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Meyjarauga hot spring, Hveravellir, Kjölur, Central Iceland

Ingimar G. Haraldsson

**UNU-GTP TRAINING ACTIVITIES ABROAD  
2005-2017**

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Geothermal Training Programme

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## **UNU-GTP TRAINING ACTIVITIES ABROAD 2005-2017**

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## INTRODUCTION

After UNU-GTP training had been confined to Iceland since the inception of the programme in 1978, the training was taken to the developing countries in 2005 in response to the pledge of the Icelandic Government for supporting the objectives of the UN Millennium Development Goals. The *Workshop for Decision Makers on Geothermal Projects and their Management*, held at Lake Naivasha in Kenya that year proved to be the beginning of a string of activities abroad. The Workshop was followed up by a Short Course series in Kenya held for the benefit of African countries, which has endured to this day, with various modifications introduced along the way. In 2006, the *Workshop for Decision Makers on Geothermal Projects in Central America* was held in El Salvador, with a Short Course series following for the benefit of Latin American and Caribbean countries. In 2010, UNU-GTP responded to requests for additional training activities abroad by implementing the first customer designed trainings in cooperation with its partners in Indonesia and Kenya. Such tailored training has since become routine, with 2-9 activities organized per year since 2010.

I was involved in the organization and set-up of these activities from the start and saw them grow into the important pillars they are today in the operations of UNU-GTP. This includes both the UN Development Goals Short Course series in Kenya and in El Salvador, and the customer-designed short courses and training activities carried out in many countries and on four continents, since their start in 2010, and finally the Diploma Course given in El Salvador for Latin America. Mr. Ingimar G. Haraldsson became involved in the Short Courses in El Salvador soon after he started working for UNU-GTP in 2010. Subsequently, he assumed responsibility for many of the training activities abroad after becoming Deputy Director in 2013), including the annual Short Courses in El Salvador and Kenya, various tailored trainings and the implementation of the Geothermal Diploma Course for Latin America, in collaboration with our partners.

Some of the trainings / short courses have been reported on in detail in various publications through the years, while many have not. An overview of UNU-GTP's training activities abroad has not existed in a single publication to this day. Thus this report is very welcome, giving a good overview of UNU-GTP training activities abroad over the period 2005-2017.

Finally, I would like to mention that Ingimar's report with the figures in colour is available for downloading on our website [www.unugtp.is](http://www.unugtp.is), under publications.

Lúdvík S. Georgsson, Director  
United Nations University  
Geothermal Training Programme

## ACKNOWLEDGEMENTS

The author would like to acknowledge the immense effort of instructors, Icelandic and foreign, who have contributed in myriad ways to the training abroad over the years – not to mention the UNU-GTP staff. The effort that is the UNU Geothermal Training Programme is a collective one.

UNU-GTP has been blessed by instructors' willingness to contribute and it is my belief that their interaction with participants of varied backgrounds, in different settings, has often (usually) been of great professional and personal value. Those of us who are involved in the operations of the United Nations University Geothermal Training Programme like to believe that the programme has considerable impact in our partner countries (and recent assessments of the programme lend weight to that belief (Georgsson, 2018)), but the programme has without a doubt also had a very positive impact on the Icelandic geothermal community as an interface of exposure to different geothermal settings and cultures.

Reports and memos have been written about many of the trainings and many of those are referred to under references herein. In other cases, accounts are rooted in news stories published on the UNU-GTP website ([www.unugtp.is](http://www.unugtp.is)) or in internal documentation collected and written by the author and co-workers. In particular, Director Lúdvík S. Georgsson is acknowledged for his role in training activities abroad through the years. A large part of the information on the early trainings has been collected from his coffers.

Photos have generally been taken by UNU-GTP staff, but some by professional photographers and instructors. These have been archived in UNU-GTP's photo repository, which the author has drawn upon. However, special thanks are due to Dr. Björn S. Hardarson for a positive response to a request for photos from the tailored trainings in Kenya back in 2010.

Finally, I would like to acknowledge and thank all the good people near and far whom I have met through the trainings in which I have been personally involved as an organizer and/or instructor. My views have expanded and my world has become richer.

## ABSTRACT

After operating geothermal training activities in Iceland since 1979, UNU Geothermal Training Programme started conducting training activities abroad in 2005, in cooperation with local partners. These can broadly be classified into Workshops and Short Courses held in support of the United Nations Development Goals (MDGs and SDGs), tailored training activities, and the backing of geothermal education centres for Latin America and Africa. An overview is provided of these activities, which have taken place in Africa, the Americas, Asia, and Europe, covering extensive subject material. An assessment is made of the scale of activities, as well as female participation, based on statistics presented in tables throughout the text. The scale of training activities abroad was comparable to the 6 Month Geothermal Training Programme in Iceland over the period 2013-2017. Women are underrepresented in training activities abroad, mostly on account of their low participation ratio in the geothermal workforce of partner countries. However, the share of women has been increasing in activities directly sponsored by UNU-GTP through the years. Training activities abroad have expanded the impact of UNU-GTP training from earlier years and become an important pillar of the programme's operations.

## TABLE OF CONTENTS

	Page
1. INTRODUCTION.....	1
2. WORKSHOPS AND SHORT COURSES HELD IN SUPPORT OF THE UNITED NATIONS MILLENNIUM DEVELOPMENT GOALS .....	2
2.1 The African series.....	2
2.2 The LAC series.....	3
2.3 Workshop in China.....	5
3. THE UNITED NATIONS SUSTAINABLE DEVELOPMENT GOALS AND THE SDG SHORT COURSE SERIES.....	7
3.1 The UN Sustainable Development Goals in the context of geothermal development .....	7
3.2 The SDG Short Courses for the Americas.....	9
3.3 The SDG Short Courses for Africa.....	10
4. TAILORED TRAINING .....	13
4.1 Training activities for the Kenyan geothermal companies, KenGen and GDC.....	13
4.2 Trainings supported by MFA-ICEIDA and NDF for African countries .....	16
4.3 Trainings in Europe supported by EEA Grants .....	21
4.3.1 Workshops and short courses in the Azores.....	21
4.3.2 Workshops and short courses in Romania .....	23
4.3.3 Short course for Hungarians in Iceland.....	24
4.4 Other tailored trainings.....	25
5. GEOTHERMAL EDUCATION CENTRES IN LATIN AMERICA AND AFRICA .....	28
5.1 Geothermal Diploma Course for Latin America .....	28
5.2 The African Geothermal Centre of Excellence .....	29
6. STEPPING BACK – TAKING THE BROAD VIEW.....	30
6.1 The scale of training abroad .....	32
6.2 Participation of women in training abroad .....	34
6.3 Evaluation of training beyond scale .....	37
7. CONCLUSION.....	38
REFERENCES.....	39

## LIST OF FIGURES

1. Snapshots from the MDG Short Courses in Kenya.....	3
2. Snapshots from the MDG Short Courses in El Salvador .....	5
3. Workshop for Decision Makers on Direct Heating Use of Geothermal Resources in Asia in China. ....	6
4. Graphical representation of the UN Sustainable Development Goals. ....	7
5. SDG Short Course I in El Salvador. Clockwise from top left: Group photo, lecture, project work, field trip to Berlin geothermal power plant. ....	9
6. Group project work at SDG Short Course II in El Salvador.....	10
7. Participants and lecturers of SDG Short Course I in the Olkaria geothermal field. Mt. Longonot in the background. ....	10
8. Lecture at SDG Short Course I in Kenya.....	10
9. SDG Short Course I in Kenya. Clockwise from top left: Field work by Lake Bogoria, lecture discussion, project work, instruction at the Oserian flower farm.....	12

10.	SDG Short Course II in Kenya. Clockwise from top left: Lecture on the chemistry of geothermal fluids, lecture on geothermal utilization in Kenya, discussion on the geothermal resources of Sudan, group photo. ....	12
11.	Man vs. field. A small team of geoscientists doing primary mapping work in the Silali geothermal prospect in the Kenyan Rift Valley, with the temperature approaching 50°C in the caldera. The work was part of the programme of Short Course on Geoscientific Exploration. ....	14
12.	Hands-on training in the Silali geothermal prospect.....	14
13.	Instructor and participants at Course on Geoscientific Exploration for Geothermal Resources..	14
14.	Clockwise from top left: a) Short Course on Deep Geothermal Exploration in Rwanda, June 2013; b) Short Course on Geothermal Development for Decision Makers from Burundi, DRC and Rwanda, held in Kenya in September 2013; c) Short Course on Geothermal Development for Decision Makers from Malawi, Tanzania and Zambia, held in Kenya in November 2013; d) Workshop for Geothermal Development Donors in Iceland, May 2014. ....	18
15.	Clockwise from top left: a) Short Course on Well Design and Geothermal Drilling Technology in Ethiopia, January 2015; b) Short Course on Preparations of Bankable Geothermal Documents in Ethiopia, January-February 2015; c) Short Course on Geothermal Project Management in Ethiopia, February 2015; d) Short Course on Geothermal Project Management in Kenya, May 2015. ....	19
16.	Clockwise from top left: a) Short Course on Preparation of Bankable Documents for Geothermal Projects in Djibouti, September 2015; b) Short Course on Geothermal Project Management in Djibouti, September 2015; c) Short Course on Well Design and Geothermal Drilling Technology in Djibouti, May 2016; d) Short Course on Borehole Geophysics for Geothermal Development in Ethiopia, June 2016. ....	20
17.	From left: a) Short Course on Project Management for Geothermal Development at ARGeo-C6 in Ethiopia, October-November 2016; b) Introductory Short Course on Geothermal Project Management run within AGCE in Kenya, May 2017. ....	20
18.	Clockwise from top left: a, b) Short Course III on Borehole Geophysics in Geothermal Development (note that 2 participants connected remotely); c) Short Course IV on Chemistry of Thermal Fluids; d) Short Course VI on Geophysical Exploration for Geothermal Resources. ....	22
19.	Participants engaged in field work during Short Course VI on Geophysical Exploration for Geothermal Resources in São Miguel island of the Azores.....	22
20.	Short Course I on Utilization of Low- to Medium-Enthalpy Geothermal Resources.....	24
21.	Participants and organizers of Short Course on Status of Geothermal Energy.....	24
22.	Participants of Course on Geothermal Drilling in Indonesia.....	25
23.	Participants and lecturers of Short Course on Geothermal Exploration and Development in El Salvador. San Vicente geothermal field and volcano (Chichontepec) in the background.....	26
24.	Participants of Short Course on Geothermal Exploration carrying out exercises in Los Azufres.....	27
25.	Share of women in the MDG and SDG Short Courses in Kenya and El Salvador, with the latter series denoted by black marker borders (2016 and 2017) (Tables 1, 3, 5, and 7). Linear trends through the data points indicate an improvement over time.....	35
26.	The ratio of women taking part in tailored trainings by category. The big dots denote the average ratio within each category. As the number of women is not certain for the two training activities held for GDC in 2010 and 2012, only the trainings held for KenGen are reported here.....	36



**LIST OF TABLES**

- 1. Workshop and Short Courses held in Africa in support of the MDGs 2006-2015. All of the Short Courses were held in Kenya, except for the latter course in 2008, which was held in Uganda. ....2
- 2. Participants in the Millennium Workshop and Short Courses in Africa 2005-2015.....3
- 3. Workshop and Short Courses held in El Salvador in support of the MDGs 2006-2015.....4
- 4. Participants in the Millennium Short Courses in Central America 2007-2015.....5
- 5. SDG Short Courses for Latin America and the Caribbean (LAC region).....10
- 6. Structure of SDG Short Courses for Africa .....11
- 7. SDG short courses for Africa.....11
- 8. Training activities for GDC and KenGen in 2010-2014 .....13
- 9. Trainings and workshops for African countries supported by MFA-ICEIDA as part of the Geothermal Exploration Project.....17
- 10. Workshop and short course in the Azores 2014-2016, funded by EEA Grants.....21
- 11. Workshop and short courses in Romania 2016-2017, funded by EEA Grants .....23
- 12. Miscellaneous tailored trainings .....25
- 13. Diploma Course in El Salvador 2013-2017 .....28
- 14. Summary of some key statistics on trainings held in support of the United Nations development goals .....30
- 15. Summary of some key statistics on tailored trainings.....31
- 16. Summary of some key statistics on the Diploma Course in El Salvador. A comparison is made with the 6 month training programme in Iceland.....32
- 17. Participation of women in workshops, short courses and tailored trainings as evaluated by a simple head count vs. participant days .....36

## 1. INTRODUCTION

The United Nations University Geothermal Training Programme (UNU-GTP) was founded in late 1978 and started operations in 1979 (Georgsson, 2018). Up to 2005, its training activities took place solely in Iceland.

In November 2005, the *Workshop for Decision Makers on Geothermal Projects and their Management* was held by Lake Naivasha in Kenya in cooperation with Kenya Electricity Generating Company Ltd. (KenGen) and other partners. This event marked the beginning of on-site training efforts. A corresponding *Workshop for Decision Makers on Geothermal Projects in Central America* was held in El Salvador in 2006 and *Workshop for Decision Makers on Direct Heating Use of Geothermal Resources in Asia* was held in China in 2008. The workshops in Kenya and El Salvador were followed up with a series of short courses held in support of, and dedicated to, the United Nations Millennium Development Goals (MDGs).

As the MDGs ran their course and were superseded by the Sustainable Development Goals (SDGs) at the start of 2016, UNU-GTP initiated a new series of short courses in cooperation with its partners in Kenya and El Salvador that take heed of and support the SDGs, in particular Goal 7. Two SDG short courses have been held in each country (as of end of year 2017).

