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United Nations University Geothermal Training Programme in Iceland: Training Activities Abroad

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ABSTRACT

Since 2005, the United Nations University Geothermal Training Programme (UNU-GTP) has conducted and collaborated on varied training activities outside of Iceland. A Short Course series supporting the UN Millennium Development Goals (MDGs) on Surface Exploration for Geothermal Resources was started in 2005 in Kenya to benefit African countries. A similar series was started in 2006 in El Salvador to benefit Latin American and Caribbean countries, where the topics change each year. A workshop for decision makers on direct use of geothermal resources was held in China in 2008 for Asian countries. The Short Course series in Kenya and El Salvador were overhauled in 2016 in support of the UN Sustainable Development Goals (SDGs). A total of 1449 participants benefitted from the 26 Short Courses and Workshops dedicated to the UN Development Goals over the period 2005-2018.

Since 2010, UNU-GTP has offered tailored training on demand. These trainings have varied in topics, target groups and duration. Forty three workshops, short courses and extended training programmes have been conducted in four continents at the end of 2018, benefitting 922 participants.

Since 2013 UNU-GTP has contributed to a geothermal Diploma Course run within the academic framework of the University of El Salvador, first in an assessment and advisory role (2013-2015) and later as an implementing partner (2016-2018). The programme has greatly increased the possibilities for aspiring Latin American geothermal professionals to obtain dedicated training in the geothermal disciplines in their native tongue. Likewise, the African Geothermal Centre of Excellence (AGCE) has been gaining momentum in recent years. UNU-GTP has had an advisory role in its conceptualization and conducted one of two opening short courses under the interim phase in cooperation with local partners in 2017. The annual SDG Short Courses in Kenya may become an integral component of the AGCE.

The impact of UNU-GTP training abroad is evaluated in terms of scale (participant days) and an elementary theory of change is presented. In line with its gender equality policy, UNU-GTP has a positive impact on the participation of women in developing countries' geothermal sector through its gender balanced candidate selection.

1. INTRODUCTION

In 2005, the United Nations University Geothermal Training Programme (UNU-GTP) ran its first geothermal workshop abroad in cooperation with local partners. This initial workshop was followed up with further training activities in the following years, all financed by UNU-GTP. In 2010, the programme started offering tailored training to paying customers. Another step was taken in 2013, when UNU-GTP started contributing in an advisory role to a regional geothermal programme for Latin America, later becoming a full implementing partner. These activities and their impacts are discussed further in subsequent sections.

2. THE UN MILLENNIUM SHORT COURSE SERIES

In 2005-2015, UNU-GTP held Workshops and Short Courses with partners in Kenya, El Salvador and China, dedicated to supporting the UN Millennium Development Goals (MDGs) as further described below.

2.1 Africa

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 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 also Geothermal Development Company Ltd. (GDC, since 2009) 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 (Table 1 and Figure 1).

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 (dd.mm.yy)	No. countries	No. particip.	No. women	Particip. days
WS[1] for Dec. Makers on Geoth. Projects and their Management	14-18.11.05	5	30		150
SC[2] I on Surface Exploration for Geothermal Resources	13-22.11.06	6	23	3 (13%)	195.5
SC II on Surface Exploration for Geothermal Resources	02-17.11.07	11[3]	30	6 (20%)	405
SC III on Exploration for Geothermal Resources	24.10-17.11.08	11[3]	37	6 (16%)	888
SC on Geothermal Project Management and Development	20-22.11.08	10[3]+2[4]	24	2 (8%)	72
SC IV on Exploration for Geothermal Resources	01-22.11.09	11[3]	45	9 (20%)	945
SC V on Exploration for Geothermal Resources	29.10-19.11.10	13[3]	56	13 (23%)	1176
SC VI on Exploration for Geothermal Resources	27.10-18.11.11	15[3]	58	10 (17%)	1276
SC VII on Exploration for Geothermal Resources	27.10-18.11.12	14[3]	61	17 (28%)	1311.5
SC VIII on Exploration for Geothermal Resources	31.10-23.11.13	18[3,5]	70	20 (29%)	1505
SC IX on Exploration for Geothermal Resources	02-23.11.14	18[3]	58	15 (26%)	1189
SC X on Exploration for Geothermal Resources	09-30.11.15	18[3]	62	19 (31%)	1271
	Total:	**22[3]+2[4]**	**554[6]**	**120+ (~23%)**	**10,384**

1: Workshop; 2: Short Course; 3: Including Yemen; 4: One participant came from Germany and another from Italy; 5: One of the participants represented the African Development Bank; 6: Algeria (2), Burundi (14), Cameroon (3), Comoros (14), D.R. Congo (13), Djibouti (25), Egypt (2), Eritrea (19), Ethiopia (35), Kenya (256), Malawi (14), Morocco (1), Mozambique (7), Niger (1), Nigeria (6), Rwanda (28), Sudan (8), Tanzania (35), Uganda (35), Zambia (17), Zimbabwe (1), Yemen (15), others (3).

Figure 1: Snapshots from the MDG Short Courses in Kenya.

2.2 Latin America and the Caribbean

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 2, 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 was one week, with an exception in 2007 (Table 2). These Short Courses were carried out in English and Spanish according to the preference of lecturers, with translation offered between the two languages for those who need it.

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 MDG Workshop and Short Courses were attended by 412 participants from 15 countries in Latin America and the Caribbean over the period 2006-2015 (Table 2; Figure 2).

2.3 Asia

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, 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.

TABLE 2: Workshop and Short Courses held in El Salvador in support of the MDGs 2006-2015.

