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**UNU-GTP**

Geothermal Training Programme

Orkustofnun, Grensasvegi 9,  
IS-108 Reykjavik, Iceland

40<sup>th</sup> Anniversary Workshop  
April 26 2018

## **FORTY YEARS OF GEOTHERMAL TRAINING IN ICELAND – HISTORY, STATUS AND FUTURE DIRECTION**

**Lúdvík S. Georgsson**

United Nations University Geothermal Training Programme  
Orkustofnun, Grensásvegi 9  
IS-107 Reykjavík  
ICELAND  
*lsg@os.is*

### **ABSTRACT**

United Nations University Geothermal Training Programme (UNU-GTP) in Iceland specializes in capacity building in geothermal exploration and development for professionals from countries or regions often referred to as developing countries. This is achieved through hands-on training, post-graduate academic studies in Iceland, and through short courses, workshops and training in the relevant countries. From its start in 1979, the annual 6-month training in Iceland has been at the core of UNU-GTP's operations. During the period 1979-2017, 670 UNU Fellows have completed the 6-month training. From 1999, UNU-GTP has also provided Fellowships for academic studies in Iceland in cooperation with University of Iceland and later also Reykjavik University. Presently, 5 new MSc Fellowships and 1 new PhD Fellowship are awarded annually. To date, 57 have completed an MSc degree, and 2 have defended their PhD thesis on a UNU-GTP Fellowship. Four more are currently carrying out their PhD studies. Most of the UNU Fellowships for training or studies in Iceland have been financed by the Icelandic Government, while some have been sponsored through international support, or by local companies.

The UN Millennium Short Course Series for E-Africa, held annually in Kenya in 2005-2015, and for Central America, later extended to Latin America and the Caribbean, held almost annually in El Salvador in 2006-2015, are a different aspect of UNU-GTP's capacity building activities, bringing the training to the developing countries. UNU-GTP has worked closely with the national energy companies, in Kenya with KenGen and GDC, and in El Salvador with LaGeo. In 2016, the series were reorganized to focus on the UN Sustainable Development Goals. More than 1100 participants have benefitted from these series in 2005-2017. In addition, UNU-GTP has also been able to offer customer-designed training and courses in line with the needs of clients, which have support of local or external financial mechanisms. This has become an important part of the operations of UNU-GTP in recent years, with 40 events, extending from 2 days up to 6 months.

Despite strong efforts over the years, the need for geothermal capacity building is as high as ever, with UNU-GTP trying to answer that need. Additional efforts include becoming an active partner in running the 5-month Diploma Course given in Spanish in El Salvador from 2016 in cooperation with LaGeo. Furthermore, UNU-GTP has actively supported the formal establishment of the African Geothermal Center of Excellence (AGCE) in Kenya, which is now in an interim phase under the guidance of UNEP in Nairobi.

## 1. INTRODUCTION

United Nations University (UNU) dates back to 1973, when its charter was adopted by the UN General Assembly, and Tokyo was selected as the site for its operations, which started in September 1975. From the start, Iceland supported the idea of establishing UNU and even considered it a good venue, where Iceland could come in with support to developing nations. The first official statement on establishing a UNU geothermal institute in Iceland under the UNU umbrella was made by Ambassador Ingvi S. Ingvarsson at the Fourth Session of the UN Committee on Natural Resources in March 1975. After a visit by UNU Vice Rector Walter Manshard and Dr. James M. Harrison to Iceland in June 1976 for discussions, and visits of potential hosting institutions, it was proposed that a geothermal training centre should be established and that it should be hosted at Orkustofnun – National Energy Authority of Iceland (OS), due to its access to a large number of geothermal scientists and engineers, and excellent laboratory facilities, drill rigs and logging equipment (Fridleifsson, 1998).

The proposal to UNU to establish a Geothermal Training Programme in Iceland was adopted by the Government of Iceland in March 1978, and submitted to UNU in Tokyo. UNU organised an international workshop at Laugarvatn in Iceland in July 1978 to determine the need for a programme like this and to avoid duplicating already existing programmes (in Italy, Japan and New Zealand). The workshop was attended by representatives of four UN agencies and many geothermal specialists from different countries with good geothermal potential. The conclusion of the workshop read: “*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 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).

In October 1978, the Government of Iceland decided to ask Orkustofnun to sign an *Agreement on Association* with the UNU. Soon after, it was decided that Dr. Ingvar Birgir Fridleifsson would become the first Director of the programme. The *Agreement between the United Nations University and the National Energy Authority of the Republic of Iceland on the Status of Association* was signed in Tokyo on 27<sup>th</sup> December 1978, and in Reykjavik on 13<sup>th</sup> February 1979, to enter into force on 1<sup>st</sup> March 1979. The first two UNU Fellows, who came from the Philippines, arrived in Iceland in May 1979 (Fridleifsson, 2008). Including the 40<sup>th</sup> annual session in 2018, which started on 17<sup>th</sup> April 2018, 694 scientists and engineers from 61 countries are expected to have completed the 6-month training at the end of 2018. This paper describes the activities of UNU-GTP through its 40 years of operation, as it looks towards a near future, which may see some changes in its international attachment.

## 2. INSTITUTIONAL BACKGROUND AND ORGANIZATION

UNU-GTP ([www.unugtp.is](http://www.unugtp.is)) has from the start of its activities been operated at Orkustofnun ([www.os.is](http://www.os.is)). Orkustofnun (OS) used to be the main governmental institution in exploration associated with geothermal development and utilization, and is now under the Ministry of Tourism, Industry and Innovation. From 2003, this function was taken over by the newly formed ÍSOR - Iceland GeoSurvey ([www.isor.is](http://www.isor.is)), while the main responsibilities of Orkustofnun have become advise to the Government of Iceland on energy related topics. With both OS and ÍSOR located in Orkugardur – Energy House, the geoscientific geothermal experts of ÍSOR (many of whom are former staff members of OS) have continued to support UNU-GTP, with the latter hiring the expertise it needs from ÍSOR. Thus, close cooperation of UNU-GTP with geothermal research has continued, along with the integration of the UNU Fellows with the specialists of ÍSOR. The UNU Fellows have full access to the research facilities and the multidisciplinary research environment of ÍSOR (and OS), which is amongst the leading geothermal energy research institutions in the world.

UNU-GTP also has a close cooperation with University of Iceland (UI) and Reykjavík University (RU). Staff members of the geoscientific and engineering departments of the two universities have been amongst key lecturers and supervisors of UNU Fellows since the establishment of UNU-GTP. Furthermore, a co-operation agreement was signed in 2000 between UNU-GTP and 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 (30 ECTS units). The agreement was later extended to PhD studies. A similar cooperation agreement was signed with RU in 2013.