Due to demand for short courses on specific topics and other site-based training, UNU-GTP started offering tailored training in 2010, with the first such efforts taking place that same year, two in Indonesia and two in Kenya. In all, UNU-GTP has carried out 40 such training activities in cooperation with its partners.

Since 2013, UNU-GTP has contributed to a geothermal diploma course offered in El Salvador, first in an advisory role, but later as an implementing partner. Discussions have also taken place regarding UNU-GTP's support to the recently established African Geothermal Centre of Excellence.

The report presents an overview of these activities, which have supplemented and supported the training activities in Iceland.

## 2. WORKSHOPS AND SHORT COURSES HELD IN SUPPORT OF THE UNITED NATIONS MILLENNIUM DEVELOPMENT GOALS

### 2.1 The African series

The *Workshop for Decision Makers on Geothermal Projects and their Management* was held in Kenya in 2005 as a contribution towards realizing the objectives of the UN Millennium Development Goals (MDGs) (Georgsson, 2010; Georgsson et al., 2015). It was followed up by annual Short Courses focusing on surface exploration for geothermal resources, held in Kenya in cooperation with Kenya Electricity Generating Company Ltd. (KenGen) and later Geothermal Development Company Ltd. (GDC) over the period 2006-2015 as shown in Table 1. The need for a focus on surface exploration had emerged in the Workshop, as most target countries (ARGeo countries) were still in the exploration stage. The number of participating countries expanded in subsequent years and the duration of the courses grew from 10 days in 2006 to roughly 3 weeks in 2008, which was then maintained. The *Short Course on Geothermal Project Management and Development*, held in Uganda in 2008, was also a part of the MDG series of Short Courses for Africa.

The Workshop and Short Courses were attended by 554 participants from 21 countries in Africa, as well as Yemen (Tables 1 and 2; Figure 1). The publishing of papers in association with the courses allowed UNU-GTP to build an extensive collection of lectures and papers on geothermal development, which have contributed to the possibility of offering training that is tailored to the needs of a particular client. The papers have been published on CDs and are available on UNU-GTP's website: [www.unugtp.is](http://www.unugtp.is).

TABLE 1: Workshop and Short Courses held in Africa in support of the MDGs 2006-2015. All of the Short Courses were held in Kenya, except for the latter course in 2008, which was held in Uganda.

Name	Dates	No. countries	No. particip.	No. women	Participant days
Workshop for Decision Makers on Geothermal Projects and their Management	14-18 Nov, 2005	5	30		150
Short Course I on Surface Exploration for Geothermal Resources	13-22 Nov, 2006	6	23	3 (13%)	195.5
Short Course II on Surface Exploration for Geothermal Resources	2-17 Nov, 2007	11 <sup>1</sup>	30	6 (20%)	405
Short Course III on Surface Exploration for Geothermal Resources	24 Oct – 17 Nov, 2008	11 <sup>1</sup>	37	6 (16%)	888
Short Course on Geothermal Project Management and Development	20-22 Nov, 2008	10 <sup>1</sup> +2 <sup>2</sup>	24	2 (8%)	72
Short Course IV on Surface Exploration for Geothermal Resources	1-22 Nov, 2009	11 <sup>1</sup>	45	9 (20%)	945
Short Course V on Surface Exploration for Geothermal Resources	29 Oct – 19 Nov, 2010	13 <sup>1</sup>	56	13 (23%)	1176
Short Course VI on Surface Exploration for Geothermal Resources	27 Oct – 18 Nov, 2011	15 <sup>1</sup>	58	10 (17%)	1276
Short Course VII on Surface Exploration for Geothermal Resources	27 Oct – 18 Nov, 2012	14 <sup>1</sup>	61	17 (28%)	1311.5
Short Course VIII on Surface Exploration for Geothermal Resources	31 Oct – 23 Nov, 2013	18 <sup>1,3</sup>	70	20 (29%)	1505
Short Course IX on Surface Exploration for Geothermal Resources	2-23 Nov, 2014	18 <sup>1</sup>	58	15 (26%)	1189
Short Course X on Surface Exploration for Geothermal Resources	9-30 Nov, 2015	18 <sup>1</sup>	62	19 (31%)	1271
<b>Total:</b>		<b>22<sup>1</sup>+2<sup>2</sup></b>	<b>554</b>	<b>120+ (~23%)</b>	<b>10,384</b>

1: Including Yemen; 2: One participant came from Germany and another from Italy; 3: One of the participants represented the African Development Bank.

TABLE 2: Participants in the Millennium Workshop and Short Courses in Africa 2005-2015

	05	06	07	08	08 <sup>1</sup>	09	10	11	12	13	14	15	Total
Algeria			1					1					2
Burundi				2	1	2	2	1	2	2	1	1	14
Cameroon										1	1	1	3
Comoros			2			2	3	2	1	1	2	1	14
D.R. Congo				1	1			1	3	3	2	2	13
Djibouti		2	1	2	3	2	2	3	2	3	2	3	25
Egypt			1									1	2
Eritrea	2	3	2	2	1	2		2		2	1	2	19
Ethiopia	5+2 <sup>2</sup>	3	1	2	3	3	1	3	3	3	3	3	35
Kenya	6+9 <sup>2</sup>	10	13	18		21	31	30	28	32	30	28	256
Malawi							3	3	2	3	1	2	14
Morocco							1						1
Mozambique							1	1	2	1	1	1	7
Niger										1			1
Nigeria									2	2	1	1	6
Rwanda			2	2	1	3	3	4	6	3	2	2	28
Sudan									2	3	2	1	8
Tanzania	2	2	2	2	4	3	3	2	3	2	3	7	35
Uganda	4	3	3	2	5	3	2	2	3	2	3	3	35
Zambia				2	2	2	3	2		3	1	2	17
Zimbabwe											1		1
Yemen			2	2	1	2	1	1	2	2	1	1	15
Others					2					1			3
<b>Total</b>	<b>30</b>	<b>23</b>	<b>30</b>	<b>37</b>	<b>24</b>	<b>45</b>	<b>56</b>	<b>58</b>	<b>61</b>	<b>70</b>	<b>58</b>	<b>62</b>	<b>554</b>

1: Held in Uganda. All other courses in Kenya.; 2: Added number shows lecturers, who were also participants.



FIGURE 1: Snapshots from the MDG Short Courses in Kenya

## 2.2 The LAC series

In 2006, the *Workshop for Decision Makers on Geothermal Projects in Central America* was held in El Salvador in cooperation with LaGeo S.A. de C.V., with similar goals as the Workshop in Kenya a year

earlier, i.e. to reach out to decision makers and raise awareness of the potential of geothermal utilization in the Central American target countries (Georgsson, 2010; Georgsson et al., 2015). The workshop was followed up with a series of semi-annual Short Courses that varied in topics from year to year as shown in Table 3, with the list of participating countries expanding through the years to include countries throughout Latin America and the Caribbean (LAC region), i.e. Mexico, Caribbean island states, and the Andean countries of South America. The duration of the courses has mostly been one week, with exceptions (Table 3). They have been carried out in English and Spanish according to the preference of lecturers, with translation offered between the two languages for those who need it.

TABLE 3: Workshop and Short Courses held in El Salvador in support of the MDGs 2006-2015

Name	Dates	Target region	No. countries	No. particip.	No. women	Participant days
Workshop for Decision Makers on Geothermal Projects in C-America	27 Nov – 2 Dec, 2006	Central America	4	50		250
Short Course I on Geothermal Development in C-America: Resources Assessment and Environmental Management	15 Nov – 1 Dec, 2007	Central America and Mexico	6	45		270
Short Course II on Surface Exploration for Geothermal Resources	17-30 Oct, 2009	Central America and the Caribbean	7+2 <sup>1</sup>	32	13 (41%)	384
Short Course III on Geothermal Drilling, Resource Development and Power Plants	16-22 Jan, 2011	LAC	10	62	14 (23%)	372
Short Course IV on Geothermal Development and Geothermal Wells	11-17 Mar, 2012	LAC	12 <sup>2</sup>	65	15 (23%)	390
Short Course V on Conceptual Modelling of Geothermal Systems	24 Feb – 2 Mar, 2013	LAC	12	61	18 (30%)	366
Short Course VI on Utilization of Low- and Medium Enthalpy Geothermal Resources and Financial Aspects of Utilization	23-29 Mar, 2014	LAC	13 <sup>3</sup>	55	23 (42%)	330
Short Course VII on Surface Exploration for Geothermal Resources	14-22 Mar, 2015	LAC	13	42	18 (43%)	294
<b>Total:</b>			<b>15<sup>4</sup>+2</b>	<b>412<sup>5</sup></b>	<b>~1/3</b>	<b>2,656</b>

1: The additional countries were Spain (1) and Switzerland (1); 2: Three participants did not represent countries, but rather international funding institutions (Inter-American Development Bank – IDB, and World Bank – WB); 3: Two participants attended from IDB; 4: Bolivia, Chile, Colombia, Costa Rica, Dominica, El Salvador, Ecuador, Guatemala, Honduras, Mexico, Montserrat, Nicaragua, Peru, St. Kitts and Nevis, and St. Vincent and the Grenadines (Table 4); 5: Some of the participants have attended more than one course.

The variation in topics between years is a testament to the range of development stages found within the participating countries, with some having produced electricity from geothermal resources for decades and others being in the early stages of exploration. The tackling of new topics has allowed UNU-GTP to build up a large collection of course programmes and accompanying study material, which has been an important factor in enabling the offering of tailored training. As is the case for the African courses, the papers have been published on CDs and are available online. Some of the papers have been used as part of the study material for the 6 month studies in Iceland.

The Workshop and Short Courses were attended by 412 participants from 15 countries in Latin America and the Caribbean over the period 2006-2015 (Tables 3 and 4; Figure 2). The participation in the Short Courses is broken down by country in Table 4, with 50 participants having taken part in the initial Workshop.

TABLE 4: Participants in the Millennium Short Courses in Central America 2007-2015

Country	2007	2009	2011	2012	2013	2014	2015	Total
Bolivia				1			3	4
Chile				5	5	4	3	17
Colombia			5	2	4	2	5	18
Costa Rica	6	7	6	1	2	3	2	27
Dominica		2	2	2	1	1	1	9
El Salvador	22	9	23	28	18	26	10	136
Ecuador			1	2	3	2	3	11
Guatemala	1	1	2	1	2	2		9
Honduras	2	2	5	2	4	1	2	18
Mexico	1		3	6	6	3	3	22
Montserrat						1	1	2
Nicaragua	13	7	13	11	11	5	6	66
Peru					3	1	2	6
St. Kitts and Nevis		2	2	1	2	2		9
St. Vincent and the Grenadines							1	1
Others		2		3		2		7
<b>Total</b>	<b>45</b>	<b>32</b>	<b>62</b>	<b>65</b>	<b>61</b>	<b>55</b>	<b>42</b>	<b>362</b>



FIGURE 2: Snapshots from the MDG Short Courses in El Salvador

**2.3 Workshop in China**

In May 2008, the *Workshop for Decision Makers on Direct Heating Use of Geothermal Resources in Asia* was held in China in cooperation with the Tianjin Bureau of Land, Resources and Real Estate Management and the Tianjin Bureau of Geology and Mineral Exploration and Development (Fridleifsson et al., 2008). The Workshop was attended by 118 participants from 7 Mid- and Far-Eastern

countries (Figure 3), with a duration of 6 days. Aspirations were set to follow up on the Workshop with a Short Course series similar to those in El Salvador and Kenya, but funding did not prove sufficient in subsequent years, largely due to the Financial Crisis of 2008.

Material presented and written for these events has been published on CDs and is also available on the website of the UNU-GTP ([www.unugtp.is](http://www.unugtp.is)).



FIGURE 3: Workshop for Decision Makers on Direct Heating Use of Geothermal Resources in Asia in China

### 3. THE UNITED NATIONS SUSTAINABLE DEVELOPMENT GOALS AND THE SDG SHORT COURSE SERIES

#### 3.1 The UN Sustainable Development Goals in the context of geothermal development

The United Nations Sustainable Development Summit 2015 was held during 25-27 September 2015. On the opening day of the summit, the post-2015 Sustainable Development Goals (SDGs) were unanimously adopted as targets to be reached by 2030 (United Nations, 2015a; Figure 4). UNU-GTP has supported the overall aim and targets of Goal 7 in all its operations since its establishment – in Iceland and abroad. The formal recognition and adoption of the Goal by the UN system was therefore very much welcomed.



FIGURE 4: Graphical representation of the UN Sustainable Development Goals (United Nations, 2015b)

In response, UNU-GTP and its cooperating partners initiated a new series of Short Courses that were to take heed of and support the Goals. In particular, the courses were to support Goal 7, which has the overall aim of ensuring access to affordable, reliable, sustainable and modern energy for all, with the following stated targets (United Nations, 2015c):

- By 2030, ensure universal access to affordable, reliable and modern energy services;
- By 2030, increase substantially the share of renewable energy in the global energy mix;
- By 2030, enhance international cooperation to facilitate access to clean energy research and technology, including renewable energy; and
- By 2030, expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, in particular least developed countries, Small Island Developing States (SIDS), and land-locked developing countries, in accordance with their respective programmes of support.