Name	Dates (dd.mm.yy)	No. countries	No. particip.	No. women	Particip. days
WS for Decision Makers on Geoth. Projects in Central America	27.11-02.12.06	4	50		250
SC I on Geothermal Development in Central America: Resources Assessment and Environmental Management	25.11-01.12.07	6	45		270
SC II on Surface Exploration for Geothermal Resources	17-30.10.09	7+2[1]	32	13 (41%)	384
SC III on Geoth. Drilling, Resource Developm. and Power Plants	16-22.01.11	10	62	14 (23%)	372
SC IV on Geothermal Development and Geothermal Wells	11-17.03.12	12[2]	65	15 (23%)	390
SC V on Conceptual Modelling of Geothermal Systems	24.02-02.03.13	12	61	18 (30%)	366
SC VI on Utilization of Low- and Medium Enthalpy Geothermal Resources and Financial Aspects of Utilization	23-29.03.14	13[3]	55	23 (42%)	330
SC VII on Surface Exploration for Geothermal Resources	14-22.03.15	13	42	18 (43%)	294
	Total:	**15+2**	**412[4]**	**~1/3**	**2,656**

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 (4), Chile (17), Colombia (18), Costa Rica (27), Dominica (9), El Salvador (136), Ecuador (11), Guatemala (9), Honduras (18), Mexico (22), Montserrat (2), Nicaragua (66), Peru (6), St. Kitts and Nevis (9), and St. Vincent and the Grenadines (1), others (7). Some of the participants have attended more than one course.

Figure 2: Snapshots from the MDG Short Courses in El Salvador.

2.4 The role of MDG Workshops and Short Courses in strengthening other facets of UNU-GTP's operations

By designing programmes covering a range of subjects, preparing lecture material, publishing papers, and cooperating across borders, a considerable wealth of material and experience accumulated within UNU-GTP through the MDG Workshops and Short Courses. This fed into and strengthened other facets of UNU-GTP operations, in particular contributing to the possibility of offering training that is tailored to the needs of a particular client, as well as enriching the 6 month training in Iceland (e.g. through the distribution of Short Course papers to Fellows and a greater understanding of lecturers who have contributed to trainings abroad of the local conditions, which translates into greater relevance in approach). The papers have been published on CDs and are available on UNU-GTP's website: *www.unugtp.is*.

3. THE UN SUSTAINABLE DEVELOPMENT GOALS SHORT COURSE SERIES

The United Nations Sustainable Development Summit 2015 was held during 25-27 September 2015. On the opening day of the summit, the Sustainable Development Goals (SDGs) were unanimously adopted as targets to be reached by 2030 (United Nations, 2015). 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 adoption of the Goal by the UN system was therefore very much welcomed.

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.*

The Short Courses are well suited to help fulfil SDG 7 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 the main alternatives;
- The Short Courses come about through international cooperation that is meant to facilitate research and transfer knowledge between countries and generations; and
- The Short Courses are directed at the developing countries and Small Island Developing States (e.g. Caribbean Islands and the Comoros).

In addition, the courses support 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 a challenge 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.

3.1 SDG Short Courses for Latin America and the Caribbean

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. 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 & Haraldsson, 2017). The first three courses in the series are shown in Table 3 and photos are shown in Figure 3.

Table 3: SDG Short Courses for Latin America and the Caribbean (LAC region).

Name	Dates (dd.mm.yy)	No. countries	No. particip.	No. women	Particip. days
SDG SC I on Sustainability and Environmental Management of Geothermal Resource Utilization, and the Role of Geothermal in Combatting Climate Change	04-10.09.16	14[1]	68	23 (34%)	408
SDG SC II on Feasibility Studies for Geothermal Projects	17-23.09.17	14[2]	66	32 (48%)	396
SDG SC III on Reservoir Characterization: Well Logging, Well Testing and Chemical Analysis	16-22.09.18	18	76	29 (38%)	456
	Total:	**18[3]**	**210**	**84 (40%)**	**1,260**

1: As well as representatives from the World Bank; 2: As well as a representative from the Organization of Eastern Caribbean States; 3: Argentina (5), Bolivia (9), Chile (4), Colombia (16), Costa Rica (5), Dominica (2), Ecuador (7), El Salvador (95), Guatemala (2), Honduras (2), Jamaica (1), Mexico (16), Montserrat (3), Nicaragua (23), Peru (7), St. Kitts and Nevis 5), St. Lucia (2), St. Vincent and the Grenadines (4), Others (2).

Figure 3: SDG Short Course I in El Salvador.

3.2 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 (Figure 4). 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.

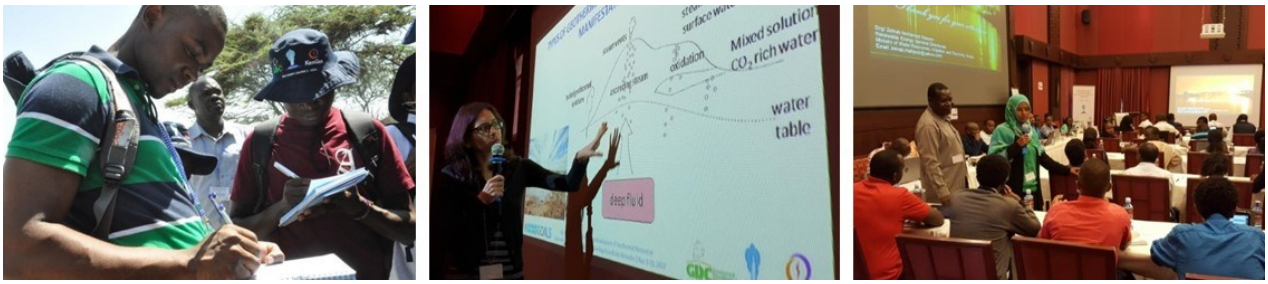

Figure 4: SDG Short Courses I and II in Kenya.