UNU-GTP has five permanent staff members (employed by Orkustofnun), but lecturers, supervisors and support staff are hired on short-term contracts from ÍSOR, UI, RU, and other geothermal and engineering agencies/companies. Every year, about 100 staff members of these institutions render services to UNU-GTP. This makes it possible to provide highly specialized training in the eight lines of specialization offered. Dr Ingvar Birgir Fridleifsson was the founding Director of UNU-GTP, and until 2013 he served as Director, except for four training sessions, in 1981 when Dr Hjalti Franzson deputized for him, and in 1986-1988 when his deputy was Dr Jón Steinar Gudmundsson. Mr Lúdvík S. Georgsson became the Deputy Director of the UNU-GTP in 1990, and in Mid-2013, he took over as Director and holds the position to date. Other current staff members are Mr Ingimar G. Haraldsson, Deputy Director since 2013, Ms Thórhildur Ísberg, School Manager, Mrs Málfríður Ómarsdóttir Environmental Scientist, and Mr Markús A.G. Wilde, Service Manager.

Since 2015, the UNU-GTP is governed by a Board, with Dr Gudni Jóhannesson, Director General of Orkustofnun as its chairman. Other board members are Mrs María Erla Marelsdóttir, Director General of Directorate for International Development Cooperation, representing the Ministry for Foreign Affairs, Dr Jakob Rhyner, Vice Rector of UNU for Europe, representing UNU, and Mr Lúdvík S. Georgsson, Director of UNU-GTP, ex officio. The Board of UNU-GTP has met two times a year since it was established.

The UNU-GTP is academically governed by a Studies Board, which is composed of high level geothermal experts responsible for each of the specialized lines of study which have been on offer in the 6-month training in recent years. The Director of UNU-GTP is the chairman of the Studies Board. Other current members of the Studies Board are Ms. Anette Kaergaard Mortensen (Landsvirkjun) in Geothermal Geology, Dr. Hjalti Franzson (ÍSOR) in Borehole Geology, Mr. Gylfi Páll Hersir (ÍSOR) in Geophysical Exploration, Mr. Benedikt Steingrímsson (ÍSOR) in Borehole Geophysics, Ms. Saeunn Halldórsdóttir (ÍSOR) in Reservoir Engineering, Mr. Finnbogi Óskarsson (ÍSOR) in Chemistry of Thermal Fluids, Prof. Brynhildur Davídsdóttir (UI) in Environmental Sciences, Dr. Páll Valdimarsson (pvald ehf.) in Geothermal Utilization, Mr. Kristinn Ingason (Mannvit) in Drilling Technology, and Prof. Helgi Thór Ingason (RU) in Project Management and Finances. The Studies Board meets 3-4 times a year. It sets the academic standards for the training and designs training schedules for the different study lines and each UNU Fellow. The generous work of the members of the Studies Board through the years is gratefully acknowledged.

### **3. MAIN OPERATIONS OF UNU-GTP**

#### **3.1 Introduction**

The hallmark of UNU-GTP has been to give university graduates engaged in geothermal work intensive training in their chosen fields of specialization, with the UNU Fellows working under the guidance of geothermal professionals in Iceland. The training is to some extent tailor-made for the individual and the needs of his institution/country. All participants are selected by private interviews. During site visits to the developing countries UNU-GTP representatives visit geothermal fields, research institutions and energy utilities. Fellows are selected for training in the specialized fields which are considered most relevant to promote geothermal development in their respective country.

During 1979-2017, 670 scientists and engineers from 60 countries completed the six-month course, or its equivalent. Of these, 39% have come from Africa, 35% from Asia, 14% from Latin America and the Caribbean (LAC), 11% from Europe and 1% from Oceania. During this period, 149 women have completed the programme, or 22% of the participants. Gender equality is an important part of UNU-GTP strategic policy, and, in recent years, female participation has grown consistently.

UNU-GTP also offers UNU Fellows the possibility of extending their studies to pursue MSc or PhD degrees in geothermal sciences or engineering in cooperation with University of Iceland and Reykjavik University. The MSc programme was started in 1999 in cooperation with University of Iceland, and the PhD programme in late 2008. A similar cooperation agreement with Reykjavik University was signed in 2013, with the first MSc Fellow at RU starting in August 2014. In January 2018, 57 MSc Fellows had completed their degree, with 10 pursuing their studies, 5 of whom are expected to complete their studies in Mid-2018, while 5 new ones are expected to start with the autumn academic term of 2018. The first PhD Fellows defended their theses in 2013 and 2016 at UI, both women from Kenya dealing with environmental and social effects of geothermal development. Currently (spring 2018), 4 are pursuing their studies at UI, with the fifth expected to start his studies in the autumn, the first to do so on UNU-GTP PhD Fellowship at RU.

Figure 1 shows the development of the UNU-GTP training activities in Iceland from the start of the 6-month training in 1979, including the academic studies.

