cooperation with the UI is to go a step further in assisting selected countries in building up their specialist groups.

A total of 10 scientists and engineers have graduated with MSc during 2001-2007. Six have come from Kenya, and one from each of Iran, Jordan, Mongolia, and Uganda. The MSc theses have been published in the UNU-GTP publication series, and can be obtained from the UNU-GTP home page (www.unugtp.is).

There are eleven UNU Fellows in the MSc programme in the spring term of 2008. They come from China (1), Djibouti (1), El Salvador (1), Ethiopia (1), Indonesia (2), Iran (2), Kenya (1), Mongolia (1), and the Philippines (1). Six additional UNU MSc Fellows are expected in September 2008. In 2008 the UNU-GTP will for the first time grant Fellowships for PhD studies, also in cooperation with the University of Iceland.

5. BUILDING OF SPECIALIST GROUPS

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 Asia and Latin America.

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. As mentioned before, 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 after their training in Iceland.

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

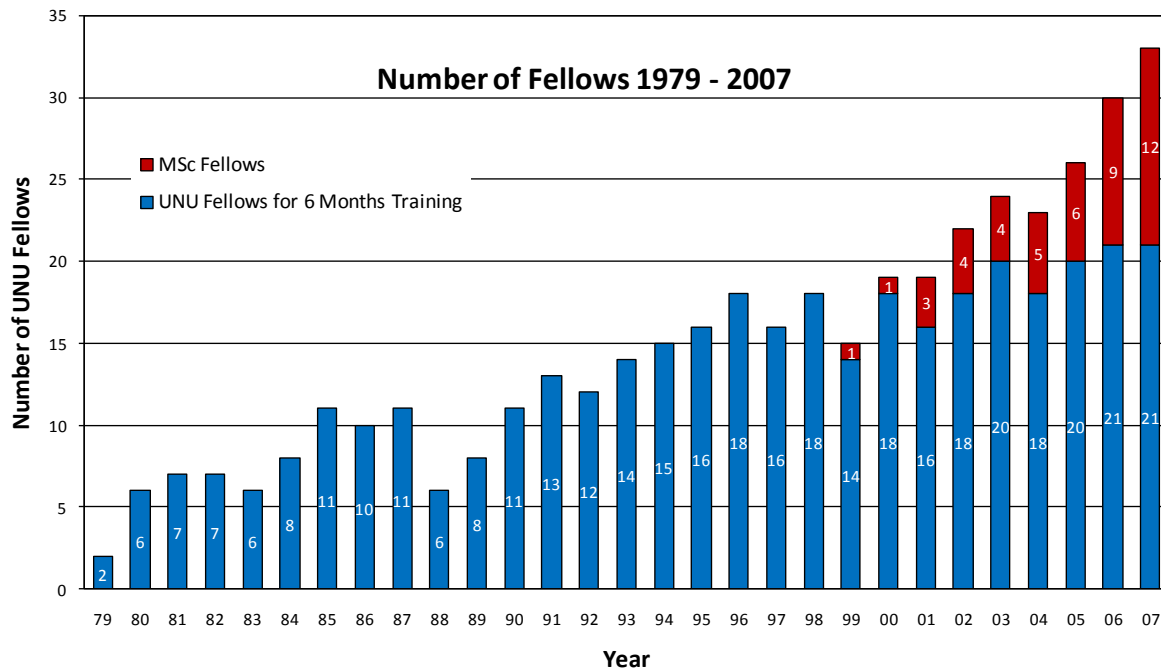


FIGURE 2: Number of Fellows completing six month courses and studying for MSc in 1979-2007

Figure 2 shows the number of Fellows completing the six month specialized training per year during 1979-2007 and the MSc students. 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, there have been 18-21 Fellows graduating after six month courses per year and 2-3 MSc Fellows. The latter number is expected to rise to 5-6 per year from 2008.

5. CAPACITY BUILDING IN ASIA

A total of 165 geoscientists and engineers from 10 Asian countries have completed the 6 months specialized training. The number of graduates from each country and their specializations can be seen in Table 2. Table 3 shows the top five countries in Asia with the largest number of graduates: China (65), Philippines (31), Indonesia (22), Iran (19), and Mongolia (8).

TABLE 3: Number of UNU Fellows from top five Asian countries and specializations 1979-2007

	China	Indonesia	Iran	Mongolia	Philippines
Geological Exploration			1	1	
Borehole Geology	3	5	3		4
Geophysical Exploration	1	3	1	1	5
Borehole Geophysics	2	2	1		4
Reservoir Engineering	22	5	1	1	9
Chemistry of Fluids	13	1	1	1	6
Environmental Studies	9	1	3		
Geothermal Utilization	13	5	7	4	3
Drilling Technology	2		1		
Total	65	22	19	8	31

The UNU Fellows from China have come from 14 provinces, cities, and autonomous regions (Figure 3). Most of the graduates from China are working in research and development of low-temperature fields for direct heating applications. They have mainly been trained in reservoir engineering (22), chemistry (13), geothermal utilization (13), and environmental studies (9). The largest groups have come from Beijing and Tianjin. The Chinese Fellows are playing a very important role in the geothermal development in the country. Many of the former UNU Fellows have become leading experts in their specialities in different parts of China, and several have become well known in the international geothermal community (Zhao et al., 2003). The first Chinese MSc Fellow is expected to complete her studies in 2008.