The Short Courses are well suited to help fulfil the Goal as:

- Geothermal energy prices compare well with other environmentally benign energy sources;
- Medium- to high-enthalpy geothermal resources can be used to provide reliable base load power over long periods of time to large populations;
- While the sustainability of geothermal utilization can be drawn into question, partly on account of the transient nature of the resources themselves when looking at long time spans, the resources can be utilized for extended durations provided that development is approached cautiously and resources managed well;



- Geothermal resources can be utilized to provide heat and electricity in as modern a way as any other energy resources;
- The short courses come about through international cooperation that is meant to facilitate research and transfer knowledge between countries and generations;
- The short courses are directed at the developing countries and Small Island Developing States (e.g. Caribbean Islands and the Comoros).

In addition, special note is taken of Goals 5 and 13:

- *Goal 5: Achieve gender equality and empower all women and girls.*  
This is in line with UNU-GTP's strategic plan. The ratio of women to the overall number of participants in short courses, 6-month studies and advanced academic studies in Iceland has been improving with time and the goal is to improve further on this. However, it must be noted that the pool of candidates is often male dominated, so even if women are given preference over men in the selection process, it is still difficult to reach gender parity. This is counter-acted by informing cooperating entities of the emphasis placed on gender equality and the importance of nominating women.
- *Goal 13: Take urgent action to combat climate change and its impacts.*  
It is well recognized that greenhouse gas emissions from geothermal utilization projects are significantly lower than the emissions associated with projects that make use of fossil energy. The utilization of geothermal resources therefore contributes to the mitigation of climate change when used in place of fossil fuels. Geothermal energy may also be used to help with adaptation where climate change effects are inescapable and negative.

Furthermore, the Short Course series is expected to contribute to other SDGs indirectly:

- *Goal 1: End poverty in all its forms everywhere.*  
It is expected that capacity building aimed at enhancing geothermal development will help to bring energy to more people, which in turn will increase their economic opportunities and reduce poverty. Such opportunities may arise from better and more reliable access to electricity, but also possibilities for direct utilization of geothermal resources in specific areas, such as for drying agricultural products, horticulture, aquaculture, bathing and tourism, and various industrial processes. The development of geothermal resources will lead to direct and derived employment, with positive local economic effects, and some businesses may be established in response to opportunities arising with availability of geothermal energy.
- *Goal 3: Ensure healthy lives and promote well-being for all at all ages.*  
It is expected that access to geothermal energy will increase opportunities for leading healthier lives. One example is the possibility of changing from biomass cook-stoves to electrical cook-stoves, with improved and more reliable access to electricity, which has the potential of improving indoor air quality.
- *Goal 8: Promote inclusive and sustainable economic growth, employment and decent work for all.*  
Economic growth is strongly linked to energy utilization: In order for an economy to grow, access to energy is of major importance. This in turn is linked to Goal 1. It is expected that capacity building aimed at enhancing geothermal development will help realize this goal.
- *Goal 9: Build resilient infrastructure, promote sustainable industrialization and foster innovation.*  
Geothermal development brings with it construction of energy utilization systems, such as power plants, and calls for a power grid to carry the electricity to consumers. The availability of energy also promotes industrialization, whether it be through utilization of electricity or heat. Geothermal power plants often bring with them new roads that are utilized by the wider population and sometimes open access to regions that were inaccessible before. There are also

examples of locals benefitting from water supply systems that have been constructed for the primary purpose of supplying water for geothermal drilling and power plant operations.

- *Goal 15: Sustainably manage forests, combat desertification, halt and reverse land degradation, halt biodiversity loss.*  
The utilization of geothermal energy can in some cases help reduce reliance on wood for cooking, which can decrease pressure on forests.
- *Goal 16: Revitalize the global partnership for sustainable development.*  
One of the aims of the short courses is to strengthen relationships between stakeholders in geothermal development within and between countries, for the benefit of geothermal development on national, regional and global scales. In particular, the short courses are a realization of the following target: Enhance international support for implementing effective and targeted capacity-building in developing countries to support national plans to implement all the sustainable development goals, including through North-South, South-South and triangular cooperation.

### 3.2 The SDG Short Courses for the Americas

The first short course associated with the SDGs was *SDG Short Course I on Sustainability and Environmental Management of Geothermal Resource Utilization, and the Role of Geothermal in Combatting Climate Change*, held in cooperation with LaGeo S.A. de C.V. in El Salvador during 4-10 September 2016 (Figure 5). As the title implies, the emphasis was on sustainable management and utilization of geothermal resources, and the contribution that geothermal development can make towards climate change mitigation. The launching of the Salvadoran SDG series coincided with the Short Course being incorporated as an internal component of the *Geothermal Diploma Course for Latin America* (Georgsson and Haraldsson, 2017; Section 5.1). The first two courses in the series are shown in Table 5 and photos are shown in Figures 5 and 6.



FIGURE 5: SDG Short Course I in El Salvador. Clockwise from top left: Group photo, lecture, project work, field trip to Berlin geothermal power plant.

TABLE 5: SDG Short Courses for Latin America and the Caribbean (LAC region)

Name	Dates	No. countries	No. particip.	No. women	Participant days
SDG Short Course I on Sustainability and Environmental Management of Geothermal Resource Utilization, and the Role of Geothermal in Combatting Climate Change	4-10 Sep, 2016	14 <sup>1</sup>	68	23 (34%)	408
SDG Short Course II on Feasibility Studies for Geothermal Projects	17-23 Sep, 2017	14 <sup>2</sup>	66	32 (48%)	396
<b>Total:</b>		<b>16<sup>3</sup></b>	<b>134</b>	<b>55 (41%)</b>	<b>804</b>

1: As well as representatives from the World Bank; 2: As well as a representative from the Organization of Eastern Caribbean States; 3: Argentina, Bolivia, Chile, Colombia, Costa Rica, Dominica, Ecuador, El Salvador, Guatemala, Mexico, Montserrat, Nicaragua, Peru, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines.



FIGURE 6: Group project work at SDG Short Course II in El Salvador

### 3.3 The SDG Short Courses for Africa

The first Short Course dedicated to the SDGs in Africa was *SDG Short Course I on Exploration and Development of Geothermal Resources*, held in cooperation with KenGen and GDC at Lake Bogoria and Lake Naivasha in Kenya during 10-30 November 2016 (Figures 7 and 8). As in El Salvador, the course rested on the solid foundations of the earlier MDG Short Course series, although some changes in approach and content were introduced to better reflect the SDGs and the evolving needs of African countries.



FIGURE 7: Participants and lecturers of SDG Short Course I in the Olkaria geothermal field. Mt. Longonot in the background.



FIGURE 8: Lecture at SDG Short Course I in Kenya

Some of these are as follows:

- Greater emphasis on the concept of sustainability and actions to combat climate change.
- While the emphasis on surface exploration is still strong in the SDG series as it was in the MDG series, the coverage of topics has been expanded to include most aspects of geothermal development.
- While the focus of the project work of the earlier series has first and foremost been on high-temperature geothermal resources, attention is also directed towards low- to medium-temperature resources in the SDG series. This is due to the growing realization over the years that the nature of geothermal resources in the Western Branch of the East African Rift System (EARS) is

different from that of the Eastern Branch. This was crystallized in the *Technical Workshop on the Geologic Development and Geophysics of the Western Branch of the Greater East African Rift System*, held during 9-11 March 2016 in Rwanda under the auspices of the African Rift Geothermal Development Facility (ARGeo) of the United Nations Environment Programme (UNEP) (Omenda et al., 2016).

The courses are attended by participants from geothermal institutions and companies in African countries with possibilities for geothermal utilization (e.g. geological surveys, electricity generation companies, regulatory bodies and ministries).

As in the earlier MDG series, the Short Courses are run in much the same way from year to year. The course structure, as run in 2016 and 2017 is shown in Table 6.

TABLE 6: Structure of SDG Short Courses for Africa

Day	Activities	Location
1	Opening	Lake Bogoria
2	Overview lectures on geothermal field exploration.	Lake Bogoria
3-6	Field work under the guidance of GDC and KenGen.	Lake Bogoria and surroundings
7	Transport to Lake Naivasha, with exploration of the Menengai caldera and tour of the Menengai geothermal field along the way. Visit to GDC facilities.	Transit
8-12	Lectures on geology, geophysics, geochemistry, drilling and more. Field mapping of geological structures in the Olkaria geothermal field. Visit to KenGen laboratories. Assessment test 1.	Lake Naivasha, Olkaria geothermal field
13-16	Project work. Processing of data from high- and low-temperature geothermal fields. Analysis of results. Conceptual models and siting of wells. Presentations.	Lake Naivasha
16-17	Seminar. Reports from guest lecturers and participants on geothermal resources and status of geothermal development in their home countries. Discussion.	Lake Naivasha
18	Reservoir engineering, environmental-, social- and regulatory issues, utilization.	Lake Naivasha
19	Field trip to utilization sites in the Olkaria geothermal field.	Olkaria geoth.field
20-21	Utilization, project management, financial models and financing. Assessment test 2. Closing.	Lake Naivasha

The first two courses in the series are listed in Table 7 and photos are shown in Figures 7-10.

TABLE 7: SDG short courses for Africa

Name	Dates	No. countries	No. particip.	No. women	Participant days
SDG Short Course I on Exploration and Development of Geothermal Resources	10-30 Nov, 2016	16	61	21 (34%)	1220
SDG Short Course II on Exploration and Development of Geothermal Resources	9-29 Nov, 2017	17	63	22 (35%)	1260
<b>Total:</b>		<b>19<sup>1</sup></b>	<b>124</b>	<b>43 (35%)</b>	<b>2,480</b>

1: Cameroon, Comoros, Djibouti, Democratic Republic of the Congo (DRC), Egypt, Eritrea, Ethiopia, Kenya, Madagascar, Malawi, Morocco, Mozambique, Nigeria, Rwanda, Sudan, Tanzania, Uganda, Yemen, and Zambia.



FIGURE 9: SDG Short Course I in Kenya. Clockwise from top left: Field work by Lake Bogoria, lecture discussion, project work, instruction at the Oserian flower farm



FIGURE 10: SDG Short Course II in Kenya. Clockwise from top left: Lecture on the chemistry of geothermal fluids, lecture on geothermal utilization in Kenya, discussion on the geothermal resources of Sudan, group photo

#### 4. TAILORED TRAINING

Since 2010, UNU-GTP has conducted various short courses and long term training efforts in cooperation with local partners in 4 continents. As of end of year 2017, a total of 40 training programmes of short, medium and long duration had been conducted. Twenty-one of those had been conducted in African countries (Djibouti (3), Ethiopia (5), Kenya (12), and Rwanda (1)), 15 in Europe (Iceland (3), Portugal / Azores (8), and Romania (4)), 2 in Asia (Indonesia), and 2 in Latin America (El Salvador (1) and Mexico (1)). These programs have ranged from 2-day workshops for decision makers intended to provide overview and serve as platforms for discussion, to in-depth training of experts leading to certification equivalent to the 6-month studies in Iceland.

Some of the trainings have been called for by geothermal companies in order to strengthen employee skill sets, some have been carried out in cooperation with local education establishments, while others have been implemented in response to requests from development donors. Fifteen trainings have been requested by the Icelandic International Development Agency (ICEIDA) / Icelandic Ministry for Foreign Affairs (MFA), 12 have been held in cooperation with entities within the European Economic Area funded by EEA Grants, 8 have been procured by the two Kenyan geothermal companies (KenGen and GDC), and 5 have been requested by others. A total of 868 participants have benefitted from these trainings (but fewer individuals as some have attended more than one training), accounting for around 13,992 participant training days.

##### 4.1 Training activities for the Kenyan geothermal companies, KenGen and GDC

From 2010 to 2014, UNU-GTP carried out 8 training activities for the two large Kenyan geothermal companies, KenGen and GDC (Table 8). These activities were to some extent a result of the formation of GDC in 2008. As many experts left KenGen to work with GDC, both companies needed to hire people to fill vacant and new positions. This in turn called for rapid training of the incoming professionals.

TABLE 8: Training activities for GDC and KenGen in 2010-2014

Name	Dates	Client	No. part.	No. women	Participant days
Short Course on Geoscientific Exploration	17 May – 13 Jun, 2010	GDC	49	14 <sup>1</sup> (29%)	1176
Course on Geoscientific Exploration for Geothermal Resources	13 Sep 2010 – 22 Jan 2011	KenGen	40	6 (15%)	2440
Training in Borehole Geology	14 Nov 2011 – 3 Mar 2012	GDC	8	2 <sup>1</sup> (25%)	480
Course on Geothermal Technology	16 Apr – 14 Jul, 2012	KenGen	45	13 (29%)	3510
Advanced Training in Borehole Geology	16 Jul 2012 – 2 Feb 2013	KenGen	5	2 (40%)	780
Advanced Training in Geothermal Geochemistry	22 Aug – 29 Sep, 2012	KenGen	17 <sup>2</sup>	7 (41%)	282 <sup>3</sup>
Training in TFT-Measurements of Two-Phase Flow	31 Mar – 12 Apr, 2014	KenGen	18	6 (33%)	216
Advanced Training in Structural Geology	31 Mar – 26 Jul, 2014	KenGen	11	6 (55%)	330
<b>Total:</b>			<b>193<sup>4</sup></b>	<b>56 (29%)</b>	<b>9,214</b>

1: Number of women estimated from the female ratio at KenGen trainings; 2: Maximum number of participants. As the training was carried out in phases, the number of active participants varied; 3: Obtained by counting the number of active participants per active day; 4: Some participants attended more than one training.

*Short Course on Geoscientific Exploration* was held in May to June 2010 for recently hired personnel at GDC. The focus was on practical training in geology, geophysics, and geochemistry, with the course consisting of one week of lectures and three weeks of hands-on training, i.e. practical exercises and field work, in connection with the upcoming campaign in the Silali geothermal prospect (Árnason et al., 2010; Figures 11 and 12). The training was carried out by experts at ÍSOR – Iceland GeoSurvey.