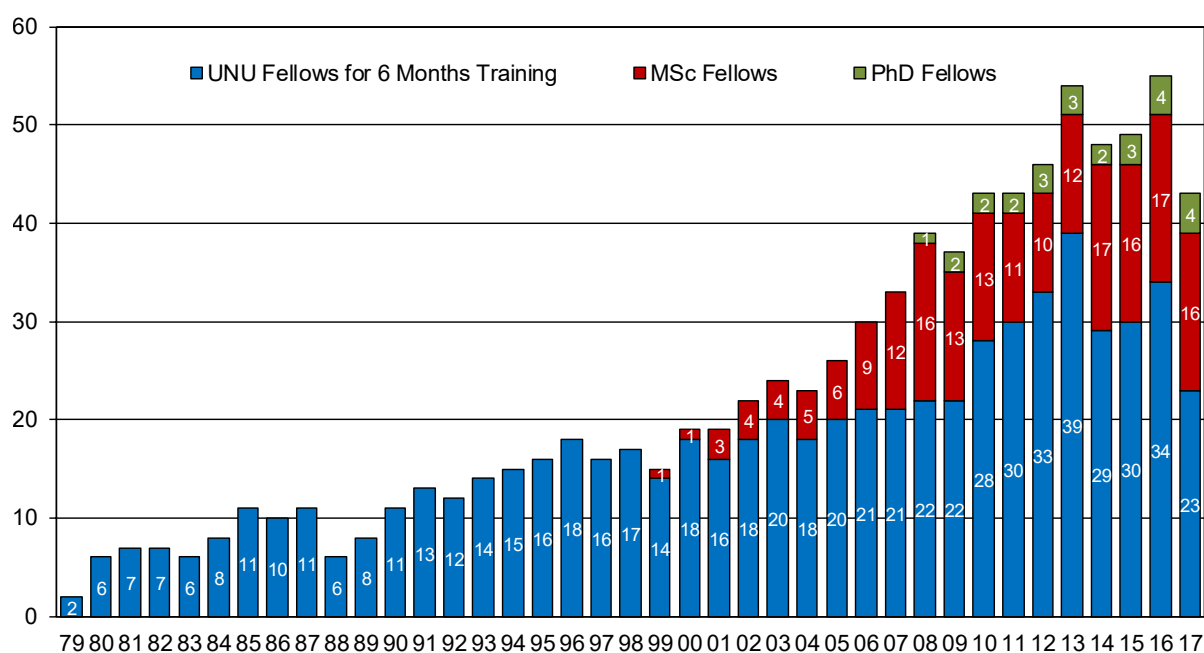


FIGURE 1: Number of UNU Fellows in 1979-2017

The UN Millennium Short Course Series, and their later continuation through the UN Sustainable Development Goals Short Course Series, for East Africa – held in Kenya, and the LAC region – held in El Salvador, have been a special contribution of the Government of Iceland to the Development Goals of the United Nations. With it the training was brought to the developing part of the world. A part of the objective was also to increase the cooperation between specialists in neighbouring countries in sustainable use of geothermal resources. About 200 scientists/engineers and decision makers participated in the 3 one-week workshops, which started the series, and about 1150 scientists/engineers have now been trained at the annual Short Courses, which have extended for 1-3½ weeks. Many former UNU Fellows are lecturers and co-organizers of the UNU-GTP Workshops and Short Courses.

During the last few years, the need for geothermal training has been well beyond what UNU-GTP is

able to fulfil and service through its regular financing from the Official Development Assistance of the Government of Iceland. Therefore, UNU-GTP has taken its training activities one step further by offering courses or training fulfilling specific needs of a paying customer. The content of these events has varied significantly, based on the needs of the respective client, including regular short courses and hands-on training, with a time frame varying from a few days to several months for individual events. This need has also seen additional UNU Fellowships funded by partner countries/institutions, either directly or through international or bilateral agencies.

### 3.2 6-month training in Iceland

### 3.2.1 Basic organization

The organization of the 6-month training goes back to the establishment of the programme. Then it was decided to offer the training in eight different study lines in geoscience and engineering, with the addition of a ninth study line in environmental science in 1997. This setup remained until 2015. The training is divided into 4 main phases. All participants attend the introductory lecture course (6 weeks, usually with three lectures in the morning and practical work in the afternoon) which aims at giving background knowledge on most aspects of geothermal energy resources and technology, and to generate an appreciation for the interrelationship between the various disciplines necessary to develop geothermal projects, from the initial exploration to the stages of implementation and utilization. Participants take two written tests during the course. The introductory course is followed by lectures and practical training in the respective specialized fields (6 weeks), in some cases with a test at the end. The most important part is though the execution of an individual research project with supervision from experts in the project topics (10-12 weeks) which is concluded with an extensive research project report. In addition, excursions are arranged to many main geothermal fields under exploration and utilization in Iceland with seminars held and case histories studied on each field (2 weeks in total). Training usually starts in late April and ends in October each year.

In 2014, UNU-GTP set into motion a revision of its activities. Four of the nine study lines on offer were combined into 2, and a new study line added, with the 6-month training thus reorganized into 8 different lines, run for the first time in the present format in 2015. Furthermore, a group-project assignment was added into the study schedule parallel with introductory lectures, where the Fellows work together as a team with real data from geothermal systems. This is done to train them in the various fields of geothermal sciences and engineering. Thus, the UNU Fellows participate in lectures and excursions through the first half of the programme and work on individual projects and research in their chosen field of expertise for the second half of the programme as shown in Table 1. By offering these different study lines, UNU-GTP has been able to create a sound basis for geothermal capacity knowledge in its partner countries. The programme itself, as well as its close connection to research fields of geothermal energy, will continue to be an essential contribution to geothermal research worldwide, not least through the research projects of the UNU Fellows. Each participant is meant to follow only one line of training, but within each line there is some flexibility. A further description can be found on the UNU-GTP website ([www.unugtp.is](http://www.unugtp.is)), but the current lines of specialized training are the following:

TABLE 1: Time schedule and basic content of the 6-month training in Iceland

Group Project Work	WEEK	Geothermal Geology	Geophysical Exploration	Reservoir Eng. & Borehole Geoph.	Chemistry of Thermal Fluids	Environmental Science	Geothermal Utilization	Drilling Technology	Project Managm. and Finances
	1	Introductory Lecture Course and Group Project Work							
	2								
	3								
	4								
	5								
	6	Specialized Training: Lectures, Practicals, Visits and Excursions							
	7								
	8								
	9								
	10								
	11	Main Excursion							
	12	Specialized Training cont.							
	13								
	14								
	15	Individual Project and Report Writing							
	...								

- *Geothermal Geology* where practical training is given both in basic geological and geothermal mapping, and in borehole geology through geological logging, and analyses of drill cuttings and cores. The identification of alteration minerals (microscope and x-ray diffraction) and the interpretation of the alteration mineralogy forms an integral part of the course. Participants should have a degree in geology.
- *Geophysical Exploration* is practical training in conducting geophysical surveys of geothermal areas and interpretation of the data. The emphasis is on resistivity measurements, but insight also given into thermal, magnetic, gravity and seismic methods. Participants should have a degree in geophysics, physics, mathematics or engineering.
- *Reservoir Engineering and Borehole Geophysics* covers the essentials of geophysical measurements in boreholes used for geothermal investigations, with an emphasis on temperature and pressure measurements, and the methodology needed to obtain information on the hydrological characteristics of geothermal reservoirs, including reservoir physics, well and reservoir modelling, resource assessment and monitoring responses. Participants should have a degree in engineering, physics, geophysics, mathematics or hydrogeology.
- *Chemistry of Thermal Fluids* gives an insight into the role of thermal fluid chemistry in geothermal exploration and exploitation, including sampling, analysis of major constituents, thermodynamics, water-rock interaction and interpretation of results and monitoring responses. Participants should have a degree in chemistry, geochemistry or chemical engineering.
- *Environmental Science* covers Environmental Impact Assessments (EIA), laws and policies, the planning and execution of EIA projects and environmental auditing. Scientific methods suitable for environmental monitoring are assessed and ecological impact, pollution, mitigation measures, and occupational safety considered. Participants should have a degree in science or engineering.
- *Geothermal Utilization* deals with thermal design of power plants and systems, power plant components, control systems, and corrosion and scaling. Direct utilization is also given due scope with a good overview of its possibilities as indicated by the L ndal Diagram, and scientific modelling of utilization systems. Participants should have a degree in engineering.
- *Drilling Technology* provides engineers with the information and on-site training necessary to prepare them for the work of drilling engineers or supervisors. The course deals with the selection of drilling equipment, well design, casing programmes, cementing techniques, cleaning and repairs of production wells. Participants should have a degree in mechanical or civil engineering.
- *Project Management and Finances* is a new line of study since 2015 with the aim to strengthen the management side of geothermal projects, which has often been underestimated, not least in developing countries. An overview is given of project management as a scientific discipline, and some financial tools to assist in this introduced with emphasis on geothermal aspects. The participants have the chance to be licensed as international Project Managers (through IPMA – International Project Management Association). Participants should have a degree in engineering or in economics.