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 4 and the first three courses in the series are listed in Table 5.

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 (Haraldsson, 2018). At the end of 2018, a total of 43 training programmes of short, medium and long duration had been conducted. Twenty-three of those had been conducted in African countries (Djibouti (3), Ethiopia (5), Kenya (12), and Rwanda (3)), 16 in Europe (Iceland (4), Portugal / Azores (8), and Romania (4)), 2 in Asia (Indonesia), and 2 in Latin America (El Salvador (1) and Mexico (1)). These activities 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.

Table 4: 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

Table 5: SDG short courses for Africa.

Name	Dates (dd.mm.yy)	No. countries	No. particip.	No. women	Particip. days
SDG SC I on Exploration and Development of Geothermal Resources	10-30.11.16	16	61	21 (34%)	1220
SDG SC II on Exploration and Development of Geothermal Resources	09-29.11.17	17	63	22 (35%)	1260
SDG SC III on Exploration and Development of Geothermal Resources	07-27.11.18	13	32[1]	11 (34%)	640
	Total:	**19[2]**	**156**	**54 (35%)**	**3,120**

1: GDC did not participate in 2018, resulting in fewer participants; 2: Cameroon (3), Comoros (5), Djibouti (7), Democratic Republic of the Congo (DRC) (3), Egypt (1), Eritrea (3), Ethiopia (10), Kenya (82), Madagascar (2), Malawi (6), Morocco (3), Mozambique (1), Nigeria (3), Rwanda (4), Sudan (3), Tanzania (7), Uganda (8), Yemen (1), Zambia (4).

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. Eighteen 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 922 participants have benefitted from these trainings (but fewer individuals as some have attended more than one training), accounting for around 14,100 participant training days.

4.1 Training for the Kenyan geothermal companies

From 2010 to 2014, UNU-GTP carried out 8 training activities for the two large Kenyan geothermal companies, KenGen and GDC (Table 6). 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. The increase in training demand also reflects the added emphasis placed by the Government of Kenya on the development of the country's geothermal resources.

Table 6: Training activities for GDC and KenGen in 2010-2014.

Name	Dates (dd.mm.yy)	Client	No. part.	No. women	Participant days
Short Course on Geoscientific Exploration	17.05-13.06.10	GDC	49	*14*[1] (*29%*)	1176
Course on Geoscientific Exploration for Geothermal Resources	13.09.10-22.01.11	KenGen	40	6 (15%)	2440
Training in Borehole Geology	14.11.11-03.03.12	GDC	8	*2*[1] (*25%*)	480
Course on Geothermal Technology	16.04-14.07.12	KenGen	45	13 (29%)	3510
Advanced Training in Borehole Geology	16.07.12-02.02.13	KenGen	5	2 (40%)	780
Advanced Training in Geothermal Geochemistry	22.08-29.09.12	KenGen	17[2]	7 (41%)	282[3]
Training in TFT-Measurements of Two-Phase Flow	31.03-12.04.14	KenGen	18	6 (33%)	216
Advanced Training in Structural Geology	31.03-26.07.14	KenGen	11	6 (55%)	330
		Total:	**193[4]**	***56 (29%)***	**9,214**

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.

Some of these trainings (those counting more than 500 participant days) are described further below.

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; Figure 5).

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, the second one covered chemistry of thermal fluids, and the third phase was devoted to geophysical exploration. All of the phases consisted of lectures, exercises, field work, and project work (Georgsson et al., 2010).

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 six modules held from 16 April – 14 July, 2012: Geological Exploration and First Introduction to Borehole Geology (2 weeks); Geophysical Exploration (3 weeks); Chemistry of Thermal Fluids and Environmental Management (2 weeks); Reservoir Monitoring (2 weeks); Drilling Technology (2 weeks); and Borehole Geology (2 weeks).

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 from 16 July 2012 to 2 February 2013, with a break over holidays. 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*) 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 (Georgsson et al., 2020). 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 KenGen and UNU-GTP.

The on-site instruction for these trainings was carried out by experts from ÍSOR – Iceland GeoSurvey.

4.2 Training sponsored by MFA-ICEIDA and NDF in Africa

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 7. 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.

Table 7: Trainings and workshops for African countries supported by MFA-ICEIDA as part of the Geothermal Exploration Project. Many of the trainings were co-funded by NDF.

Name	Dates (dd.mm.yy)	Host country	Beneficiary countries	No. part.	No. women	Particip. days
SC on Deep Geothermal Exploration	25-29.06.13	Rwanda	Rwanda	20	3 (15%)	100
SC on Geothermal Development for Decision Makers from Burundi, DRC and Rwanda	25-28.09.13	Kenya	Burundi, DRC, Rwanda	13	1 (8%)	52
SC on Geothermal Development for Decision Makers from Malawi, Tanzania and Zambia	26-30.11.13	Kenya	Malawi, Tanzania, Zambia	23	2 (9%)	115
Workshop for Geothermal Development Donors	27-28.05.14	Iceland	African countries[1]	48	12 (25%)	96
SC on Well Design and Geoth. Drilling Technology	12-24.01.15	Ethiopia	Ethiopia	30	1 (3%)	360
SC on Preparations of Bankable Geoth. Documents	26.01-03.02.15	Ethiopia	Ethiopia	25	6 (24%)	200
SC on Geothermal Project Management	9-20.02.15	Ethiopia	Ethiopia	25	3 (12%)	250
SC on Geothermal Project Management	18-28.05.15	Kenya	Kenya	26	7 (27%)	260
SC on Preparation of Bankable Documents for Geothermal Projects	5-10.09.15	Djibouti	Djibouti	18	2 (11%)	108
SC on Geothermal Project Management	12-21.09.15	Djibouti	Djibouti	16	2 (13%)	144
SC on Well Design and Geothermal Drilling Technology	14-26.05.16	Djibouti	Djibouti	23	2 (9%)	276
SC on Borehole Geophysics for Geothermal Development	6-18.06.16	Ethiopia	Ethiopia	27	4 (15%)	297
SC on Project Management for Geothermal Development	31.10-01.11.16	Ethiopia	East Africa	34	6 (18%)	68
Introductory SC on Geothermal Project Management	26-30.05.17	Kenya	Kenya	16	4 (25%)	80
			Total:	**344[2]**	**55[2] (16%)**	**2,406**