FIGURE 11: Man vs. field. A small team of geoscientists doing primary mapping work in the Silali geothermal prospect in the Kenyan Rift Valley, with the temperature approaching 50°C in the caldera. The work was part of the programme of Short Course on Geoscientific Exploration



FIGURE 12: Hands-on training in the Silali geothermal prospect

The *Course on Geoscientific Exploration for Geothermal Resources* was carried out in phases for KenGen from 13 September 2010 to 22 January 2011, spanning 11 active weeks of training. The first phase covered geological exploration and borehole geology and ran from 13 September to 23 October 2010 (Figure 13), and the second phase covered chemistry of thermal fluids, running from 23 November to 11 December. The third phase was devoted to geophysical exploration and was held after the holidays, during 10-22 January 2011. All of the phases consisted of lectures, exercises, field work, and project work (Georgsson et al., 2010). Experts of ÍSOR – Iceland GeoSurvey carried out the training activities on site.



FIGURE 13: Instructor and participants at Course on Geoscientific Exploration for Geothermal Resources

*Training in Borehole Geology* was held for GDC from November 2011 to March 2012 to train 8 early career borehole geologists in conjunction with the exploration

drilling phase in Menengai geothermal field. The training was carried out in two 5 week phases, one in 2011 and the latter in early 2012, with the aim of aiding decision making during drilling by utilizing geologic information to its full potential. The training included an examination and streamlining of working routines for geologic monitoring during drill works in Menengai in collaboration with senior geologists at GDC. The training was carried out by two experts from ÍSOR – Iceland GeoSurvey.

The *Course on Geothermal Technology* was an extensive 13 week on-site training programme on geothermal resources development carried out for the benefit of 45 junior professionals at KenGen. The programme consisted of the following modules:

- Geological Exploration and First Introduction to Borehole Geology, 16-28 April (2 weeks);
- Geophysical Exploration, 30 April – 19 May (3 weeks);
- Chemistry of Thermal Fluids and Environmental Management, 21 May – 2 June (2 weeks);
- Reservoir Monitoring, 4-16 June (2 weeks);
- Drilling Technology, 18-30 June (2 weeks);
- Borehole Geology, 2-14 July (2 weeks).

The training was carried out by experts of ÍSOR – Iceland GeoSurvey.

*Advanced Training in Borehole Geology* followed up on the previous training for KenGen with a focused 6 month (26 week) programme on borehole geology for 5 KenGen geologists. The training was carried out on-site in shifts by experts of ÍSOR – Iceland GeoSurvey from 16 July 2012 to 2 February 2013, with a break between 15 December 2012 and 7 January 2013. This approach allowed the training to take place in the future work environment of the trainees, ensuring relevance and providing opportunities for mixing instruction and on-the-job training in the most feasible manner. The scope of the training was similar to that of the specialized line of Borehole Geology in the 6 month training programme in Iceland. The trainees delivered project reports at the end of the training that were published by UNU-GTP as Geothermal Training in Kenya 2012-2013 ([www.unugtp.is/en/publications](http://www.unugtp.is/en/publications)) in much the same way that the reports of 6 month Fellows in Iceland appear in the annual publication *Geothermal Training in Iceland*, also available on-line. The 5 Kenyan geologists were presented with a UNU-GTP diploma on par with that awarded to graduates of the 6 month training in Iceland. They have since made contributions to the annual Short Courses in Kenya held in support of the UN Development Goals and two went on to complete an MSc degree in geology from the University of Iceland in 2016 with support from UNU-GTP.

*Advanced Training in Geothermal Geochemistry* was held for selected staff members of the Geochemical Division of KenGen in 2012. The training was carried out in two phases by experts of ÍSOR – Iceland GeoSurvey, the former during 6-22 August and the latter during 17-29 September (Óskarsson et al., 2012; Fridriksson et al., 2012). The aim of the training was to give the trainees a good understanding of the general methods used in the chemistry of thermal fluids in geothermal exploration and development, both in practical and theoretical terms, as well as reviewing and streamlining working procedures in collaboration with senior KenGen chemists. The number of trainees varied between periods and phases, with the maximum number of participants reaching 17.

*Training in TFT-Measurements of Two-Phase Flow* was held for KenGen in March to April 2014 to train selected employees in the theory and practice of tracer flow testing (TFT). The training included lectures on the theory of the method, tracers and technology used, as well as field work including tracer pipeline injection and sampling, and calculations of enthalpy of two phase flows based on recorded and measured results. The objective was to enable the team of participants to make routine TFT measurements for monitoring on-line flow and enthalpy of the production wells in Olkaria, as well as the rate of injection into reinjection wells. The training was carried out by an expert of ÍSOR – Iceland GeoSurvey.

*Advanced Training in Structural Geology* was carried out for KenGen during March to July 2014. The objective was for KenGen's team of borehole geologists to become better acquainted with surface geology. The training was divided into three phases. The first phase consisted of lectures and practical



desk work, the second phase entailed field work, and the third phase involved map preparation, lab work and report writing based on information obtained through the previous phase. During the training, the participants carried out detailed geologic mapping of potential geothermal resource areas, including tectonic and stratigraphic features, surface petrology, mineralogy, lithology, and geothermal surface manifestations, using GIS software to create maps. As drilling activities were ongoing in Olkaria at the time, the team of borehole geologists was divided into two groups that took turns in the training. Each phase of the training was thus held twice to allow the whole team to participate. Instruction was carried out by experts from ÍSOR – Iceland GeoSurvey.

#### **4.2 Trainings supported by MFA-ICEIDA and NDF for African countries**

The Icelandic International Development Agency (ICEIDA), which was integrated into the Icelandic Ministry for Foreign Affairs at the beginning of 2016, has supported several trainings in Africa, often in cooperation with the Nordic Development Fund (NDF), as shown in Table 9. These have been held within the framework of the *Geothermal Exploration Project*, a sub-project of the *Geothermal Compact in East Africa*. One of the objectives of the project, which had an official implementation period from 2013 through 2017, was to assist East African Rift System (EARS) countries in building capacity and expertise in the field of geothermal utilization and policy.

The first of the trainings requested and supported by ICEIDA was *Short Course on Deep Geothermal Exploration*, held in Kigali, Rwanda in June 2013 (Figure 14a). The course gave a general introduction on surface exploration, but focused in greater depth on geothermal wells, drilling, borehole geology, geochemistry, and environmental science in anticipation of drilling that was soon to take place at Karisimbi. The short course was attended by 20 employees of the Energy, Water and Sanitation Authority (EWSA), mostly from the Geothermal Development Unit, but a few from other departments. The training was carried out with support from experts of ÍSOR – Iceland GeoSurvey.

The next efforts were directed towards *decision makers* in the geothermal sector to increase understanding and awareness of geothermal resources. *Short Course on Geothermal Development for Decision Makers from Burundi, DRC and Rwanda*, was held by Lake Naivasha in Kenya in September 2013 (Figure 14b). The short course was organized by UNU-GTP in collaboration with KenGen and GDC at the request of ICEIDA, which financed the course as part of the Regional Geothermal Exploration Project in Rwanda, Burundi and DRC, supported by the European Union and implemented through the Great Lakes Energy Agency (EGL). The course covered the basics of geothermal exploration and development and was attended by 13 participants from the project steering committee, i.e. Burundi (3), Congo (3), Rwanda (3), the three EGL member states (3), and the European Union delegation in Rwanda (1), with lecture support from ÍSOR – Iceland GeoSurvey. Lecture material was provided both in French and English, as many of the participants were French speakers.

*Short Course on Geothermal Development for Decision Makers from Malawi, Tanzania and Zambia*, held by Lake Naivasha, Kenya in November 2013 (Figure 14c). The course was similar in setup to the previous one. It was held in cooperation with GDC and KenGen, with financing provided by ICEIDA and NDF. The course was attended by 23 participants from the three countries, i.e. Malawi (7), Tanzania (7), Zambia (8), and UNEP (1), with lecture support coming from ÍSOR – Iceland GeoSurvey, GDC, KenGen and UNEP (Ragnarsson et al., 2013).

The third event for decision makers was *Workshop for Geothermal Development Donors*, held in Iceland in May 2014 (Figure 14d). The workshop was financed by ICEIDA and organized by UNU-GTP as a follow-up to a Donors Collaboration Meeting jointly hosted by the African Union and ICEIDA. The meeting and the workshop were attended by 48 participants representing 9 African countries and 14 donor institutions, as well as Icelandic entities (see footnote to Table 9). The workshop, which was held at the Blue Lagoon and Reykjavik Energy headquarters, provided a general overview of various aspects of geothermal exploration and development and included an excursion to geothermal fields and utilization facilities on the Reykjanes Peninsula.

TABLE 9: Trainings and workshops for African countries supported by MFA-ICEIDA as part of the Geothermal Exploration Project

Name	Dates	Host country	Beneficiary countries	No. part.	No. women	Participant days
Short Course on Deep Geothermal Exploration	25-29 Jun, 2013	Rwanda	Rwanda	20	3 (15%)	100
Short Course on Geothermal Development for Decision Makers from Burundi, DRC and Rwanda	25-28 Sep, 2013	Kenya	Burundi, DRC, Rwanda	13	1 (8%)	52
Short Course on Geothermal Development for Decision Makers from Malawi, Tanzania and Zambia	26-30 Nov, 2013	Kenya	Malawi, Tanzania, Zambia	23	2 (9%)	115
Workshop for Geothermal Development Donors	27-28 May, 2014	Iceland	African countries <sup>1</sup>	48	12 (25%)	96
Short Course on Well Design and Geothermal Drilling Technology	12-24 Jan, 2015	Ethiopia	Ethiopia	30	1 (3%)	360
Short Course on Preparations of Bankable Geothermal Documents	26 Jan – 3 Feb, 2015	Ethiopia	Ethiopia	25	6 (24%)	200
Short Course on Geothermal Project Management	9-20 Feb, 2015	Ethiopia	Ethiopia	25	3 (12%)	250
Short Course on Geothermal Project Management	18-28 May, 2015	Kenya	Kenya	26	7 (27%)	260
Short Course on Preparation of Bankable Documents for Geothermal Projects	5-10 Sep, 2015	Djibouti	Djibouti	18	2 (11%)	108
Short Course on Geothermal Project Management	12-21 Sep, 2015	Djibouti	Djibouti	16	2 (13%)	144
Short Course on Well Design and Geothermal Drilling Technology	14-26 May, 2016	Djibouti	Djibouti	23	2 (9%)	276
Short Course on Borehole Geophysics for Geothermal Development	6-18 Jun, 2016	Ethiopia	Ethiopia	27	4 (15%)	297
Short Course on Project Management for Geothermal Developm.	31 Oct – 1 Nov, 2016	Ethiopia	East Africa	34	6 (18%)	68
Introductory Short Course on Geothermal Project Management	26-30 May, 2017	Kenya	Kenya	16	4 (25%)	80
<b>Total:</b>				<b>344<sup>2</sup></b>	<b>55<sup>2</sup> (16%)</b>	<b>2,406</b>

1: Participants came from Burundi, Comoros, Democratic Republic of the Congo, Djibouti, Eritrea, Ethiopia, France, Germany, Iceland Kenya, Rwanda, Uganda, United States and other countries, representing geothermal companies and institutions in Africa, development donors (AfDB, African Union, ARGeo-UNEP, BGR, ICEIDA, IRENA, JICA, KfW, NDF, World Bank, USAID-Power Africa), and private enterprises.; 2: Some individuals participated in more than one training.

The emphasis of the courses that followed was largely on three main themes:

- 1) Project management for geothermal projects;
- 2) Bankable documents for geothermal projects;
- 3) Wells and drilling.



FIGURE 14: Clockwise from top left: a) Short Course on Deep Geothermal Exploration in Rwanda, June 2013; b) Short Course on Geothermal Development for Decision Makers from Burundi, DRC and Rwanda, held in Kenya in September 2013; c) Short Course on Geothermal Development for Decision Makers from Malawi, Tanzania and Zambia, held in Kenya in November 2013; d) Workshop for Geothermal Development Donors in Iceland, May 2014.

*Short Course on Well Design and Geothermal Drilling Technology* was held in Ethiopia in January 2015 for employees of the Geological Survey of Ethiopia (GSE) and Ethiopian Electric Power (EEP) (Figure 15a). The course covered the basics of well design and geothermal drilling technology. The first week was conducted in Addis Ababa, while the second was carried out by Lake Ziway, allowing for a field visit to the Aluto Langanjo geothermal field (Thórhallsson et al., 2015). The short course was attended by 30 participants from GSE and EEP with lecturing support from ÍSOR – Iceland GeoSurvey and Mannvit. The course was financed by ICEIDA and NDF as part of the Geothermal Exploration Project in East Africa.

*Short Course on Preparations of Bankable Geothermal Documents* was held in Addis Ababa, Ethiopia in January to February 2015 for employees of GSE, EEP and the Ministry of Water, Irrigation and Energy (MWIE) (Figure 15b). The course covered the basics of preparations of documents required for the financing of geothermal projects. It was attended by 25 participants, with lecturing support from Landsvirkjun Power and an independent consultant, and financing by ICEIDA and NDF (Haraldsson, 2015a).

*Short Course on Geothermal Project Management* was held in Addis Ababa in Ethiopia in February 2015 for employees of GSE, EEP and MWIE (Figure 15c). As the title implies, the course covered the basics of project management for geothermal projects. The course was conducted in Addis Ababa and was attended by 25 participants, with lecture support from Verkís and Reykjavík University (Chatenay et al., 2015). Financing came from ICEIDA and NDF.