A significant part of the practical training is done in connection with the research projects of the Fellows. The project topic is always selected with respect to the conditions of the home country of the participant. Whenever possible, the participants bring with them data from geothermal projects in their home countries to use as a basis for the project. In 2017, 19 out of 23 projects dealt, at least partially, with geothermal areas/subjects related to the home countries of the Fellows. All project reports have been published by UNU-GTP. Since 1994, the reports have been published in the annual book *Geothermal training in Iceland* (international publishing code ISBN 978-9979-68). The books are mailed to universities, libraries and leading geothermal research institutions in over 50 countries, and to some former UNU Fellows. Copies can be obtained upon request. All research reports from 1979 to 2017 are also available at the UNU-GTP website ([www.unugtp.is](http://www.unugtp.is)).

Table 2 lists the countries of origin of the participants who have completed the 6-month training during 1979-2017, and the specialized courses they have attended. The largest groups of Fellows have come from Kenya (124), China (87), Ethiopia (41), El Salvador and Philippines (40), Indonesia (32) and Iran (25). Nine other countries have sent 10-20 participants. Kenya overtook China as the leading recipient country in 2013. Regular contact has been held with former UNU Fellows by sending them an informal annual newsletter. The majority of the Fellows keep in contact with UNU-GTP and each other through e-mail correspondence, or through Facebook or other social/multimedia platforms.

TABLE 2: Fellows of UNU Geothermal Training Programme 1979-2017

Country	Geothermal geology <sup>1</sup>	Geophysical exploration	Reservoir engineering & borehole geophysics <sup>2</sup>	Chemistry of therm. fluids	Environmen. Studies <sup>3</sup>	Geothermal utilization	Drilling technology	Project managem. & finances <sup>4</sup>	Total
Albania						2			2
Algeria	1	1		1		1			4
Azerbaijan					1				1
Bangladesh	1	1	2	1					5
Bolivia			1	1			1		3
Bulgaria			3	2					5
Burundi	1					1			2
China	3	1	39	16	10	16	2		87
Comoros		2							2
Costa Rica	4	3	2	3	2	4			18
Djibouti	4	1	4	3	1	2	2		17
Dominica				1					1
D.R. Congo	1								1
Ecuador	1		1			1			3
Egypt	1		2	1					4
El Salvador	3	2	7	9	5	10	4		40
Eritrea	2	2	1	2					7
Ethiopia	6	7	9	6	1	8	3	1	41
Georgia						1			1
Greece		1				2			3
Guatemala	1		1	1					3
Honduras	1	1				1			3
Hungary		1	2			2		1	6
India						3			3
Indonesia	5	3	10	1	3	9	1		32
Iran	5	1	3	2	4	9	1		25
Jordan	1		2	2		1			6
Kenya	24	16	14	18	12	15	21	4	124
Latvia						1			1
Lithuania			1			1			2
Macedonia				1					1
Malawi	1			1		2			4
Mexico	1		5			1			8
Mongolia	1	2	1	2		5	1		12
Morocco		1							1
Nepal				1		1			2
Nicaragua	1		5	5	2				13
Pakistan	2		1	1					4
Papua N.G.	2	1	1		1				5
Philippines	4	7	19	6		4			40
Poland	1		6	1		6			14
Portugal	1		1			1	1		4
Romania	1		1	1		4	1	1	9
Russia	1		2	5	1				9
Rwanda	2	2	2	1	2	2	1		12
Serbia			2	1					3
Slovakia			2						2
Sri Lanka	1	2	1						4
St.Kitts & Nevis			1			1			2
St.Vinc. & Gre.			1						1
Sudan						1			1
Tanzania	6	1	1	3	2	1		1	15
Thailand	1		2	1		1			5
Tunisia			1			5			6
Turkey	1		1	4	1	3			10
Uganda	7	3	1	5	1				17
Ukraine			2						2
Vietnam	2	1	1	2			1		7
Yemen	3			1					4
Zambia						1			1
<b>Total</b>	<b>104</b>	<b>64</b>	<b>164</b>	<b>112</b>	<b>49</b>	<b>129</b>	<b>40</b>	<b>8</b>	<b>670</b>

<sup>1</sup> Geological Exploration and Borehole Geology combined into Geothermal Geology from 2015

<sup>2</sup> Reservoir Engineering and Borehole Geophysics combined into one line from 2015

<sup>3</sup> Environmental Sciences opened in 1997

<sup>4</sup> Project Management & Finances opened in 2015

One guest lecturer with a strong international reputation is invited every year as a UNU Visiting Lecturer to give a lecture series and to lead discussions with the UNU Fellows. Usually he lectures for 1-2 weeks in Reykjavik. Table 3 lists the UNU Visiting Lecturers since 2000. Papers related to many of the lectures of the UNU Visiting Lecturers have been published and are available on request in printed format, or open-file at the UNU-GTP website ([www.unugtp.is](http://www.unugtp.is)) under Publications.



TABLE 3: UNU Visiting Lecturers 2000-2017

2000	Trevor Hunt	New Zealand	2009	Wilfred Elders	USA
2001	Hilel Legman	Israel	2010	Roland N. Horne	USA
2002	Karsten Pruess	USA	2011	Ernst Huenges	Germany
2003	Beata Kepinska <i>UNU Fellow 1994</i>	Poland	2012	Cornel O. Ofwona <i>UNU Fellow 1996</i>	Kenya
2004	Peter Seibt	Germany	2013	Kevin Brown	New Zealand
2005	Martin Mwangi <i>UNU Fellow 1982</i>	Kenya	2014	Malcolm Grant	New Zealand
2006	Hagen Hole	New Zealand	2015	Meseret Teklemariam <i>UNU F. 1984</i>	Ethiopia
2007	José Antonio Rodriguez	El Salvador	2016	James Koenig	USA
2008	Wang Kun <i>UNU Fellow 1998</i>	China	2017	Juliet Newson	New Zealand

The 2013 and 2016 groups of 34 UNU Fellows in Iceland are the largest to date (Figure 2 shows the 2016 group). In 2012-2013, a breakthrough was also reached when UNU-GTP was for the first time able to give a similar training as the 6-month training in a partner country, with 5 borehole geologists from KenGen being trained on site in Kenya through customer sponsored training. Consequently, they were given the same status as the 6-month UNU Fellows in Iceland, meaning that in all 39 trainees completed this kind of training in 2013.



FIGURE 2: The 2016 UNU Fellows in Iceland – one of the two largest group to date with 34 participants

### 3.2.2 Selection of UNU Fellows and site visits

Generally, candidates for participation in the 6-month training in Iceland must have a university degree in science or engineering and speak English fluently. Furthermore, they should have a minimum of one-year's practical experience in geothermal work, be less than 40 years of age, and have a permanent position dealing with geothermal energy at a non-private energy company/utility, research institution, or university in their home country. Much care is taken in selecting the participants. The traditional selection procedure is through site visits, which are conducted by representatives of 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 which are considered relevant to promote geothermal development in the respective country. All qualified candidates are interviewed personally by UNU-GTP staff members or other representatives of the programme.