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 first of the trainings requested and supported by ICEIDA was *Short Course on Deep Geothermal Exploration*, held in Kigali, Rwanda in June 2013. 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 next efforts were directed towards decision makers in the geothermal sector to increase understanding and awareness of geothermal resources. Two similar courses were held in Kenya for decision makers from Burundi, DRC and Rwanda on one hand and Malawi, Tanzania and Zambia on the other. The third one assembled geothermal development donors and decision makers for a 2 day workshop in Iceland.

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; and
3) Wells and drilling.

All three types of courses were run in Ethiopia at the beginning of 2015, with repetitions or similar setups run subsequently in other countries. The project management courses in particular were run repeatedly, albeit with different durations depending on the needs of the particular settings, going from a 2 day condensed overview course at the ARGeo-C6 in Addis Ababa up to two week involved affairs, which included an exam for D-level certification of the International Project Management Association. A course on borehole geophysics was also conducted in Ethiopia in 2016.

In 2018, MFA-ICEIDA also sponsored two additional courses in connection to the ARGeo-C7 in Kigali as shown in Table 8.

Table 8: Two of the short courses leading up to the Seventh African Rift Geothermal Conference in Kigali, Rwanda, 2018.

Name	Dates (dd.mm.yy)	Beneficiary countries	No. part.	No. women	Particip. days
SC I on Management and Financing for Geoth. Project Development	29-30.10.18	12[1]	25	6 (24%)	50
SC II on Low-T Geoth. Systems and Direct Use Applications	29-30.10.18	12[2]	24	8 (33%)	48
			49	**14 (29%)**	**98**

1: Burundi (2), Comoros (1), DRC (1), Djibouti (1), Ethiopia (2), Kenya (9), Malawi (1), Mozambique (1), Rwanda (3), Tanzania (2), Uganda (1), China (1); 2: Burundi (1), Comoros (1), DRC (1), Djibouti (1), Ethiopia (2), Kenya (7), Malawi (1), Mozambique (1), Rwanda (5), Tanzania (1), Uganda (2), Germany (1).

Out of the trainings sponsored by ICEIDA / MFA-ICEIDA for African countries (Figure 5), 6 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, 1 to direct uses, and 1 has been an overview course on deep geothermal exploration. These have covered a total of 2,504 participant days.

Figure 5: Photos from the trainings sponsored by MFA-ICEIDA in Africa over the period 2013-2018. Many of the trainings were co-funded by NDF. Left to right, top to bottom: Same sequence as in Tables 7 and 8.

4.3 Training funded by EEA Grants in Europe

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 (OS), 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.

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 9; Figure 6). A seventh short course was also called for and paid directly by EDA Renováveis, subsequent to the courses sponsored by EEA Grants (Table 10). 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. Four employees of EDA Renováveis were also enrolled in the 6-month training in Iceland in 2014 and 2015 as part of the collaboration.

Table 9: Workshop and short courses funded by EEA Grants during the period 2014-2017.

Name	Dates (dd.mm.yy)	No. part.	No. women	Particip. days
Azores				
Workshop on Geothermal Energy for Decision Makers	08-09.09.14	14	4 (29%)	28
Short Course I on Geological Exploration of Geothermal Fields	10-20.09.14	11	4 (36%)	104.5
Short Course II on Geothermal Utilization and Geothermal Power Plants	17-29.11.14	14	6 (43%)	154
Short Course III on Borehole Geophysics in Geothermal Development	15-27.06.15	11	5 (45%)	126.5
Short Course IV on Chemistry of Thermal Fluids	07-19.09.15	12	6 (50%)	138
Short Course V on Well Design and Geothermal Drilling Technology	18-30.01.16	14	6 (43%)	140
Short Course VI on Geophysical Exploration for Geothermal Resources	4-16.04.16	12	5 (42%)	132
Total:				**823**
Romania				
Workshop on Utilization of Geothermal Resources for Decision Makers from Romania	27-28.05.16	18	6 (33%)	36
Short Course I on Utilization of Low- to Medium-Enthalpy Geothermal Resources	04-08.04.16	38	8 (21%)	190
Short Course II on Geothermal Resource Exploration	30.05-03.06.16	20	3 (15%)	100
Short Course III on Resource Assessment and Management	13-17.03.17	30	6 (20%)	150
Total:				**476**
Hungary				
Short Course on Status of Geothermal Energy	11-14.10.16	11	5 (45%)	44
Total EEA short courses:				**1,343**

Figure 6: Participants engaged in field work during Short Course VI on Geophysical Exploration for Geothermal Resources in São Miguel island of the Azores.

In the summer of 2015, UNU-GTP entered into a partnership agreement with the University of Oradea in Romania 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 9), as well as the enrolment of 4 Romanian Fellows in the 6-month training programme in Iceland in 2016.