*Short Course on Geothermal Project Management* was held in Nakuru, Kenya in May 2015 for 26 employees of GDC (Figure 15d). Lecture support came from Verkís and Reykjavík University. The short course was followed up by preparation and review for the D-level certification exam of the International Project Management Association (IPMA), which was held on 30 May for the participants of the course (Haraldsson, 2015b). The exam was administered by the Icelandic Project Management Association on behalf of IPMA. The training was funded by ICEIDA and NDF.



FIGURE 15: Clockwise from top left: a) Short Course on Well Design and Geothermal Drilling Technology in Ethiopia, January 2015; b) Short Course on Preparations of Bankable Geothermal Documents in Ethiopia, January-February 2015; c) Short Course on Geothermal Project Management in Ethiopia, February 2015; d) Short Course on Geothermal Project Management in Kenya, May 2015.

*Short Course on Preparation of Bankable Documents for Geothermal Projects* was held in Djibouti in September 2015 for 18 employees of the Djiboutian Development Office for Geothermal Energy (ODDEG), the Ministry of Energy, Water and Natural Resources (MERN) and the Djibouti Centre for Research Studies (CERD) (Figure 16a). The course followed up on the similar course held in Ethiopia earlier in the year. It covered the basics of preparation of documents required for the financing of geothermal projects and consisted of lectures, exercises, examinations and group work, with simultaneous translation provided to French. The course was financed by ICEIDA, with lecture support from Landsvirkjun (Haraldsson, 2015c).

*Short Course on Geothermal Project Management* was held in Djibouti in September 2015 for 16 employees of ODDEG, MERN and CERD (Figure 16b). As in Ethiopia and Kenya before, the course covered the basics of project management for geothermal projects in the context of the International Project Management Association (IPMA) competence baseline and consisted of lectures, group work, exercises and an examination, with simultaneous translation provided in French where needed. Financing came from ICEIDA with lecture support from Verkís (Haraldsson, 2015d).

*Short Course on Well Design and Geothermal Drilling Technology* was held in Djibouti in May 2016 for 23 employees of ODDEG, CERD and the Ministry of Agriculture (Figure 16c). The course was held at the request of, and financed by, the Directorate for International Development Cooperation of the Icelandic Ministry for Foreign Affairs, still under the emblem of ICEIDA, which had been integrated into the Ministry at the beginning of the year. The subject material was covered through lectures, exercises and group projects, with one day devoted to a field trip to the Assal area (Haraldsson, 2016a). Lecture support came from ÍSOR – Iceland GeoSurvey and Mannvit.

*Short Course on Borehole Geophysics for Geothermal Development* was held in Ethiopia in June 2016 for 27 employees of GSE and the Geothermal Sector Development Project of EEP (Figure 16d). The course covered various aspects of well logging, well testing and reservoir monitoring and consisted of lectures, exercises and actual logging and testing of wells in the field. It lasted two weeks and was conducted in Addis Ababa, aside from two days of field work in the Aluto Langano geothermal field (Haraldsson, 2016b). The short course was funded by the Icelandic Ministry for Foreign Affairs – ICEIDA (MFA-ICEIDA) and NDF, with lecture support from ÍSOR – Iceland GeoSurvey.



FIGURE 16: Clockwise from top left: a) Short Course on Preparation of Bankable Documents for Geothermal Projects in Djibouti, September 2015; b) Short Course on Geothermal Project Management in Djibouti, September 2015; c) Short Course on Well Design and Geothermal Drilling Technology in Djibouti, May 2016; d) Short Course on Borehole Geophysics for Geothermal Development in Ethiopia, June 2016.

The two-day *Short Course on Geothermal Project Management* was held as a pre-conference short course of the Sixth African Rift Geothermal Facility conference (ARGeo-C6) in Addis Ababa, during 31 October – 1 November, 2016 (Figure 17a). The course was a condensed version of earlier project management short courses, most of which had had a duration of 2 weeks. The course was attended by 34 participants from 11 African countries (Burundi, Comoros, Djibouti, Democratic Republic of the Congo, Ethiopia, Kenya, Malawi, Rwanda, Tanzania, Uganda, and Zambia), with lecture support from Verkis, KenGen and GDC (Haraldsson, 2016c). Funding was provided by MFA-ICEIDA and NDF.

*Introductory Short Course on Project Management* was held by Lake Naivasha in May 2017 for 16 participants from GDC and KenGen (Figure 17b). The course was organized by UNU-GTP and KenGen under the framework of the Interim Phase of the African Geothermal Center of Excellence (AGCE), with financial backing from MFA-ICEIDA and NDF. The course had a duration of 5 days and was modelled on previous project management short courses, consisting of lectures and practical group projects, with lecture support from Verkis, KenGen and GDC (Haraldsson, 2017).



FIGURE 17: From left: a) Short Course on Project Management for Geothermal Development at ARGeo-C6 in Ethiopia, October-November 2016; b) Introductory Short Course on Geothermal Project Management run within AGCE in Kenya, May 2017.

Out of the trainings sponsored by ICEIDA / MFA-ICEIDA for African countries, 5 have been on project management, 3 have been overview courses directed specifically at decision makers, 2 have addressed the challenge of making geothermal projects bankable, 2 have been devoted to well design and drilling, 1 to logging and well testing, and 1 has been an overview course on deep geothermal exploration. These have covered a total of 2,406 participant days. The subjects of project management and bankable documents were identified by ICEIDA as subjects of importance that had been somewhat under-addressed in the region and this aligned well with discussions that had taken place within UNU-GTP for offering project management training. The request by ICEIDA to develop short courses on these topics therefore matched well with the parallel work of establishing a new study line on Project Management and Finances in the 6-month training programme in Iceland, first run in 2015. The collaboration with the Icelandic Project Management Association on offering possibilities for pursuing IPMA certification has also been well received, both as follow-up to short courses and as an integral part of the 6-month study line.

### 4.3 Trainings in Europe supported by EEA Grants

The EEA Grants are funded by Iceland, Liechtenstein and Norway as a commitment of these countries to reduce social and economic disparities within the European Economic Area (EEA) and to strengthen bilateral relations between donor and beneficiary countries. With the support of Orkustofnun, the National Energy Authority of Iceland (NEA), which acted as donor programme partner in renewable energy programmes in Hungary, Portugal and Romania on behalf of EEA Grants, UNU-GTP entered into agreements on training activities with several project promoters in these countries. Three such agreements have been made for workshops and short courses.

A total of 1,343 participant days have accrued through the workshops and short courses funded through EEA Grants.

#### 4.3.1 Workshop and short courses in the Azores

From September 2014 to April 2016, UNU-GTP held an opening workshop and a series of 6 short courses for the employees of EDA Renováveis, the department of renewable energy within the Electricity Company of the Azores islands (EDA) of Portugal (Table 10; Figures 18 and 19).

TABLE 10: Workshop and short course in the Azores 2014-2016, funded by EEA Grants

Name	Dates	No. part.	No. women	Participant days
Workshop on Geothermal Energy for Decision Makers	8-9 Sep, 2014	14	4 (29%)	28
Short Course I on Geological Exploration of Geothermal Fields	10-20 Sep, 2014	11	4 (36%)	104.5
Short Course II on Geothermal Utilization and Geothermal Power Plants	17-29 Nov, 2014	14	6 (43%)	154
Short Course III on Borehole Geophysics in Geothermal Development	15-27 Jun, 2015	11	5 (45%)	126.5
Short Course IV on Chemistry of Thermal Fluids	7-19 Sep, 2015	12	6 (50%)	138
Short Course V on Well Design and Geothermal Drilling Technology	18-30 Jan, 2016	14	6 (43%)	140
Short Course VI on Geophysical Exploration for Geothermal Resources	4-16 Apr, 2016	12	5 (42%)	132
<b>Total:</b>				<b>823</b>



FIGURE 18: Clockwise from top left: a, b) Short Course III on Borehole Geophysics in Geothermal Development in Azores (note that 2 participants connected remotely); c) Short Course IV on Chemistry of Thermal Fluids; d) Short Course VI on Geophysical Exploration for Geothermal Resources.



FIGURE 19: Participants engaged in field work during Short Course VI on Geophysical Exploration for Geothermal Resources in São Miguel island of the Azores

The participants were to a large extent the same group of employees of EDA Renováveis throughout the training. This training series can thus be viewed as an example of a targeted training effort to build capacity within a single company. Participants who had expertise in the subject area of a given course were able to enhance their skills through close collaboration and dialogue with trainers, as well as assisting their colleagues who had expertise in different subject areas of geothermal development. These roles were then changed from course to course. The tightly-knit group of experts thus had an opportunity to expand their knowledge to new areas of expertise and become better acquainted with the work of their colleagues, allowing for even closer future collaboration.

The training took place on São Miguel island, with participants also taking part through a remote connection from Terceira island. Lecture support came from ÍSOR – Iceland GeoSurvey, Mannvit, pvald, and Verkís.

Four employees of EDA Renováveis were also enrolled in the 6 month training in Iceland in 2014 and 2015 as part of the collaboration.

#### 4.3.2 Workshop and short courses in Romania

UNU-GTP entered into a partnership agreement with the University of Oradea in Romania in the summer of 2015, on geothermal training for Romanian professionals. The agreement was supported by the RONDINE programme of the EEA Grants scheme, with facilitation by the Environment Fund Administration of the Romanian Ministry of Environment and Climate Change and Orkustofnun – the National Energy Authority of Iceland.

The collaboration consisted of a workshop and 3 short courses given in Romania in 2016-2017 (Table 11), as well as the enrolment of 4 Romanian Fellows in the 6 month training programme in Iceland in 2016.

TABLE 11: Workshop and short courses in Romania 2016-2017, funded by EEA Grants

Name	Dates	No. part.	No. women	Participant days
Workshop on Utilization of Geothermal Resources for Decision Makers from Romania	27-28 May, 2016	18	6 (33%)	36
Short Course I on Utilization of Low- to Medium-Enthalpy Geothermal Resources	4-8 Apr, 2016	38	8 (21%)	190
Short Course II on Geothermal Resource Exploration	30 May – 3 Jun, 2016	20	3 (15%)	100
Short Course III on Resource Assessment and Management	13-17 Mar, 2017	30	6 (20%)	150
<b>Total:</b>				<b>476</b>

*Short Course I on Utilization of Low- to Medium-Enthalpy Geothermal Resources* was held at the University of Oradea in April 2016 for 38 students and faculty of the university, employees of the Municipality of Oradea, and Romanian geothermal companies (Figure 20). The short course consisted of lectures, practical exercises and a field excursion, with the focus placed on direct utilization and electricity generation through binary power plants. The programme was tailored to conditions in Romania, which is mainly endowed with low- to medium enthalpy geothermal resources. Lecture support was provided by ÍSOR – Iceland GeoSurvey, pvald, and the University of Oradea.

*Workshop on Utilization of Geothermal Resources for Decision Makers from Romania* was held in late May 2016 at the University of Oradea. As the name implies the workshop was intended as an overview on the potential of geothermal utilization for Romanian decision makers, with some time allotted to interaction and discussion. The workshop was attended by 18 participants from the Municipality of Oradea, Oradea District Heating, and the University of Oradea. Lecturing was carried out by UNU-GTP and the University of Oradea with support from ÍSOR – Iceland GeoSurvey.

*Short Course II on Geothermal Resource Exploration* followed the workshop in May/June 2016 and was held at the University of Oradea as the previous programs. It consisted of lectures and practical exercises in geology, geophysics, chemistry of thermal fluids, and borehole logging in low-, as well as



high-enthalpy geothermal areas. There were 20 participants from Romanian companies interested in geothermal exploration and development and from the university. Lecturing was carried out by the University of Oradea and ÍSOR – Iceland GeoSurvey.

The final program in the series was implemented in March 2017 at the University of Oradea: *Short Course III on Resource Assessment and Management*. It consisted of lectures on geothermal systems worldwide and in Romania, the basics of reservoir engineering, logging, well testing, reservoir monitoring and management, resource assessment, numerical modelling, reinjection, and stimulation, with practical exercises carried out to put theory to practice. The course was attended by 30 participants from the University of Oradea and Transgex, with lecture support from ÍSOR – Iceland GeoSurvey.



FIGURE 20: Short Course I on Utilization of Low- to Medium-Enthalpy Geothermal Resources

#### 4.3.3 Short Course for Hungarians in Iceland

UNU-GTP was approached by employees of the Geological and Geophysical Institute of Hungary, who were interested in an overview of the status of geothermal development in Iceland and the world, exploration methods, direct uses and power generation, the management of geothermal reservoirs, environmental considerations and economics of geothermal development. *Short Course on Status of Geothermal Energy* was consequently held in Iceland during October 11-14, 2016, covering these topics, in addition to field visits to Icelandic geothermal fields and utilization sites. The course was attended by 11 participants, including 5 women, and lecturing was carried out by UNU-GTP staff and ÍSOR – Iceland GeoSurvey (Figure 21).



FIGURE 21: Participants and organizers of Short Course on Status of Geothermal Energy

#### 4.4 Other tailored trainings

In addition to the trainings held for the Kenyan geothermal companies, the trainings in Africa under the banners of the MFA-ICEIDA / NDF Geothermal Exploration Project and in Europe with funding from EEA Grants, UNU-GTP has conducted various other short and long term training activities in collaboration with partners in Asia, Europe and Latin America (Table 12).