The site visits have played a very significant part in the work and the success of UNU-GTP. Since 1979,



a total of about 220 site visits have been conducted to countries requesting training, or an average of almost 6 site visits per year. Most of the visits have been made by permanent staff members of UNU-GTP (75%), but others by members of the Studies Board and other geothermal specialists mostly from ÍSOR/Orkustofnun. The Director or the Deputy-Director of UNU-GTP normally undertake the first site visit to a given country. In addition to visiting geothermal fields, research institutions, and interviewing candidates, UNU-GTP representatives sometimes participate in local or national/regional geothermal energy conferences/seminars. Indeed, many site visits have been planned to coincide with regional conferences and seminars. In other cases, members of the Studies Board or other specialists, contracted by UNU-GTP, spend a few extra days in a given country to make site visits for UNU-GTP when they are travelling to conferences or on consultancy missions. In this way, the travel costs can be shared. In connection with the site visits, meetings are held with UNU-GTP alumni in each country/region as practicable to learn about their status and progress at work.

In recent years, the Millennium Short Course Series, and since 2016 the SDGs Short Courses in East Africa and Central America (see Section 3.4), have increasingly served as venues for selection of candidates for the more advanced training in Iceland. The courses enable the participants to show their ability and strength and thus they may get an opportunity for an interview, which consequently opens for the possibility to be selected for the training in Iceland. Thus, the Short Course Series have reduced considerably the need for conventional site visits to developing countries. In a few cases, computer telephone interviews have also been used.

The interviews are very valuable for the quality of the candidates selected for training in Iceland. A good indicator of this is that during the 39 years of the 6-month training in Iceland, only eight invited UNU Fellows have not been able to complete the six months of training. These exceptions have in most cases been due to medical reasons. This can be compared to the 670 individuals who have completed the 6-month training. Site 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 significantly to the successful sharing and transfer of specialized knowledge from Iceland to developing countries.

Most participants from developing countries receive Fellowships financed by the Government of Iceland which cover international travel, tuition fees and per diem in Iceland. In earlier years, UNU also contributed to this. In recent years the need for training has grown beyond what UNU-GTP has been able to service through its regular finances. Due to that about a third of the Fellowships in 2010-2018 have been funded by partner countries/institutions of UNU-GTP, either directly or through international or bilateral agencies, as can also be seen from the considerably bigger groups of UNU Fellows in this period. This even includes qualified participants from EU countries, such as Portugal, Hungary and Romania, who have been funded through the European Free Trade Association (EFTA), usually referred to as EEA-funds.

### 3.2.3 Evaluation

The number of UNU Fellows has gradually increased (Figure 1), mainly controlled by available financing from the Government of Iceland, which in the early 2000s was on-average sufficient to cover the costs of about 20 annual UNU Fellowships, with perhaps 1-2 additional UNU Fellowships funded through other financial mechanisms. A significant change was seen in 2010-2017 with an increased number of UNU Fellowships funded through other financial mechanisms, allowing the number of available UNU Fellowships to grow to 30 on average for this period. It is a clear recognition of the quality of the training offered at UNU-GTP, when institutions/companies in countries like Kenya and the Philippines are ready to finance UNU Fellowships in Iceland.

UNU-GTP was evaluated twice as a part of the UNU system – in 1996, when a detailed account was given within an assessment report on UNU training and Fellowship activities and in 1998, when a brief description was given in a report on the 20-year review and evaluation of the UNU. Both evaluations were favourable to UNU-GTP.

Internal assessments of the training have, in the past, mainly taken the form of interviews with former trainees and their directors during site visits or 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, anonymous questionnaires are also used to obtain the Fellows' opinion on the content of the lectures and the performance of the lecturers. Opinions on the individual phases of the training and research activities, as well as on the general support and guidance from UNU-GTP staff, working conditions at the UNU-GTP office, the attitude and support of the staff of Orkustofnun and ÍSOR, arrangements of accommodation, daily allowance, etc. are also requested. Finally, anniversary workshops have been used to evaluate the contribution of UNU-GTP in their partner countries, through papers presented by former UNU Fellows, with a very positive response.

In 2017, the four UNU sister programmes in Iceland (UNU-GTP, UNU-FTP, UNU-LRT and UNU-GEST) went through a very detailed and comprehensive evaluation process, carried out by the Swedish firm *Nirás indevelop*, which specializes in such evaluations, at the request of the Ministry for Foreign Affairs and with the support of UNU. The evaluation was commissioned to enhance accountability and learning, based on an assessment of the processes and achievements of the four programmes. Among the results the following can as an example be quoted from the executive summary: *The UNU programmes in Iceland provide training that is of high quality. Theory, professional skills training and project work are combined, which gives fellows a unique edge. Overall the four programmes have managed to achieve a relevant balance between theory and practice that maximises the usefulness of the programmes to the fellows. Moreover, the programmes take advantage from the Icelandic context and have catered to the practical and social needs of the fellows in a way that fellows have described as welcoming, caring and generally, very efficient.* With regards to cost efficiency it says: *...the cost comparison with other capacity development efforts in developed countries shows that the cost per fellow and day of the UNU Iceland programmes is at a reasonable and generally competitive level* (Nirás indevelop, 2017).

Additional quotes could be taken, but in general it must be said that the results were positive for the four programmes. At the end of the report recommendations are made on possible improvement and enhancement for the programmes to keep their strong status.

Generally speaking, the effort to have the training tailor-made to the abilities of the individual and the needs of the recipient country/institution have been successful. The number of fully qualified applicants each year is normally greater than the number of scholarships available. Our records indicate that 80% of all our trainees have continued working in the geothermal sector for five years or more, and for most of them working in geothermal, or at least in renewable energy development, becomes the career of a lifetime. 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.

### 3.3 Academic studies in Iceland

The aim of establishing an MSc programme in cooperation with UI and RU was to go further in assisting our partner countries to strengthen their specialist groups and increase their geothermal research capacity. The 6-month training at UNU-GTP fulfils 25% of the MSc programme credit requirements (30 of 120 ECTS units) at UI and RU. Since 2001, 57 UNU Fellows have completed an MSc degree in geothermal science or engineering (end of January 2018) through the UNU-GTP MSc programme, in cooperation with the UI and RU. The MSc graduates come from Bolivia 1, China 2, Costa Rica 1, Djibouti 1, El Salvador 6, Eritrea 2, Ethiopia 3, Indonesia 4, Iran 3, Jordan 1, Kenya 21, Malawi 2, Mongolia 1, Nicaragua 1, Philippines 2, Rwanda 2, Tanzania 2, Uganda 1, and Yemen 1. All of the MSc Fellows have received UNU-GTP Fellowships funded by the Government of Iceland, but 3 Fellowships have been co-sponsored by the home-country. Now, in April 2018, 10 additional former UNU Fellows are pursuing their MSc studies in Iceland, with 5 of them due to complete in the coming few months,

while 5 new ones are expected to start in July/August. All MSc theses have been published in the UNU-GTP publication series, and can be obtained from the UNU-GTP website ([www.unugtp.is](http://www.unugtp.is)).