FIGURE 3: UNU Fellows in China 1980-2007 have come from 15 provinces, cities and autonomous regions

The UNU Fellows from the Philippines and Indonesia have all been trained in the research and development of high-temperature fields for electricity generation. The Philippines have mostly come from PNOC, the main power producer in the Philippines, but also several from the Department of Energy. The Philippines are the second country in the world in geothermal electricity production and many of the UNU Fellows have contributed significantly to that, and have become the leaders of their specialities or reached top management positions both within PNOC and the Ministry of Energy. The first Filipino MSc Fellow is expected to get his degree in 2008.

The Indonesians have mostly come from Pertamina, the state company for oil and power development. Several of the UNU Fellows have reached high positions within Pertamina, in exploration but especially in development and production. The geothermal branch of Pertamina is now run as a separate daughter company, Pertamina Geothermal. Two Indonesians are now pursuing MSc studies in Iceland.

The UNU Fellows from Iran have been trained in all nine specialized fields offered by the UNU-GTP. The first ones came from NRI, the Electric Power and Research Centre, but the majority has come from SUNA, Renewable Energy Organization of Iran under the Ministry of Energy, which now holds the main responsibility for geothermal research in Iran on behalf of the Ministry of Energy. They have mostly been working in geothermal research and development for electricity production, but also

in the co-generation of electricity and direct use for heating applications. The first Iranian to complete his MSc studies in Iceland graduated in 2005, and two are expected to complete in 2008.

The UNU Fellows from Mongolia have come from the National Renewable Energy Center, or associated institutions. They have focussed both on the development of the low-temperature resources available in Mongolia and their exploration, and are now leading the work in getting Mongolia on the geothermal map. The first Mongolian to complete MSc studies in Iceland graduated in 2005, and one is currently pursuing his MSc studies.

6. PARTICIPATION IN WORLD GEOTHERMAL CONGRESS

The International Geothermal Association organizes the World Geothermal Congress every five years. The third such congress was held in Turkey in April 2005 (WGC 2005) with over 1300 participants from 80 countries. The UNU-GTP in Iceland was very well represented at the WGC 2005. 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 the home page (www.unugtp.is).



FIGURE 4: 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.

Seventy seven former UNU Fellows from 25 countries attended the congress in Turkey (Figure 4). Most of them received travel fellowships funded by the UNU-GTP in Iceland and the UNU Centre in Japan. Sixty one 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.

7. GEOTHERMAL WORKSHOPS AS CONTRIBUTION TO UN MILLENNIUM GOALS

The Government of Iceland has secured core funding for the UNU-GTP to expand 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 (starting in 2008). The announcement on this was made at the International Conference for Renewable Energies held in Bonn (Germany) in June 2004. This is a contribution of the Government of Iceland towards the Millennium Development Goals of the United Nations.

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 energy power stations and utilities in the respective countries/regions. A part of the objective of the workshops/short courses is to increase the cooperation between specialists in the respective countries in the field of sustainable use of geothermal resources. The courses may in the future develop into sustainable regional geothermal training centres.



FIGURE 5: Participants in the UNU-GTP short course in E-Africa in 2007

The first workshop in Africa (entitled “Workshop for Decision Makers on Geothermal Projects and their Management”) was held in Kenya in November 2005 with participants from Eritrea, Ethiopia, Kenya, Tanzania and Uganda. In 2006 and 2007, short courses covering surface exploration of geothermal resources were given over a time period of 2-3 weeks, with participants coming from up to 11 countries (Figure 5), mainly in East Africa. UNU-GTP has cooperated with the Kenyan Electricity Generating Authority (KenGen), in these courses. The lectures have been given by a few professionals from Iceland and several former UNU Fellows in the region, mainly from Kenya. The UNU-GTP has 100 graduates in 10 African countries.

The first workshop in Central America (“Workshop for Decision Makers on Geothermal Projects in Central America”) was held in El Salvador in November 2006. It was co-hosted by UNU-GTP and LaGeo S.A de C.V. in El Salvador. The participants came mainly from the four countries of Central America active in geothermal development, i.e. Costa Rica, El Salvador, Guatemala and Nicaragua. The aim of the workshop was to give high level decision makers from the respective 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 Central American event entitled “Short Course on Geothermal Development in Central America - Resource Assessments and Environmental Management” was held in El Salvador in November 2007. The participants came from Costa Rica, El Salvador, Guatemala, Honduras, Mexico, and Nicaragua. The lecturers came from Costa Rica, El Salvador, Iceland, Kenya, Nicaragua, and the Philippines. The UNU-GTP has 54 graduates in six Latin American countries.