TABLE 12: Miscellaneous tailored trainings

Name	Country	Sponsor	Dates	No. part.	No. women	Participant days
Course on Geothermal Drilling	Indonesia	SenterNovem	25 Jan – 19 Feb, 2010	16 <sup>1</sup>	3 (19%)	316 <sup>2</sup>
Short Course on Geothermal Scaling and Corrosion	Indonesia	Pertamina, World Bank, Netherlands Embassy	19-23 Apr, 2010	23	3 (13%)	115
Short Course on Geothermal Exploration and Development	El Salvador	Organization of American States	7-12 Nov, 2011	14	1 (7%)	84
Short Course on Geothermal Exploration	Mexico	CeMIEGeo	24-29 Nov, 2014	42	8 (19%)	252
Short Course VII on Geothermal Drilling Operations	Azores, Portugal	EDA Renováveis	27 Feb – 10 Mar, 2017	15	2 (13%)	150
ARENA Programme in Iceland	Iceland	Icelandic Ministry for Foreign Affairs	5-11 Nov, 2017	16	7 (44%)	112
<b>Total:</b>				<b>126</b>	<b>24 (19%)</b>	<b>1,029</b>

1: In addition to the 16 participants from PGE and ESDM who participated for the whole duration of the short course, there were 3 participants from SEG during the group work that took place in the last week; 2: Counting in the 3 SEG participants.

The *Course on Geothermal Drilling* was held for PT Pertamina Geothermal Energy (PGE) in January – February 2010 with organizational support from the Indonesian National Development Planning Agency (Bappenas) and financial support from SenterNovem, an agency of the Dutch Ministry of Economic Affairs. It was the first tailored training implemented by UNU-GTP. The course was set up as an intense drilling course for drilling supervisors and geoscientists engaged in the geothermal drilling effort taking place in Indonesia at the time. The course consisted of lectures and group work in Jakarta, Garut and Bandung, as well as site visits to Ulubelu, Lumut Balai and Lahendong where drilling was on-going, Kamojang and Tompaso. Instruction was carried out by two experts of ISOR – Iceland GeoSurvey and three experts of Filtech Energy Drilling Corporation of the Philippines (FEDCO). The course was attended by 12 employees of PGE and 4 from the Indonesian Ministry of Mines (ESDM) (Figure 22). In addition, 3 employees of Star Energy (SEG) participated in the group work, which took place in the final week (Thórhallsson et al., 2010a).



FIGURE 22: Participants of Course on Geothermal Drilling in Indonesia

*Short Course on Geothermal Scaling and Corrosion* was held for PGE in Jakarta in April 2010, with support from the World Bank and the Embassy of the Netherlands in Indonesia. The goal was to meet needs that had arisen for training on scaling and corrosion in geothermal wells and installations for engineers and geoscientists engaged in the geothermal utilization effort taking place in Indonesia. The training was carried out by three Icelandic geothermal experts. Two employees of Pertamina Drilling Service Indonesia (PDSI) and 2 from the General Directorate of Minerals, Coal and Geothermal Resources (Minerba Pabum) attended the training in addition to the 19 employees of PGE (Thórhallsson et al., 2010b).

*Short Course on Geothermal Exploration and Development* was held at the request of the Organization of American States (OAS) in November 2011 for the benefit of South American countries engaged in geothermal exploration. The course covered the basics of geothermal exploration and development, including an introduction to geothermal energy in Latin America and the world, geoscientific exploration and drilling, power generation and direct use, environmental impacts, and laws and regulations pertinent to the utilization of geothermal resources. Lecturing was carried out by UNU-GTP with support by experts from ÍSOR – Iceland GeoSurvey and the University of Iceland and participants came from Chile (1), Colombia (3), Costa Rica (1), Ecuador (3), El Salvador (3), and Peru (3) (Figure 23).



FIGURE 23: Participants and lecturers of Short Course on Geothermal Exploration and Development in El Salvador. San Vicente geothermal field and volcano (Chichontepec) in the background.

*Short Course on Geothermal Exploration* was implemented in the Los Azufres geothermal power plant facilities in Mexico in November 2014 at the request of the Mexican Center of Innovation for Geothermal Energy (Centro Mexicano de Innovación en Energía Geotérmica – CeMIEGeo). The short course gave an overview of geological, geochemical and geophysical geothermal exploration, as well as introducing conceptual modelling of geothermal systems and environmental impacts of geothermal utilization, introduced through lectures, practical exercises and field work (Figure 24). The 42 participants came mostly from the Federal Electricity Commission (Comisión Federal de Electricidad – FDE) and the National Autonomous University of Mexico (UNAM), but also from other Mexican universities and institutions. The training was carried out by experts from ÍSOR – Iceland GeoSurvey and CFE.

*Short Course VII on Geothermal Drilling Operations* was a continuation of the series of short courses held in the Azores in 2014-2016 (Section 4.3.1). Whereas the former courses had been funded through the EEA Grants scheme, this course was funded directly by EDA Renováveis to bring its drilling crew and other employees up to date on drill rigs recently purchased from Iceland, with emphasis on practical work. The training was carried out by two Icelandic experts.

The *ARENA Programme in Iceland* was held at the request of the Icelandic Ministry for Foreign Affairs to support the work of the Arctic Remote Energy Networks Academy (ARENA), an Arctic Council Sustainable Development Working Group Project. The objective was to bring together a group of participants from remote settlements within the Arctic region for workshops and site visits to learn about



FIGURE 24: Participants of Short Course on Geothermal Exploration carrying out exercises in Los Azufres

renewable energy possibilities from current technology, community, and project development leaders. The participants of the project attended workshops and short courses in Yellowknife in the Northwest Territory of Canada (March), Fairbanks in the state of Alaska of the United States (June), and finally in Reykjavík, Iceland in November 2017. The participants (7 from Alaska, 7 from Canada, and 2 from Greenland) received lectures on geothermal exploration, development and utilization, covering both electrical generation and direct use. They also got an introduction to large and small scale hydro-power development in Iceland. The programme also included field trips to geothermal and hydro utilization sites.

## 5. GEOTHERMAL EDUCATION CENTRES IN LATIN AMERICA AND AFRICA

### 5.1 Geothermal Diploma Course for Latin America

A Specialized Geothermal Diploma Course has been offered at the University of El Salvador for several years. The first two courses were run in 2010 and 2012, mostly for Salvadorans, with financial support from Italy, implemented in cooperation with Salvadoran and Italian partners (de Velis and Montalvo, 2011; Caprai et al., 2012; Haraldsson et al., 2013; Axelsson, 2013; Haraldsson, 2015e). The Nordic Development Fund (NDF) and the Inter-American Development Bank (IDB) then pledged additional funding to secure the program over the period 2013-2015, with implementation support from Consejo Nacional de Energía (CNE) and LaGeo. UNU-GTP carried out an evaluation of the program as run in the first two years of implementation and continued to serve in an advisory role through participation in the programme's Academic Committee over the period 2013-2015 (Table 13). During this period 10 scholarships were reserved for Salvadorans, 10 scholarships were reserved for Latin American participants from outside of El Salvador, and up to 10 additional places were offered to participants who could attend without scholarships.

In early 2016, NDF pledged further funding to support the continuation of the Diploma Course in 2016-2017, with the Icelandic Ministry for Foreign Affairs as the implementing agency. UNU-GTP also became a direct implementing partner along with LaGeo and the University of El Salvador (Table 13). In light of some changes in the implementation of the program, including added responsibility assumed by LaGeo, the name of the programme was changed to *Geothermal Diploma Course for Latin America*. The number of available scholarships and class size were unchanged from the previous funding period.

TABLE 13: Diploma Course in El Salvador 2013-2017

Year	Direct funding	UNU-GTP role	Dates	Countries	No. particip.	No. women	Participant days
2013	NDF / IDB	Advisory	8 Aug – 15 Dec	8 <sup>1</sup>	26	7 (27%)	2,886 <sup>2</sup>
2014	NDF / IDB	Advisory	2 Jun – 7 Nov	8 <sup>3</sup>	26	6 (23%)	3,276 <sup>4</sup>
2015	NDF / IDB	Advisory	1 Jun – 9 Nov	7 <sup>5</sup>	32	9 (39%)	4,192 <sup>6</sup>
2016	NDF	Implementation partner	15 Aug – 17 Dec	7 <sup>7</sup>	30	9 (30%)	2,970 <sup>8</sup>
2017	NDF	Implementation partner	26 Jun – 1 Dec	8 <sup>9</sup>	30	15 (50%)	3,510 <sup>10</sup>
<b>Total:</b>				<b>11</b>	<b>144</b>	<b>46 (32%)</b>	<b>16,834</b>

1: Argentina (1), Chile (1), Ecuador (1), El Salvador (16), Guatemala (2), Honduras (1), Nicaragua (2), Peru (2); 2: Rough estimate of 111 active days based on the academic calendar. Generally there were 6 active days per week. Even though programmed activities did not cover the whole day, it is concluded based on interviews with students that the workload did (and then some); 3: Argentina (1), Bolivia (2), Colombia (2), Ecuador (2), El Salvador (14), Guatemala (1), Nicaragua (3), Peru (1); 4: Rough estimate of 126 active days based on the academic calendar; 5: Argentina (2), Colombia (2), Ecuador (2), El Salvador (20), Mexico (2), Nicaragua (2), Peru (2); 6: Rough estimate of 131 active days based on the academic calendar; 7: Bolivia (1), Colombia (2), Ecuador (1), El Salvador (20), Mexico (2), Nicaragua (3), Peru (1); 8: Rough estimate of 99 active days based on the academic calendar. SDG Short Course I accounted for 5 of those days (the Diploma Course students did not participate in the field trip to Berlin geothermal power plant, as they visited Berlin on other occasions); 9: Argentina (1), Bolivia (2), Chile (1), Colombia (2), Ecuador (1), El Salvador (20), Mexico (1), Nicaragua (1), Peru (1); 10: Rough estimate of 117 active days based on the academic calendar. SDG Short Course II accounted for 5 of those days (as before, the DC students did not participate in the short course field trip, as they had other opportunities to do so).

At this juncture it was decided to include the annual UNU-GTP / LaGeo Short Course as an integral part of the Diploma Course curriculum (Section 3.2). Thus, in addition to participants invited specially for the Short Course from the LAC region, it would also be open to the Diploma Course students who would benefit from the topics presented, as well as from exposure to international lecturers and participants. This arrangement was run successfully in 2016 and 2017.

While the Diploma Course is carried out almost exclusively in Spanish, the Short Course is carried out in English and Spanish according to the preference of lecturers, with translation offered between the two languages for those who need it. This reflects the larger target region for the Short Course, as it includes the Lesser Antilles Islands of the Caribbean (where English is dominant) in addition to Latin America.

The coupling of the SDG Short Course series to the Geothermal Diploma Course for Latin America is well fitting in light of both undergoing critical overhaul in 2016 and the important role of UNU-GTP and LaGeo in both.

## **5.2 The African Geothermal Centre of Excellence (AGCE)**

After having been discussed for several years the African Geothermal Centre of Excellence (AGCE) is currently in an interim phase supported by the Icelandic Ministry for Foreign Affairs and others. Introductory Short Course on Geothermal Project Management was one of two short courses held to mark the initialization of this phase (Section 4.2). The possibility of running the SDG Short Courses for Africa (Section 3.3) within the framework of the AGCE has been discussed (Georgsson, 2018), but some work remains before this can be implemented.

## 6. STEPPING BACK – TAKING THE BROAD VIEW

This paper has presented an overview of the work that has been undertaken by UNU-GTP abroad since 2005. Although the coverage is not exhaustive, it should give a reasonable idea about this face of the coin of UNU-GTP operations – the other being the operations in Iceland, most notably the 6 month training programme and the advanced studies (MSc and PhD). These activities have been categorized as follows:

- Workshops and Short Courses held in support of the United Nations Millennium Development Goals (2005-2015):
  - MDG Workshop and Short Courses for Africa (Kenya and Uganda): 2005-2015.
  - MDG Workshop and Short Courses for the LAC region (El Salvador): 2006-2015.
  - MDG Workshop for Asia (China): 2008
- Short Courses held in support of the United Nations Sustainable Development Goals (2016- ):
  - SDG Short Courses for Africa (Kenya): 2016- .
  - SDG Short Courses for the LAC region (El Salvador): 2016- .
- Tailored trainings (2010- ):
  - Training activities for the Kenyan geothermal companies, KenGen and GDC: 2010-2014.
  - Training activities for African countries supported by MFA-ICEIDA and NDF within the framework of the Geothermal Exploration Project: 2013-2017.
  - Training activities in Europe supported by EEA Grants: 2014-2017.
  - Miscellaneous training activities: 2010- .
- Support to regional geothermal training centres:
  - Geothermal Diploma Course for Latin America (El Salvador): 2013- .
  - African Geothermal Centre of Excellence: Advisory support from initial stages.

Information on individual trainings has been presented in Tables 1-13, and a summary for the categories is shown in Tables 14-16.