In 2016, 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 (Table 9).

4.4 Other tailored trainings

In addition, UNU-GTP has conducted various other short and long term training activities in collaboration with partners in Asia, Europe and Latin America (Table 10).

Table 10: Miscellaneous tailored trainings.

Name	Country	Sponsor	Dates (dd.mm.yy)	No. part.	No. women	Particip. days
Course on Geothermal Drilling	Indonesia	SenterNovem	25.01-19.02.10	16[1]	3 (19%)	316[2]
Short Course on Geothermal Scaling and Corrosion	Indonesia	Pertamina, World Bank, Netherlands Embassy	19-23.04.10	23	3 (13%)	115
Short Course on Geothermal Exploration and Development	El Salvador	Organization of American States	07-12.11.11	14	1 (7%)	84
Short Course on Geothermal Exploration	Mexico	CeMIEGeo	24-29.11.14	42	8 (19%)	252
SC VII on Geothermal Drilling Operations[3]	Azores, Portugal	EDA Renováveis	27.02-10.03.17	15	2 (13%)	150
ARENA Programme in Iceland	Iceland	MFA[4]	05-11.11.17	16	7 (44%)	112
OSCE[5] Field Study on Geotherm. Energy	Iceland	MFA	10-11.09.18	5	2 (40%)	10
			Total:	**131**	**26 (20%)**	**1,039**

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; 3: Following up on the short courses supported by EEA Grants; 4: Icelandic Ministry for Foreign Affairs 5: Organization for Security and Cooperation in Europe.

5. REGIONAL TRAINING CENTRES

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 & Montalvo, 2011; Caprai et al., 2012; Haraldsson et al., 2013; Axelsson, 2013; Haraldsson, 2015). 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 11). During this period 10 scholarships were reserved on an annual basis 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.

Table 11: Diploma Course in El Salvador 2013-2018.

Year	Direct funding	UNU-GTP role	Dates (dd.mm)	Countries	No. particip.	No. women	Participant days
2013	NDF / IDB	Advisory	08.08-15.12	8[1]	26	7 (27%)	2,886[2]
2014	NDF / IDB	Advisory	02.06-07.11	8[3]	26	6 (23%)	3,276[4]
2015	NDF / IDB	Advisory	01.06-09.11	7[5]	32	9 (39%)	4,192[6]
2016	NDF	Implementation partner	15.08-17.12	7[7]	30	9 (30%)	2,970[8]
2017	NDF	Implementation partner	26.06-01.12	8[9]	30	15 (50%)	3,510[10]
2018	MFA-ICEIDA / NDF	Implementation partner	25.06-07.12	7[11]	30	10 (33%)	3,480[12]
			Total:	**11**	**174**	**56 (32%)**	**20,314**

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; 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); 11: Argentina (1), Bolivia (1), Colombia (1), El Salvador (18), Honduras (1), Mexico (3), Nicaragua (5); 12: Rough estimate of 116 active days based on the academic calendar. SDG Short Course III accounted for 5 of those days.

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 (MFA-ICEIDA) as the implementing agency. UNU-GTP also became a direct implementing partner along with LaGeo and the University of El Salvador (Table 11). 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. In 2018, MFA-ICEIDA became a direct financial sponsor of the programme, providing over 50% of funding.

With the changes that took place in 2016, it was decided to include the annual UNU-GTP / LaGeo Short Course as an integral part of the Diploma Course curriculum (Section 3.1). 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 2016-2018. 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 African Geothermal Centre of Excellence

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 3.2) within the framework of the AGCE has been discussed (Georgsson, 2018), but some work remains before this can be implemented.

5.3 Sino Icelandic Geothermal Training Program

The possibility of establishing a geothermal training programme in China, with academic support from UNU-GTP, has been discussed. As of late 2019, Sinopec Green Energy Company / Sinopec Management Institute has plans to run a 5 week geothermal training programme for 40 Chinese participants in cooperation with Orkustofnun – the National Energy Authority of Iceland / UNU-GTP (Georgsson et al., 2020). The programme may evolve and expand, depending on the aspirations of the Chinese counterparts.

6. IMPACT OF UNU-GTP TRAINING ACTIVITIES ABROAD

Evaluating the impact of training abroad is a challenging, albeit achievable, task. A qualitative evaluation can be based on a theory of change as covered further below (Sections 6.2 and 6.3) and some numbers, indicators and trends can also be assessed for a quantitative appraisal (Sections 6.1 and 6.3).

6.1. The scale of training abroad

While the number of participants and duration of training are both partial indicators of how extensive a training programme is, the two are often combined in a single metric that can be used to compare the scale of different training activities. In short,

$$PD = \sum_{i=1}^{N} P_i \cdot fD_i \quad (1)$$

where N, P_i and fD_i are the number of days of instruction, number of participants taking part in the training on each day, and the fraction of a whole day (0-1, with a standard whole day taken as 8 hours or thereabouts) over which the training extends. In many cases the number of participants is constant for the duration of training, with the training filling a whole day's schedule, in which case Equation 1 can be expressed simply as $PD = P \cdot D$, with D denoting the total number of active days. There are certain caveats in this metric, however, that need to be kept in mind.

When one looks at a training activity designed as a single line of study for a particular group, the total number of active days (D) can be viewed as a rough measure of the amount of information that is conveyed, assuming that information exchange is roughly constant between days and between trainings. If one assumes that each participant absorbs this information in much the same way, even when comparing between different training activities, the number of participants (P) can be looked at as an indicator of how often the information is copied. The nature of these two indicators is therefore quite different and their combination in a single product should be taken with some caution. Thus, although 5 participants training for 1 day will yield the same PD metric as 1 participant training for 5 days, the impact is different in character. The former will convey more superficial knowledge to many, while the latter conveys deeper knowledge to few. Either case may be appropriate depending on the particular needs of the target group.