In addition, seven former UNU Fellows, all but one coming from Africa, have been admitted to the PhD programme at UI and RU on UNU-GTP Fellowships, with the first two starting in the academic year 2008-2009. On February 15, 2013 a milestone was reached when the first of these defended her dissertation, with the second defending her dissertation in 2016. Both come from Kenya. Currently, four are pursuing their PhD studies, with one new due in September 2018.

### 3.4 The UN Millennium and SDGs Short Course Series

The *UN Millennium Short Course Series* in 2005-2015, succeeded in 2016 by the *UN SDGs Short Course Series*, were a very important addition to the activities of UNU-GTP, allowing it to bring considerable part of the training to our important partner regions in East Africa and Latin America, in cooperation with local energy institutions/companies (Fridleifsson, 2004; Georgsson et al., 2015a and 2015b). The original series saw annual workshop / short courses held in Kenya from 2005 to 2015, and for Central America – later extended to Latin America and the Caribbean Islands (LAC) – in El Salvador, from 2006 to 2015. A lot of material presented and papers written for these events were published on CDs and is also available on the website of UNU-GTP ([www.unugtp.is](http://www.unugtp.is)).

In line with the new goals set forward by UN through the *SDGs*, new series of annual short courses were introduced in late 2016, to be held in Kenya and El Salvador, replacing the old series, and taking their inspiration from the *UN Sustainable Development Goals*. To date, two events have been run within both series. In Africa, 678 participants have had the opportunity to attend events of these two series since their start in 2005, and a similar number for Latin America is now 546 participants.

With the Short Courses UNU-GTP has been able to reach a far larger number of geoscientists and engineers in East Africa than through its conventional training in Iceland, and, thus, it has been possible to spread geothermal knowledge to a wider region and audience, and contribute to potential geothermal development in new countries. The Short Courses have also been an important element in catalysing increased cooperation between the countries in East Africa. A detailed description of the *UN Millennium Short Course Series* and of the succeeding *UN SDGs Short Course Series* is given in another paper and presentation for this 40<sup>th</sup> Anniversary Workshop (Haraldsson, 2018).

### 3.5 Sponsored customer-designed short courses and training activities

The possibility for customer-designed short courses or training offered to partner countries was opened in 2010. This service was triggered by the urgent need for training in countries planning fast-tracking of geothermal development, while it has also been an offspring of the regular training, and the Millennium Short Course Series and the material prepared there. This has proven a good opportunity for some countries/institutions in need of a rapid capacity building process, which have themselves the strength or the support of external sources (e.g. multilateral or bilateral aid agencies) to finance such events. The paying customer defines the outline of the Short Course, while UNU-GTP is responsible for the quality of the contents. In 2010-2017, 40 different events have been given for various customers, with 21 of these held in Africa. Further information on these events is also given in Haraldsson (2018).

### 3.6 IGA and the World Geothermal Congress

UNU-GTP has been quite active within the International Geothermal Association (IGA). The former Director served as the IGA President 1995-1998, and the present Director has served on the Board of Directors since 2013. Many former UNU Fellows are also active members in the respective national geothermal associations (e.g. in China, Costa Rica, El Salvador, Ethiopia, Indonesia, Kenya, Philippines, Poland, Romania and Turkey) which are affiliated with the IGA, and some of them have served as members of the Board of Directors of IGA.

Participation of UNU Fellows in the international World Geothermal Congresses, held by IGA every

fifth year, has always been important. The event in 2015 in Melbourne, Australia was certainly important in this regard. With about 1500 participants in total, UNU-GTP was well represented. In all, 260 papers (about 20% of all papers) were authored or co-authored by 180 former UNU Fellows. Of these 96 attended the congress (Figure 3), representing about 16.5% of the 583 graduates of UNU-GTP in 1979-2014. Many of these received travel Fellowships funded by UNU-GTP in Iceland. This can be compared with the 2010 congress in Bali in Indonesia, which 114 former UNU Fellows attended, 77 who attended the congress in Turkey in 2005, 61 the congress in Japan in 2000 and 35 the congress in Italy in 1995. WGC2020 will be held in Iceland. UNU-GTP hopes to see higher numbers of former UNU Fellows there, when the former UNU Fellows have the chance to come back “home” to Iceland.



FIGURE 3: Former UNU Fellows, UNU-GTP staff and teachers attending WGC2015 in Melbourne

UNU-GTP’s 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, as well as having the pleasure of meeting friends and colleagues from various parts of the world.

#### 4. FINANCIAL BASIS

The primary source of funding for UNU-GTP has come from the budget of the Icelandic Government – Ministry for Foreign Affairs (MFA) and is classified as Official Development Assistance (ODA). It must be stated that the four UNU programmes in Iceland have generally had a very strong support from the Icelandic Government, which has identified UNU as a key implementing agency in its development cooperation agenda. Annual contributions from the MFA used to be close to 200 M ISK – influenced to some extent by a fluctuating exchange rate of the Icelandic krona (ISK), especially in the times of the financial crisis of 2008. Last few years have seen annual contributions of 215-235 M ISK with an increase to 246 M ISK in 2018.

Prior to 2010, only minor additional funding came from other sources, such as UNDP and IAEA or bilateral agencies (ICEIDA) financing a few UNU Fellowships through the years. The last 8 years have, however, seen quite a big change in the financial spectre of UNU-GTP, which has to some extent counteracted the effect of the financial crisis in Iceland. Foreign funding has come in, not only through the customer designed short courses and training (Section 3.5), but also with an increasing number of UNU Fellowships for 6-month training financed by partner countries often with assistance from multilateral or bilateral aid agencies. In total, about 30-40% of the finances of UNU-GTP in 2011-2016 have come from these sources, on average about 140 M ISK annually. This has been very positive for UNU-GTP as well as its partner institutions in Iceland, from which teachers and supervisors have been contracted, in a difficult period for the geothermal industry in Iceland when local geothermal projects were scarce.

It is though important to underline the importance of the contribution from the Icelandic Government, which is the basis for conventional operations of UNU-GTP, through which it can meet the requests of partner nations for capacity building in geothermal energy development.