TABLE 14: Summary of some key statistics on trainings held in support of the United Nations development goals

			Total (over period)				Average (over period, per training unless otherwise noted)			
Category	Period (20xx)	No. years	Trainings	Part. <sup>1</sup>	Women	P.days <sup>2</sup>	Trainings (p. year)	Part.	Women	P.days
<b>MDG Workshops and Short Courses</b>										
Africa	05-15	11	12	554	~125 <sup>3</sup>	10,384	1.09	46.2	~10.4 (~23%)	865
LAC	06-15	10	8	412 <sup>4</sup>	~128 <sup>5</sup>	2,656	0.80	51.5	~16.0 (~31%)	332
Asia	08	1	1	118	~23 <sup>6</sup>	708	1	118	~23 (~19.8% <sup>5</sup> )	708
<b>TOTAL</b>	<b>05-15</b>	<b>11</b>	<b>21</b>	<b>1,084<sup>4</sup></b>	<b>~276</b>	<b>13,748</b>	<b>1.91</b>	<b>51.6</b>	<b>~13.1 (~25%)</b>	<b>655</b>
<b>SDG Workshops and Short Courses</b>										
SDG SCs for Africa	16-17	2	2	124	43	2,480	1	62.0	21.5 (34.7%)	1,240
SDG SCs for LAC	16-17	2	2	134	55	804	1	67.0	27.5 (41.0%)	402
<b>TOTAL</b>	<b>16-17</b>	<b>2</b>	<b>4</b>	<b>258</b>	<b>98</b>	<b>3,284</b>	<b>2</b>	<b>64.5</b>	<b>24.5 (38.0%)</b>	<b>821</b>

TABLE 14 cont'd: Summary of some key statistics on trainings held in support of the United Nations development goals

			Total (over period)				Average (over period, per training unless otherwise noted )			
Category	Period (20xx)	No. years	Trainings	Part. <sup>1</sup>	Women	P.days <sup>2</sup>	Trainings (p. year)	Part.	Women	P.days
<b>UN Development Goals Trainings (MDG + SDG)</b>										
Africa	05-17	13	14	678	~168	12,864	1.08	48.4	12.0 (~25%)	919
LAC	06-17	12	10	546 <sup>4</sup>	~183	3,460	0.83	54.6	18.3 (~34%)	346
Asia	08	1	1	118	~23	708	1	118	23 (~19.8% <sup>5</sup> )	708
<b>TOTAL</b>	<b>05-17</b>	<b>13</b>	<b>25</b>	<b>1,342</b>	<b>374</b>	<b>17,032</b>	<b>1.92</b>	<b>53.7</b>	<b>15.0 (~28%)</b>	<b>681</b>

1: Participants; 2: Participant days (person days); 3: A reliable count of women is not available for the MDG Workshop for Decision Makers in Africa, but 120 women participated from MDG SC I onwards (Table 1). It is assumed here that the ratio of women in the Workshop was the same as in MDG SC I and II combined, i.e. 17.0%. The number of women in the Workshop is thus estimated to have been 5; 4: Some participants have attended more than one short course as topics vary from year to year; 5: A reliable count of women is not available for the first two MDG trainings in El Salvador, but 101 women participated from MDG SC II onwards (Table 3). It is assumed here that the ratio of women in the MDG Workshop and MDG SC I in El Salvador was the same as in MDG SC II and III combined, i.e. 28.7%. The number of women in the Workshop is thus estimated to have been 14, and 13 in MDG SC I; 6: A reliable count of women does not exist for the Workshop in China, but Figure 3 (a subset) suggests a 19.8% ratio of women, giving an estimate of 23 females in the whole group of 118.

TABLE 15: Summary of some key statistics on tailored trainings

			Total (over period)				Average (over period, per training unless otherwise noted )			
Category	Period (20xx)	No. years	Trainings	Part. <sup>1</sup>	Women	P.days <sup>2</sup>	Trainings (p. year)	Part.	Women	P.days
<b>Tailored trainings</b>										
KenGen/GDC <sup>3</sup>	10-14	5	8	193	~56 <sup>4</sup>	9,214	1.60	24.1	~7.0 (~29%)	1,152
MFA-ICEIDA/NDF	13-17	5	14	344 <sup>5</sup>	55 <sup>5</sup>	2,406	2.80	24.6	3.9 (16.0%)	172
EEA Grants	14-17	4	12	205 <sup>6</sup>	64 <sup>6</sup>	1,343	3.00	17.1	5.3 (31.2%)	112
Other	10-17	8	6	126	24	1,029	0.75	21.0	4.0 (19.0%)	171.5
<b>TOTAL</b>	<b>10-17</b>	<b>8</b>	<b>40</b>	<b>868<sup>6</sup></b>	<b>199<sup>6</sup></b>	<b>13,992</b>	<b>5.00</b>	<b>21.7</b>	<b>5.0 (~23%)</b>	<b>350</b>

1: Participants; 2: Participant days (person days); 3: Trainings held for the Kenyan geothermal companies (Section 4.1; Table 8); 4: Number of women estimated for two trainings (Table 8); 5: Some individuals participated in more than one training; 6: Many participants attended more than one course, especially in the Azores where the group was more or less the same from course to course.



TABLE 16: Summary of some key statistics on the Diploma Course in El Salvador.  
A comparison is made with the 6-month training programme in Iceland.

Category	Period (20xx)	No. years	Total (over period)				Average (over period, per training unless otherwise noted)			
			Trainings	Part. <sup>1</sup>	Women	P.days <sup>2</sup>	Trainings (p. year)	Part.	Women	P.days
Diploma Course <sup>3</sup>	13-17	5	5	144	46	16,834	1	28.8	9.2 (31.9%)	3,367
6 Month Training <sup>4</sup>	13-17	5	5	150	50	17,937	1	30.0	10.0 (33.3%)	3,587

1: Participants; 2: Participant days (person days); 3: Geothermal Diploma Course in El Salvador;  
4: UNU 6-month training programme in Iceland.

These provide one measure of the scale of training abroad, i.e. participant days.

### 6.1 The scale of training abroad

While the number of participants and duration of training (active days) are both partial indicators of how extensive a training programme is, the combination of both in participant days is a more comprehensive indicator that allows comparison between different trainings. Assuming that each training programme is designed to fit a particular target group as well as possible, the number of participant days allows comparison of the “extensiveness” of training, and those managing funds can use cost per participant day as one indicator of funding efficiency.

The Workshops and Short Courses held in support of the UN Development Goals in Africa (Kenya and Uganda), El Salvador and China since 2005 covered just over 17,000 participant days up to 2017. Since 2010, the Kenyan and Salvadoran Short Courses have covered 12,765 participant days. By comparison, the tailored training covered almost 14,000 participant days since 2010. These efforts have thus been of similar magnitude.

Going back to Tables 1, 3, 5, and 7, one will note that the MDG and SDG Short Courses in Africa amount to a total of 12,864 participant days, while the series in El Salvador amount to 3,460 participant days. This difference attests to the importance placed on capacity building for Africa, which is in line with the UNU-GTP Strategic Plan 2016-2019 (UNU-GTP, 2016) and the emphasis placed on Africa by the UN system, the Parliament of Iceland, and the Icelandic Ministry for Foreign Affairs. Part of the reason for the large number of participant days in Africa is that a greater number of trainings have been held for Africa since 2005 than for the LAC region, but the activities have also generally had a longer duration (typically 3 weeks vs. 1 week). Looking only at the SDG Short Courses held in 2016-2017, the African courses amount to 2,480 participant days, whereas the LAC courses amount to 804 participant days. The duration was 3 weeks in Kenya and 1 week in El Salvador, while attendance was slightly greater in the latter country, an average of 67 participants attending in El Salvador (including the students of the Geothermal Diploma Course for Latin America) vs. 62 in Kenya.

When looking at the tailored training activities that have taken place since 2010, the greatest number of courses, 14, have been sponsored by MFA-ICEIDA as part of the Geothermal Exploration Project for East Africa, often in cooperation with NDF, while 12 trainings have been supported through EEA Grants, 8 by the Kenyan geothermal companies, and 6 by others. When looking at the extensiveness of training in terms of participant days, the training called for by KenGen and GDC in 2010-2014 amounts to roughly 9,200 participant days, the MFA-ICEDA/NDF sponsored activities in 2013-2017 to roughly 2,400 participant days, the training supported by EEA Grants in 2014-2017 to roughly 1,350 participant days and other miscellaneous training in 2010-2017 to just over 1,000 participant days. These numbers indicate that the scale of training called for by the Kenyan companies far surpasses other training efforts to date, as they have been categorized in this report. The large number of participant days is a testament to both the large groups that attended some of the trainings and the long duration of many activities. It

is also indicative of the emphasis placed by the Kenyan companies on enhancing the skills of junior employees soon after the establishment of GDC and the renewed vigor placed on geothermal development by the Kenyan Government at the time. Needless to say, the cooperation with KenGen and GDC has been of great importance to UNU-GTP through recent years, both in the MDG/SDG Short Courses in Kenya and the tailored training activities – not to mention the training in Iceland. The cooperation with MFA-ICEIDA/NDF and the partners of the EEA Grants projects has also been very important, with the former activities close to double those of the latter in terms of participant days. Other trainings that do not fit into the former categories account for the lowest number of participant days, at roughly 75% of the activities sponsored by EEA Grants. The numbers suggest that the formation of durable partnerships and linkages to specific project frameworks (e.g. the Geothermal Exploration Project for Africa and the EEA Grants scheme) are a good way to enhance training activities, while arrangements of ad-hoc trainings outside of such partnerships / frameworks are relatively rare.

It is also interesting to compare Short Courses and tailored trainings to the long term training programmes manifested in the Geothermal Diploma Course for Latin America and the 6-month Geothermal Training Programme in Iceland, as well as the last two to each other.

The Diploma Course in El Salvador covered roughly 16,800 participant days in the period 2013-2017 compared with roughly 17,900 participant days covered by the 6 Month Training Programme in Iceland over the same period. The two programmes therefore appear to be of a similar magnitude in terms of training effort. There are some similarities and differences between the two programmes that are worth pointing out. As the name implies, the 6 Month Training has a rough duration of 6 months, covering approximately 120 active days (i.e. days during which students are expected to be actively pursuing their work, whether it be by attending programmed activities or working on the final projects; weekends and holidays are not counted in). The Diploma Course has a shorter overall duration, typically 5 months (although this has been somewhat variable over the years due to external forces), but activities are often programmed on Saturdays. This brings the number of active days close to each other for the two programmes. The average number of students was also similar for the two programmes through this period, i.e. 28.8 in the Diploma Course and 30.0 in the 6 Month Training. Consequentially, the number of participant days is similar. Participant days, however, say nothing of the actual nature of the programmes, and there are some notable differences. While the Diploma Course offers a single study path giving an overview of the most important disciplines of geothermal development, with room for some specialization through group project work towards the end of the training, the 6 Month Training diverges into varied study lines after the first 6 weeks to allow students to specialize in their chosen field, with even greater specialization achieved through the extensive individual project work.

Over the period 2013-2017, all workshops, short courses and tailored trainings amounted to just over 13,000 participant days, compared to the 16,800 of the Diploma Course (rough) and 17,900 for the 6 Month Training (rough) over the same period. The overall scale of the short courses and tailored training activities was thus comparable to each of the long term annual programmes in terms of participant days. While the knowledge and know-how that is imparted through workshops, short courses and tailored training activities can in most cases be obtained within the long term training programmes, they cater to different needs and objectives. Some objectives are, for example:

- To reach out to decision makers with short overview programmes and discussion platforms to increase awareness of geothermal resources and their potential for utilization, which may in turn lead to greater support for geothermal projects. As decision makers are usually busy people, the events *need* to be short.
- To reach out to sizable groups of experts (say 60-70 at a time as has been the case for the Kenyan and Salvadoran Short Courses in recent years) with training on particular subjects considered to be of relevance and value to the target group. The training increases awareness and understanding, introduces repositories of knowledge that the participants can continue to draw upon, encourages dialogue between experts, and enhances skills that can be directly applied by the participants at home. The UN Development Goals short courses have also become a very important venue for UNU-GTP representatives to interview candidates for the more involved 6 month studies in Iceland. They have thus become a first screening stage for training in Iceland.

- To reach out to small groups of experts with very targeted training called for by their employers. In these cases, the training is tailored to the particular needs of the paying customer, often beyond the possibilities available in the long term annual training programmes. In the extreme case, there is an example where tailored training has been evaluated as equivalent with the 6-month training programme in Iceland, i.e. the *Advanced Training in Borehole Geology* (Section 4.1; Table 8) where 5 Kenyan borehole geologists undertook 6 month training in their native work environment.

Importantly, long term training is not suitable for all. Staying far away from home for 5-6 months is not an option for many people due to various reasons, e.g. commitments to work and/or family. In particular, it can be difficult for mothers of young children to commit to overseas studies for so long. Shorter term training on site can prove a good option in such cases.

In general, UNU-GTP places great significance on its work abroad – an important pillar of the programme.

## 6.2 Participation of women in training abroad

UNU-GTP has the policy of getting as close to gender parity, in its various facets of operation, as possible and this is reflected in the Strategic Plan 2016-2019 (UNU-GTP, 2016). The nomination of female candidates by partner institutions for training organized and financed directly by UNU-GTP has thus been encouraged and women have been preferentially selected from the candidate groups. Consequently, the ratio of women from particular countries in trainings organized and financed by UNU-GTP has on average been higher than the ratio of women nominated for the training, which in turn has hopefully been higher than the ratio of women in the workforce.

As is the case in many industrialized countries, the ratio of women entering the STEM (science, technology, engineering, and mathematics) subjects in many developing countries is low, and more so in some countries than others. Despite this, UNU-GTP has been able to increase the ratio of women participating in trainings directly sponsored by the programme over recent years (Figure 25). However, in cases where trainings are sponsored by others, UNU-GTP has less control over the make-up of the participant group. In some cases, trainings have been held for the entire group of geothermal experts in a particular country, and in those cases the ratio of women is indicative of the actual ratio of women in the geothermal workforce.