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

8. WORKSHOPS AND COURSES IN ASIA

The first UNU-GTP workshop in Asia will be the “Workshop for Decision Makers on Direct Use of Geothermal Resources in Asia” held in Tianjin 11-18 May 2008. High ranking decision makers and leading geothermal experts from China will be invited as well as from those Asian countries which have significant geothermal resources, plans and markets for space heating (replacement for coal). The criteria for a country to be invited is 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). Amongst these countries are India, Iran, Jordan, Mongolia, the Democratic People’s Republic of Korea, and the Republic of Korea. There will also be lecturers from Iceland, Japan, Germany, Poland and Switzerland. The Workshop is organized in cooperation with the Ministry of Land and Resources and the Municipality of Tianjin. The executing agencies are the United Nations University Geothermal Training Programme in Iceland (UNU-GTP), the Tianjin Bureau of Land Resources and Real Estate Management (TBLRREM), and the Tianjin Bureau of Geology and Minerals Exploration and Development (TBGMED).

About 1 million people in the Tianjin region (out of 11 million) live in houses heated by geothermal water, and many others enjoy hot tap water (heated by geothermal) in their apartments. Many of the key geothermal specialists there were trained in Iceland. The geothermal water replaces coal as a heat source. China is presently at the top of the world list on direct use of geothermal resources. China can make a significant contribution to the mitigation of climate change by making full and sustainable use of its widespread geothermal resources. We are grateful to the Chinese authorities for co-hosting the Workshop and their willingness to share their expertise with their neighbour countries and the international community.

It is expected that the Workshop in Tianjin will be followed by annual courses in China in specific aspects of the direct utilization of geothermal for space heating, bathing and other purposes. The UNU-GTP and the Tianjin Bureau of Geology and Minerals Exploration and Development (TBGMED) signed a Letter of Agreement in 2006 on discussing preliminary plans prepared by the TBGMED for establishing a geothermal sub-centre of the UNU-GTP in Tianjin. The training needs are considered to be at two levels: a) Training of professionals with university degrees; and b) Training of technicians and operators of district heating systems.

Preliminary discussions were conducted in Tianjin in February 2007. One possibility is to establish initially a training centre in Tianjin which would organize courses for operators of geothermal district heating systems. The courses would include lectures on reservoir engineering, monitoring of

production fields, environmental monitoring, as well as the design criteria for geothermal district heating systems. Specialized training would be given in the operation of down-hole pumps, production fields, reinjection fields, pumping stations, distribution systems etc. The courses would initially be designed for operators of the growing number of geothermal district heating systems in China. But participants might also be accepted from other Asian countries. The courses would probably mostly be given in Chinese, but they might also be held in English depending on the growth of geothermal district heating systems and other direct use of geothermal energy in the neighbouring countries of China.

Preliminary discussions have also been held with Pertamina in Indonesia to organize Workshops and Short Courses for the Asian countries in the exploration and development of high-temperature geothermal fields for electricity production. The Philippines and Indonesia are in the second and fourth place respectively on the world list of countries producing electricity in geothermal fields.

The UNU-GTP has 165 graduates in 10 Asian countries.

9. FUTURE PLANS OF THE UNU-GTP

In the coming five years, the core activity of the UNU-GTP will continue to be specialized training in Iceland. About 20 UNU Fellows will be accepted per year for the six month courses, and about six former UNU Fellows will be admitted annually for MSc studies (18-24 months). PhD studies will start in cooperation with the University of Iceland in 2008 with 1-2 Fellowships per year. The series of annual workshops/courses in Africa, Asia, and Central America involve a significant expansion in the activities of the UNU-GTP.

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 the UNU Fisheries Training Programme (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.

REFERENCES

Barrios M., L.A., 2003: Contribution of UNU-GTP training to geothermal development in Central America – Mexico. Proceedings of the International Geothermal Conference IGC-2003 on Multiple Integrated Uses of Geothermal Resources, Reykjavik, Iceland. Session 2, p. 11-21. www.unugtp.is

Benito, F.A. and Reyes, A.N., 2003: Contribution of UNU-GTP training to geothermal development in Asian countries. S02/22-31. Proceedings of the International Geothermal Conference IGC-2003 on Multiple Integrated Uses of Geothermal Resources, Reykjavik, Iceland. Session 2, p. 22-31. www.unugtp.is.

Kepinska, B, 2003: Contribution of UNU-GTP training to geothermal development in Central and Eastern European countries. Proceedings of the International Geothermal Conference IGC-2003 on Multiple Integrated Uses of Geothermal Resources, Reykjavik, Iceland. Session 2, p. 40-51. www.unugtp.is.

Mwangi, M.N., 2003: Contribution of UNU-GTP training to geothermal development in Africa. Proceedings of the International Geothermal Conference IGC-2003 on Multiple Integrated Uses of Geothermal Resources, Reykjavik, Iceland. Session 2, p. 1-10. www.unugtp.is.

Zhao Ping, Wang Kun and Liu Jiurong, 2003: Contribution of UNU-GTP training to geothermal development in China. Proceedings of the International Geothermal Conference IGC-2003 on Multiple Integrated Uses of Geothermal Resources, Reykjavik, Iceland. Session 2, p. 32-39. www.unugtp.is.