Another caveat, or limitation, of the PD metric, becomes apparent when considering trainings with a divergence in study paths. In such cases, there are in effect two or more programmes ongoing at the same time within the training, i.e. two or more active information streams running in parallel. More information is conveyed and more extensive resources are needed than for trainings with a single study path for all. The PD metric is blind to the greater degree of specialization that is offered in such divergent trainings and will yield the same result as for non-divergent programmes. Such divergence can for example manifest in different group projects during short term trainings or in branching from introductory studies to specialized studies to project work in long term training programmes, as is the case in the UNU-GTP 6 month studies offered in Iceland (Georgsson et al., 2020) and to a lesser degree in the Geothermal Diploma Course for Latin America offered in El Salvador.

With these caveats in mind, the participant-day indicator can be useful. 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.

Participant days reported in Tables 1-3 and 5-11 are summarized in Table 12 below.

Table 12: Summary of accumulated participant days as reported in Tables 1-3 and 5-11, with the addition of the 6 month training in Iceland.

	Short term training and tailored training abroad										Annual long term training	
	UN Development Goals[1]				Tailored training[2]						Long term annual programmes	
	Africa[3]	LAC[4]	Asia[5]	Total	Kenya[6]	East Africa[7]	Europe[8]	Misc.	Total	Total	ESDC[9]	UNU-GTP
2005	150			150						150		
2006	195.5	250		445.5						445.5		
2007	405	270		675						675		
2008	960[10]		708	1,668						1,668		
2009	945	384		1,329						1,329		
2010	1,176			1,176	3,176[11]			431	3,607	4,783		
2011	1,276	372		1,648	680[11,12]			84	764	2,412		
2012	1,311.5	390		1,701.5	4,692[12,13]				4,692	6,393.5		
2013	1,505	366		1,871	120[13]	267			387	2,258	2,886	4,012
2014	1,189	330		1,519	546	96	286.5	252	1,180.5	2,699.5	3,276	3,451
2015	1,271	294		1,565		1,322	264.5		1,586.5	3,151.5	4,192	3,600
2016	1,220	408		1,628		641	642		1,283	2,911	2,970	4,114
2017	1,260	396		1,656		80	150	262	492	2,148	3,510	2,760
2018	640	456		1,096		98		10	108	1,194	3,480	2,880
Total	13,504	3,916	708	18,128	9,214	2,504	1,343	1,039	14,100	32,228	20,314	20,817

1: Short Courses held in support of MDGs and SDGs, funded by UNU-GTP and cooperating partners in the developing countries; 2: Training funded by outside sources; 3: Held in Kenya and Uganda; 4: Held in El Salvador; 5: Held in China; 6: Requested and funded by KenGen and GDC; 7: Requested and funded by MFA-ICEDA, sometimes in cooperation with NDF; 8: Funded through the EEA Grants scheme; 9: El Salvador Diploma Course (Geothermal Diploma Course for Latin America since 2016); 10: One Short Course in Kenya and another in Uganda; 11: The *Course on Geoscientific Exploration for Geothermal Resources* was divided between 2010 (50 days) and 2011 (11 days); 12: *Training in Borehole Geology* was divided equally between 2011 and 2012; 13: Advanced Training in Borehole Geology was divided between 2012 (132 days) and 2013 (24 days).

Several observations can be made by examining Table 12:

- Great emphasis has been placed on training in Africa, which has been identified by the UN system and the Government of Iceland as a priority region for capacity building / development assistance. This is seen in the large number of participant days that have accumulated through the Short Course series held in support of the UN Development Goals, bearing witness to both the considerable duration of training (~3 weeks annually since 2008) and the large number of participants. This emphasis has also been reflected in the support of MFA-ICEIDA for the *Geothermal Exploration Project*, through which many courses in Africa have been funded. There is still vast untapped geothermal potential in Africa, and human capacity is one of the crucial factors that need to be in place to harness that potential. The need for training is extensive, and this is partially reflected in training activities requested by KenGen and GDC during 2010-2014. This emphasis on Africa has also been reflected in the composition of the groups of 6 month trainees in Iceland (Georgsson et al., 2020).
- The scale of Short Courses held in support of the UN Development Goals increased considerably in the first few years, with more than 1,500 participant days registered in all but 3 years since 2008.
- The scale of tailored trainings has been quite extensive, with 14,100 participant days accumulated since 2010 compared with 13,860 participant days accumulated through the UN Development Goals Short Courses during the same period. While the overall scale of these efforts has been similar over this period, there is a notable difference in the regularity of training. This is manifested in the (semi) annual MDG/SDG Short Courses being similar in duration and number of participants from year to year, while there is considerable variation between years in the tailored training. This variation is a function of demand. Aside from the low margins of running tailored training, this is a major reason for why market forces cannot be relied on as a primary driver for geothermal training.
- Over the period 2013-2018 (2013 being the year when UNU-GTP became formally associated with the El Salvador Diploma Course), the total scale of UN Development Goals Short Courses and tailored training abroad amounted to 14,362 participant days compared to around 20,314 and 20,817 participant days accumulated through the El Salvador Diploma Course and the 6 month training in Iceland, respectively. Viewed through the *PD* metric, the scale of MDG/SDG Short Courses and tailored training abroad is quite substantial compared to the operations in El Salvador and Iceland. However, it can be pointed out that there is a divergence of study paths in the 6-month training in Iceland after the introductory phase, first for pursuing specialized studies in 5-6 groups, after which there is further divergence to the individual level during the project phase (Georgsson et al., 2020). In the Geothermal Diploma Course for Latin America, there is mostly a single study line for all participants up to the project phase when the class diverges into subgroups of 1-4 working on different projects. As mentioned earlier, this divergence / specialization is not captured by the *PD* metric and this needs to be kept in mind when comparing between short term training activities with a low degree of divergence and long term annual training activities with a high degree of divergence.