The number and percentage of women participating in particular training activities has been reported in Tables 1, 3, 5, and 7-13, as well as in the main text. By looking at these numbers, the following can be stated:

- The average ratio of women in the Kenyan MDG Short Courses was 23.6% over the period 2006-2015 (note that the Short Course on project management in Uganda in 2008 is omitted here, as it was different in character from the surface exploration Short Courses in Kenya and is thus not helpful in spotting a trend). The ratio was below this value in the period 2006-2011 and above it in the period 2012-2015, with the highest ratio of 30.6% in 2015. In the SDG Short Courses for Africa, the ratio was 34.4% in 2016 and 34.9% in 2017. The ratio has thus increased from below and close to 20% in the early years of the courses to about a third in recent years. A linear trend through the values has a positive slope (Figure 25), indicating an overall improvement through the years.
- The average ratio of women in the MDG Short Courses for the LAC region was 31.9% over the period 2009-2015. The ratio decreased from 40.6% in 2009 to close to 23% in 2011 and 2012, before rising to 29.5% in 2013, 41.8% in 2014 and 42.9% in 2015. The ratio was 33.8% in SDG Short Course I in 2016 and 48.5% in 2017. A linear trend through the values has a positive slope (Figure 25).
- Participation of women in the MDG/SDG short course series is lower in Africa than the LAC region (Figure 25), although there is more scatter in the latter case than the former.

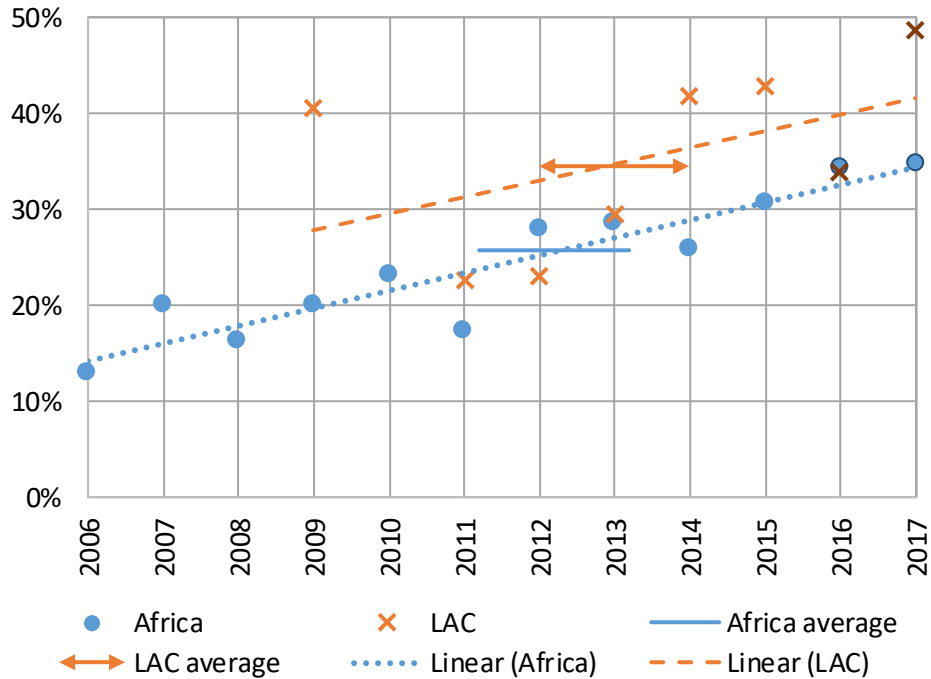


FIGURE 25: Share of women in the MDG and SDG Short Courses in Kenya and El Salvador, with the latter series denoted by black marker borders (2016 and 2017) (Tables 1, 3, 5, and 7). Linear trends through the data points indicate an improvement over time.

- In the single workshop held for Asian countries in China in 2008, the ratio of women was close to 20%.
- The ratio of women participating in the training activities for KenGen and GDC in 2010-2014 was close to 29%, 16.0% in the training sponsored by MFA-ICEIDA/NDF, 31.2% in the courses funded in Europe through EEA Grants, and 19.0% for all of the other trainings (Figure 26). The low ratio participating in the ICEIDA-MFA/NDF sponsored training is notable. Some reasons can be mentioned: i) Many of the trainings were held in countries where the ratio of women in the workforce is low; ii) Many of the trainings were held for the whole, or a substantial part, of the geothermal workforce in the country; iii) Some of the trainings were held for decision makers from African countries, who tend to be males. The ratio of women attending the training for the Kenyan geothermal companies is somewhat higher than the ratio for the African MDG Short Courses over the same period, 24.8%. As the participants in the latter trainings are invited from many different African countries, the higher ratio of women in the former may be a testament to women comprising a greater part of the geothermal workforce in Kenya than in some of the neighbouring countries. The ratio of women in the short courses in the Azores was 28.6-50.0% depending on courses, whereas the ratio in Romania was 15.0-33.3% in the four courses there. The ratio in the Hungarian group was 45.5%.
- UNU-GTP has stressed the importance of female participation in the Diploma Course in El Salvador. The ratio of women in the course has varied from 23.1% to 50.0% within the period 2013-2017, with an average of 31.9% and parity reached in 2017. The average for the 6 Month Training in Iceland over the same period was 33.3%, with a variation from 29.4% in 2013 to 41.2% in 2016.

Although comparing the number of women to the overall number of participants taking part in a training activity is telling for any particular event and for spotting trends in time, an assessment of how training activities have benefitted women overall is better undertaken by comparison of participant days (Table 17).

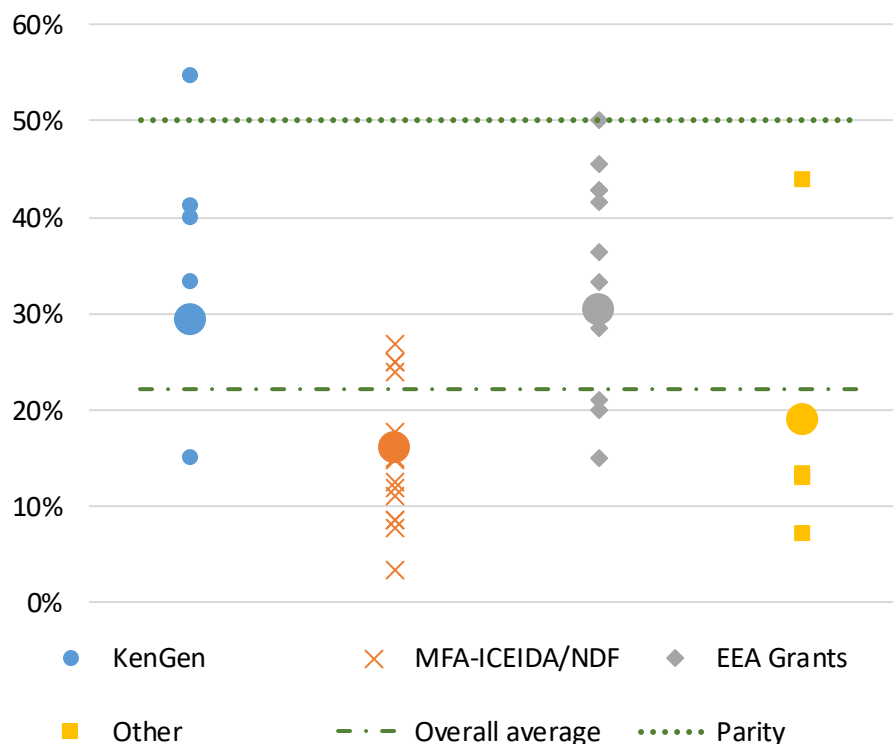


FIGURE 26: The ratio of women taking part in tailored trainings by category. The big dots denote the average ratio within each category. As the number of women is not certain for the two training activities held for GDC in 2010 and 2012, only the trainings held for KenGen are reported here.

TABLE 17: Participation of women in workshops, short courses and tailored trainings as evaluated by a simple head count vs. participant days

Category	Period (20xx)	Participants	Women	% women by number	Participant days	Participant days   Female <sup>1</sup>	% women by participant days
<b>UN Development Goals Trainings (MDG + SDG)</b>							
Africa	05-17	678	~168 <sup>2</sup>	~25%	12,864	3,316 <sup>2</sup>	~26%
LAC	06-17	546 <sup>3</sup>	~183 <sup>4</sup>	~34%	3,460	1,180 <sup>4</sup>	~34%
Asia	08	118	~23 <sup>5</sup>	~19.8% <sup>5</sup>	708	138 <sup>5</sup>	~19.8% <sup>5</sup>
<b>TOTAL</b>	<b>05-17</b>	<b>1,342</b>	<b>374</b>	<b>~28%</b>	<b>17,032</b>	<b>4,634</b>	<b>~27%<sup>6</sup></b>
<b>Tailored trainings</b>							
KenGen/GDC	10-14	193	~56 <sup>7</sup>	~29%	9,214	2,516 <sup>7</sup>	~27%
MFA-ICEIDA/NDF	13-17	344 <sup>3</sup>	55 <sup>3</sup>	16.0%	2,406	343	14.3%
EEA Grants	14-17	205 <sup>3</sup>	64 <sup>3</sup>	31.2%	1,343	471	35.1% <sup>8</sup>
Other	10-17	126	24	19.0%	1,029	195	19.0%
<b>TOTAL</b>	<b>10-17</b>	<b>868<sup>6</sup></b>	<b>199<sup>6</sup></b>	<b>~23%</b>	<b>13,992</b>	<b>3,525</b>	<b>~25%</b>
<b>Annual long term programmes</b>							
Dipl. Course	13-17	144	46	31.9%	16,834	5,358	31.8%
6 Month Tr.	13-17	150	50	33.3%	17,937	5,985	33.4%

1: Days attended by female participants; 2: The number of women attending the initial Workshop in Kenya is estimated (see note 3 in Table 14); 3: Some participants have attended more than one training; 4: The number of women attending the initial Workshop and MDG SC I in El Salvador is estimated (see note 5 in Table 14); 5: The number of women attending the Workshop in China in 2008 is estimated (see note 6 in Table 14); 6: The courses in Kenya generally weigh more than the activities in China and El Salvador due to longer duration; 7: The number of women is estimated for two trainings (Table 8); 8: The ratio of women was generally higher in the longer, and greater number of, short courses in the Azores than in Romania, which explains the rise from simple head counting.

By scrutinizing Table 17, one will observe that the ratios are very similar for the MDG and SDG Short Course series regardless of whether they are assessed by head count or participant days. There is a slight increase in the ratio for the series in Africa from head count to participant days, while there is a slight decrease in the overall ratio for all MDG and SDG trainings. The latter is due to the increased weight of the African series when counting participant days (75.5% of the total) compared to head counting (50.5%) and lower female participation in Africa than in Latin America and the Caribbean. When looking at the tailored trainings one will observe that the ratio decreases for the trainings undertaken for the Kenyan geothermal companies in 2010-2014 when going from head count to participant days, which seems to indicate that on average there was a lower ratio of women in training activities of long duration than of shorter duration. The same is observed for the MFA-ICEIDA/NDF sponsored trainings. In the case of the training activities supported through the EEA Grants scheme, the ratio is significantly greater when assessed through participant days than through head counting. This is explained by the simple fact that the ratio of women in the short courses held in the Azores tended to be larger than the ratio in the short courses held in Romania. Thus, with the former courses being both greater in number and having longer duration, the shift is to be expected. There is no difference in the ratio for the miscellaneous trainings. Overall, women participation in tailored training activities is 2 percentage points higher when evaluated through participant days than by head counting.

Again, while head counting is useful to observe trends through time, the participant day method more accurately assesses how the benefits of trainings have been distributed among the genders.

The goal is to continue increasing the share of women who receive training through encouragement and preferential selection where possible. Preferential selection is mostly applicable in trainings that are directly sponsored by UNU-GTP, but in the case of tailored trainings where the funding and initiative lies with the customer, the final selection of participants may not be up to UNU-GTP. Variation is bound to exist between different trainings, but it is important that the trends be in the right direction.

### **6.3 Evaluation of training beyond scale**

When evaluating training, there are many aspects to look to, e.g. location of training and geographical reach, number of participants and their background (employers, academic degrees, experience), subjects covered (superficial and broad (e.g. overview courses such as workshops for decision makers) vs. deep and focused (e.g. training tailored to the needs of particular experts such as TFT measurements)), method of instruction (e.g. lectures, exercises, project work, field work), duration, relevance (how well does the subject material and training approach match the needs of the target group?), overall quality, impact etc. – and perhaps the degree of bureaucracy should be mentioned as well. Some of these aspects can be presented quantitatively in a straightforward manner, while other aspects cannot be evaluated in such a concise way and need a more subjective coverage. Some of the statistics presented, and elaborated on, in this paper fall into the former category.

## 7. CONCLUSION

Training activities abroad have been an important part of UNU-GTP operations since 2005. They have been extensive in geographical reach, coverage of subject material, and scale. Trainings have been held in Africa, Asia, Europe, Latin America and the Caribbean, covering subjects from surface exploration to utilization and management of geothermal resources. The scale of these activities in the period 2013-2017 was comparable to the 6 Month Training Programme in Iceland in terms of participant days. Importantly, workshops, short courses and tailored training activities cater to needs that cannot be met through long term standardized training such as the 6 Month Geothermal Training Programme in Iceland or the Geothermal Diploma Course for Latin America. For example:

- Workshops can cater to the needs of decision makers who are short on time;
- Short courses can reach out to larger numbers of people than could possibly participate in long term trainings;
- Tailored trainings can be designed to meet very specific needs; and
- Short term training may be the only choice for people with young families (especially women) and/or demanding work commitments that do not allow spending extended periods overseas.

The training activities abroad are an important aspect of UNU-GTP's operations, and complementary to the training in Iceland.

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