## 5. GENDER EQUALITY

Gender equality and gender related issues are today a key element in Icelandic foreign policy and for the United Nations. Gender equality is also an important part of the *UN Sustainable Development Goals*. In line with its Strategic Plan for 2016-2019, UNU-GTP actively promotes Gender Equality, by a gender balanced candidate selection, cooperating with UNU-GEST on special gender and energy lectures, as well as aiming for a gender balance of lecturers in its programmes. The disadvantage is that energy related research and development is still quite male dominated, not least in the developing part of the world. Hence, the supply of female candidates is sometimes limited. This is well reflected in our statistics, as through the 40 years of 6-month training at UNU-GTP in Iceland, only 22% of the UNU Fellows have been women. The ratio is though improving and has grown to 31% for the 2010s and 37% in the last 3 years. This is a trend we expect to see continuing in the coming years. The aim of UNU-GTP is clear, it will continue to increase the share of women selected for training, studies, and teaching, with the ultimate goal to reach full gender equality in our activities as soon as possible in support of SDG 5: *Achieve gender equality and empower all women and girls*.

## 6. THE UNU-GTP WEBSITE

Open publication has always been the motto of UNU-GTP, which is in line with the general policies of the United Nations University, supporting free access to scientific material for developing nations. The reports of the UNU Fellows in Iceland have been distributed free of charge to geothermal institutions worldwide, and the same applies to publications of study material. With the general internet use, since the early 2000s, the reports have also been published in a pdf-version on the UNU-GTP website. Older reports have also been made available there. The same applies to the UNU-GTP Workshops and Short Courses, and the UNU-GTP Anniversary Publications. Papers written for these events and published in books and/or on CDs, are also all available in openly accessible publication on our website ([www.unugtp.is](http://www.unugtp.is)).

It is safe to say that with all the material now accessible on the UNU-GTP website, UNU-GTP has created one of the largest open databases in the world on geothermal exploration, development and utilization. This is easy to verify by searching for material on geothermal on the internet, through one of the large search machines, as material published by UNU-GTP will inevitably get high view scores. It is therefore interesting to look at some statistics. Table 4 shows the most viewed publications in 2016 and the number of views. The Millennium Short Course Series are obviously attracting much attention as papers presented there are in 5 of the 6 top seats. The number of views can also be considered very high for such specialized literature.

TABLE 4: Most viewed online publications of UNU-GTP for the year 2016

No.	No. views	Title and author of publication	Publication year and type/event
1	427,176	<i>Piping design: the fundam.</i> , by J.L. Henriquez and L. Aguirre	2011 – ES SCIII
2	275,680	<i>Directional well design ...</i> , by Farah Omar Farah	2013 – Report 27
3	168,247	<i>Intro. to types and classif. of rocks</i> by Geoffrey Mibei	2014 – K SCIX
4	127,189	<i>Environmental impact assessment, gen. proc.</i> , by P.F.A. Ogola	2007 – K SCII
5	139,293	<i>Biodiversity conservation</i> , by Thecla Mutia	2009 – K SCIV
6	117,159	<i>Gravity and magnetic methods</i> , by José Rivas	2009 – ES SCII

## **7. SUPPORT TO GEOTHERMAL TRAINING CENTRES IN DEVELOPING COUNTRIES**

### **7.1 The Geothermal Diploma Course in El Salvador for the LAC region**

Since the start of the UN Millennium Workshops/Short Courses in 2005/6, the long term aim is for the courses to develop into sustainable regional geothermal training centres. A Specialized Geothermal Diploma Course in geothermal energy was run in El Salvador in 2010 and 2012 with Italian support, and through cooperation with LaGeo S.A. de C.V., the main local geothermal company, and University of El Salvador (UES) (Caprai et al., 2012). At the request of the Nordic Development Fund (NDF) partnering with the Inter-American Development Bank (IDB), UNU-GTP, following a mission and a thorough review, produced a report with recommendations for improvements and a possible future direction of the diploma course (Haraldsson et al., 2013). These recommendations were largely taken into account for a continued implementation of the Diploma Course, with NDF and IDB securing the financial basis for the period 2013-2015 (de Velis, 2014). During this period, UNU-GTP took part in the Academic Committee of the programme and made annual evaluations and recommendations for improvement.

The financial situation changed again in 2016, with NDF continuing to finance the Diploma Course, but now with the ICIDA department of the Icelandic Ministry for Foreign Affairs (MFA) as a partner. At the same time, UNU-GTP assumed a direct role in the management of the programme, in cooperation with the local partners, LaGeo and UES, with a cooperation agreement signed in April 2016. As a result, the UN SDGs Short Course Series in El Salvador also became an integral part of the Diploma Course, and additionally, 2-3 experts from Iceland also came in as guest lecturers to strengthen its lecture part.

The Geothermal Diploma Course in El Salvador offers new possibilities for aspiring geothermal experts in Latin America, as the program is conducted in Spanish and in a cultural environment that in many respects is similar to that of the participants' home countries. Fellowships, covering all basic costs, have been awarded to participants from the Latin American Region, which means that about a third of the participants are foreigners while the rest is Salvadorians. In 2016-2018, 20 full Fellowships have been awarded each year – 10 of which were intended for participants outside El Salvador. With 10 additional participants financed independently, this has meant annual participation of 30 Spanish speaking geothermal students. The courses, which have lasted 4-5 months, are rather general in scope and have not offered specializations in a particular geothermal discipline, except through the 4-6 week long project work. The success of the Diploma Course programme through the years has rested on the strong expertise found within LaGeo, the state-owned geothermal exploration and electricity generation company in El Salvador. The strong ties between UNU-GTP and LaGeo have further served to increase its quality and success. A 5-year additional agreement is now being discussed.

### **7.2 African Centre of Excellence for geothermal capacity building**

The increased emphasis on development of geothermal resources, currently experienced in East Africa, and especially in Kenya in association with the goals set forward in Vision Kenya 2030 (e.g., Simiyu, 2010; Omenda and Mangi, 2016), has created a high demand on the current capacity building activities on offer by various training institutions, such as UNU-GTP in Iceland, Auckland University in New Zealand, US Power Africa / USAID, JICA of Japan, and local universities, leading to challenges to be able meet these needs. To keep the momentum of development going and meet this demand, it is urgent to take the local training to a new level. For some time, it has been discussed that the next step should be the establishment of a Regional Geothermal Training Centre for East Africa, located in Kenya. UNU-GTP has voiced its support for this.

In early 2014, GDC received the support of the Kenyan Government for establishing a centre of excellence in geothermal capacity building. The African Union also emphasized its support for such a centre in collaboration with regional and international stakeholders. The same can be said about UNU-GTP, and several other stakeholders. The question has been about the finances; can they be covered in a sustainable way? NDF and MFA/ICEIDA have expressed a will to support, but the scheduled costs are important, and they are not clear yet. UNU-GTP has also expressed its will to be a part of this project



and has suggested that the UN SDGs Short Courses can be become an integral part of the set-up, e.g. taking over the role of the Introductory Course on Geothermal Science and Technology. But for that to be implemented, an agreement on this must be reached with both KenGen and GDC, as both companies are important partners here, and the curriculum needs to be reviewed to agree with the Introductory Course. Finally, it would be important to have the cooperation of a major Kenyan University to strengthen the academic background.