In any case, it is apparent that the scale of UNU-GTP training abroad is substantial.

6.2 A theory of change applied to UNU-GTP training abroad

A theory of change identifies the goals of a process and maps backwards to point out the necessary preconditions or requirements for attaining these goals (Center for Theory of Change, 2019). The development of a sound theory of change can help to sharpen objectives and identify the most rational and efficient processes to reach those objectives. Furthermore, it can be used to help assess the impact of training.

The primary mandate of UNU-GTP is to assist developing countries in exploring and developing their geothermal resources by training groups of experts who drive this development forward within their countries. The main goal of training, whether it be in Iceland or abroad, is thus in essence the identification of geothermal resources in the partner countries and the utilization of those resources where deemed technically, socially and economically feasible to the degree that they are manifested in real projects turning out useful power, whether it be in the form of electricity or heat. This goal is in tandem with SDG 7 and the process supports various other SDGs in direct and indirect ways as previously touched on in Section 3.

Through the Short Courses in Africa, young professionals in positions at geothermal companies or in jobs otherwise related to energy development in countries with geothermal potential, have a chance to get an overview of the disciplines needed to bring geothermal projects about.

- *Experts who have recently been hired to work on geothermal projects*. They may already hold one or more university degrees in their field of expertise, but have had limited exposure to geothermal development. They get an opportunity to sharpen their skills in the context of geothermal development, getting exposed to new information, ideas, and procedures, and have a chance to mingle with foreign instructors and fellow Short Course participants, which serves to strengthen their networks and introduce repositories of further knowledge that can be revisited at a later time. They have an opportunity to get a peek into the geoscientific disciplines, related to or distinct from their own, and work to develop integrated conceptual models of geothermal resources, which requires cooperation among the different geoscientific disciplines. They are also exposed to the continued process of developing geothermal projects through assessment, planning, engineering, and management. Upon return to their jobs, they have a fuller picture of the overall process needed to bring geothermal projects about and how their particular field of expertise fits within that picture. They should be more confident as geothermal experts and their skills for inter-disciplinary cooperation should have been enhanced. They should be better able to contribute to their institutions or companies and thus to the geothermal development of their countries.
- *Experts who may not hold positions as geothermal experts, but whose positions relate to energy development in their countries (e.g. having been assigned to renewable energy teams)*. Coming from countries with known or probable geothermal potential, they may be in a position to enlighten decision makers (e.g. within ministries, government agencies, institutions or companies) upon return to their countries about the nature of geothermal resources and the possibilies that successful exploration campaigns may entail when it comes to geothermal utilization. Thus they are likely to help advance geothermal development in their countries.

The subject coverage of the Short Courses for Latin America and the Caribbean changes from year to year. The focus is on:

- *Experts in the particular fields to be covered who are likely to benefit from the coverage by gaining additional information and participating in discussions and/or who are able to contribute as lecturers*. Upon return they have sharpened their skills and expanded their professional networks. As most participants of these courses share a common language and similar culture, professional relationships across borders are of great value to increase the likelihood of regional cooperation and sharing of information.
- *Junior professionals and experts in fields different from the subject material of the particular Short Course*. They will expand their horizons to become better able to apply their skills in the context of geothermal development, cooperating between disciplines and gaining from a fuller picture of how geothermal projects are developed. This should help to enhance team spirit at home and advance projects.
- *Students of the Geothermal Diploma Course for Latin America*. They benefit from exposure to international lecturers and settings, with the Course forming part of the curriculum of the Diploma Course.

As the subjects change from year to year, some experts who have participated in a Short Course may do so again if the subject coverage is deemed relevant for them and their employers.

Too often, geothermal experts are working in relative isolation from experts of different disciplines and they may not have an easy chance to exchange information or see the full picture of what goethermal projects are about and how their contribution fits within them. The Short Courses help address this issue and encourage cooperation among the different disciplines for a more streamlined and gratifying approach to geothermal development.

An important part of the Short Courses for both Africa and the LAC region is their role as a first screening venue for the more involved 6-month studies in Iceland. Those participants who are interested in the 6-month studies are interviewed by representatives of UNU-GTP and upon approval from their employers become candidates for those studies, which may then lead further to the pursuance of MSc or even PhD degrees, which are of high value to their employers and for geothermal development in their countries. The Short Courses can thus be the first step of a long journey of enhancing knowledge and skills, and contributing to one‘s country.

As tailored training is held at the request of geothermal entities, development donors or others, there is someone out there who sees enough benefit in the training to pay for the costs. This training will often lead to similar changes and effects as those described above. In some cases the tailored training is very specialized, leading to benefits and enhanced skills within a particular discipline, in other cases the training provides overviews for decision makers who, as a result, may become better positioned to evaluate the risks and potential gains in exploring for and utilizing geothermal resources, and in some cases the training is directed at a substantial fraction of (or entire) geothermal workforce of a particular country, which serves to increase the knowledge within entire institutions, companies and governmental agencies and bring about a shared understanding.