For various reasons, the African Geothermal Center of Excellence has taken longer time to materialize than expected. But now it seems to be heading towards a realistic solution. The question is whether the financial barriers can be overcome? However, with the support of different stakeholders there is every reason to believe that. UNU-GTP fully supports this. If this hurdle is cleared, the road toward success looks clear.

## **8. IMPACT OF THE UNU GEOTHERMAL TRAINING PROGRAMME**

### **8.1 Important partner countries**

In recent years the focus of UNU-GTP has been on Africa – the continent which really needs more energy. Most of the countries in Sub-Saharan Africa acutely need to develop their indigenous energy sources and replace expensive fossil fuel with green energy. Here, the geothermal resources of the East African Rift System (EARS) are very important and *Kenya* is leading the way. According to Kenya Vision 2030, geothermal is expected provide 5000 MWe of electricity on-line in 2030. This is probably an overly optimistic goal, but with 690 MWe already on-line and further geothermal power plants scheduled in 2019 and onwards, geothermal certainly has a bright future in Kenya (Omenda and Mangi, 2016). This has also been seen in the large effort Kenya has put into geothermal capacity building, e.g. by sending 5-10 trainees annually to Iceland in the last 8 years, adding also many local short courses and training activities conducted by UNU-GTP. At present, 124 Kenyans have completed the 6-month training at UNU-GTP, scheduled to increase to 129 at the end of 2018. Kenya itself has financed about half of these, at least partially. This is by far the highest number of UNU Fellows for any country. Other E-African countries have also enjoyed a good share of UNU Fellowships, such as Ethiopia (40), Djibouti (17) and Tanzania (15), all of which are pushing hard to put geothermal electricity on-line (Georgsson and Haraldsson, 2016).

In Asia, China has traditionally been UNU-GTP's most important partner country with its strong commitment to low-temperature geothermal development. It used to be the country with most UNU Fellows until Kenya passed it in 2013. In 2017, 87 Chinese UNU Fellows had been trained at UNU-GTP, many of whom are among China's leading experts in exploration and development of its geothermal resources. It is difficult to classify China as a developing country today, but due to its strong commitment and future plans for major geothermal development UNU-GTP wants to keep good connections with China and support it along the way. Other strong partners in Asia where the focus is on high-temperature development have to be mentioned, such as the Philippines (40 former UNU Fellows) and Indonesia (32), both of which are among world leaders in geothermal electricity production, as well as Iran (25) where the first geothermal pilot plant is in the pipelines.

Last but not least, are Central America and the Caribbean. Here, El Salvador (with 40 former UNU Fellows) has been a key partner of UNU-GTP in recent years through many activities, while Costa Rica (18) and Nicaragua (13) should also be named. In all three countries geothermal plays a significant role in the local electricity production.

### **8.2 Creating opportunities**

The Icelandic geothermal industry has certainly benefitted from UNU-GTP. Jobs have been created through the teaching and supervision of UNU Fellows in Iceland. This was especially important in the aftermath of 2008 – keeping the foundation for several jobs, which would probably have been lost if not for UNU-GTP. Furthermore, the UNU-GTP network has created connection around the world for the Icelandic geothermal industry. Some have been forged through the personal contacts made between a

teacher and a trainee while in Iceland, while in other cases the general knowledge acquired in Iceland about Iceland's strong focus on geothermal solutions has paved the way.

### 8.3 Possible changes on the horizon

Through its 40 years, the operations of UNU-GTP have developed and matured through our good cooperation with our partner countries around the world and their needs. In recent years, four Icelandic programmes have operated within the UNU system, besides UNU-GTP, the Fisheries Training Programme (UNU-FTP), the Land Restoration Training Programme (UNU-LRT), and the Gender and Equality Studies and Training Programme (UNU-GEST), all built up in a similar way. Therefore, it is disappointing to have to admit that the Icelandic programmes do not seem to have the support to continue along similar lines from the current management of UNU. This means that either we will see radical changes in the implementation of the programmes leading to a reduction in our direct support to developing countries, or the programmes will need to find a new international cooperation partner for their activities. Discussions are currently ongoing regarding this and the connection with UNU. But we hope and expect that with the strong support of Government of Iceland, the Geothermal Training Programme will be able to continue its activities in a similar way in the near future fulfilling its duties in supporting geothermal development around the world, with a strong focus on the developing nations.

## 9. FOCUSING ON A GEOTHERMAL FUTURE

The UN Sustainable Development Goals are a roadmap for the world to follow in the coming years, and UNU-GTP must make a serious effort, aiming at harmonizing its operations better with these. Goal 7: *Ensure access to affordable, reliable, sustainable and modern energy for all*; and Goal 13: *Take urgent action to combat climate change and its impacts*, should be at the heart of all our activities; not forgetting Goal 5: *Achieve gender equality and empower all women and girls*. Utilization of indigenous renewable energy resources as a replacement for fossil fuels is a must in a world where ever increasing emission of greenhouse gasses associated with global warming is one of the greatest threats to mankind. This is what makes geothermal resources so valuable today. Here, the restructuring of our two annual short course series for E-Africa, and for Latin America and the Caribbean, was important, putting a strong focus on the UN Sustainable Development Goals.

With the continued support of the Government of Iceland, the Geothermal Training Programme expects to be able to continue its efforts to build capacity in developing countries around the world, endowed with geothermal potential which is worth realising for development. Our intention is to continue along similar lines as before, but perhaps with some slight changes in emphasis.

Our core activity is the 6-month training and it will continue to keep that role. Here, 24 UNU Fellows are expected to complete the training in 2018, taking the total number to 694. Increasing the number of Fellowships in Iceland for MSc studies (currently 5 new on an annual basis) and PhD studies (currently one new annually) is a feasible alternative of improvement. In UNU-GTP's strategic plan for 2016-2019, there was expressed will to be able provide a yearly research grant for a renowned geothermal expert, linked with UNU-GTP, aimed at a research-topic of significance for developing countries with geothermal potential and the geothermal industry in general. We have not received financial support to carry this out to date, but it is definitely a goal to aim at realising.

The same applies for support for regional centres in the developing countries. Active participation in the running of the 5-month Geothermal Diploma Course at UES in cooperation with LaGeo of El Salvador has strengthened UNU-GTP's status in the Spanish speaking part of world. This is a possible future model for the African Geothermal Center of Excellence. We look forward to cooperate with UNEP, GDC, KenGen, and other serious stakeholders on its academic development, and the African Union, NDF, MFA/ICEIDA and other stakeholders on the financial aspects.

Capacity building, transfer of technology and increased emphasis on policy making are key issues in the sustainable development of geothermal resources. UNU Geothermal Training Programme expects to continue to successfully support geothermal development in the world through its activities.

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