Extensive long-term programmes held repeatedly with regional participation are especially important to help geothermal development on the regional scale. This is certainly true of the Geothermal Diploma Course for Latin America and there is little doubt that its impacts will be felt in the Latin American geothermal community for years to come, even if its operations would cease. Many Latin geothermal experts take the first steps of their careers in the Diploma Course and build lasting cross-border relationships that serve to promote geothermal development at the regional scale.

Needless to say, the impacts serve to nudge geothermal development forwards and thus help in reaching the targets of SDG 7. Contributions to SDG 13 (mitigation of climate change) inevitably follow, as significantly lower greenhouse gas emissions are associated with geothermal power plants than fossil fuel power plants (although there are rare exceptions). Furthermore, the utilization of geothermal energy may contribute to adapting to the impacts of climate change, where unavoidable. Indirect contributions to other SDGs are covered in Section 3, including a basic theory of change. Contributions towards SDG 5 are covered in the following section.

6.3 The participation of women in UNU-GTP training abroad

UNU-GTP established a gender equality policy in 2016 for its various facets of operation, 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 is thus encouraged and women are preferentially selected from the candidate groups when the need arises to fulfill gender balance criteria. With these efforts, the goal is to further influence the empowerment of women within the geothermal sector as the ratio of women in the respective workforces is usually lower than the ratio of women included in the trainings.

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 7a). However, UNU-GTP has less control over the make-up of the participant group in cases where trainings are sponsored by others (Figure 7b). In some instances, trainings have been held for the entire group of geothermal experts in a particular country, with the ratio of female participants indicative of the actual ratio of women in the geothermal workforce. In such cases UNU-GTP policy has limited influence, which should be taken into account when viewing the gender statistics for the sponsored courses.

Figure 7 shows the proportion of women taking part in UN Development Short Courses (a) and in tailored trainings (b).

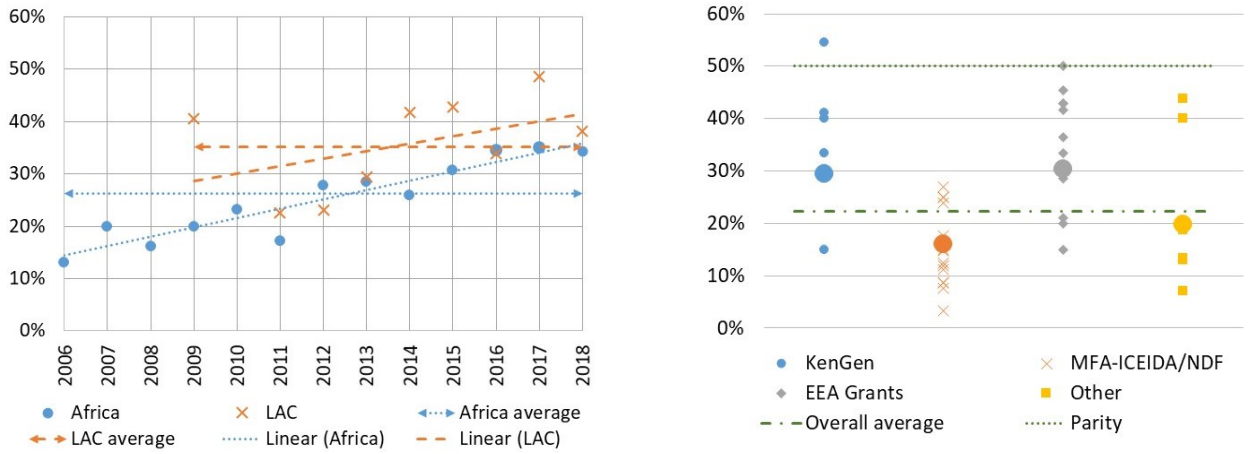

Figure 7: a) Share of women in the MDG and SDG Short Courses in Kenya and El Salvador. b) The ratio of women taking part in tailored trainings. The big dots show average within each category.

It is evident that the ratio of women has been increasing over time in the MDG and SDG Short Courses, both in Africa and El Salvador, although it has on average been higher in El Salvador than in Kenya. Female participation has therefore been moving in the right direction. The female ratio has varied substantially in the tailored trainings, with significant differences in averages between training categories. The rather low ratios in the MFA-ICEIDA / NDF sponsored training can be accounted for in part by the following: 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 until this point tend to be males. Within the EEA Grants category, the ratio of women in the short courses in the Azores was 29-50% depending on courses, whereas the ratio in Romania was 15-33% in the four trainings held there.

Gender balanced selection is applied for the UN Development Goals Short Courses, the 6-month studies, and MSc and PhD studies in Iceland, resulting in an even higher percentage of women in the studies than in tailored training.

The goal is to reach gender balance within participant groups by encouraging the nomination of women for training, and preferential selection where needed. As mentioned before, 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.

6.4 Further assessment of impacts

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 vs. deep and focused), 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 to some degree be assessed quantitatively, while most need a more subjective coverage.

Some indirect impacts of the training are even more difficult to measure, e.g. knowledge distribution by trainees within a company. In many cases, the participants mediate the knowledge and know-how gained in the training to their co-workers, either through direct pre-planned teaching sessions or through cooperation during their every-day work. Therefore, the training does not only benefit the trained participants alone, but also the wider geothermal community at home.

7. CONCLUSIONS

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. 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 that are not covered in long-term trainings; 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.

8. CLOSURE

The Geothermal Training Programme (GTP) has proudly operated under the banners of the United Nations University (UNU) for 41 years. Due to a directional change within UNU that is less fitted to GTP activities and future vision, it has been decided to part ways. The Icelandic Government, the main financial supporter of GTP, has indicated a clear will to continue the programme along similar lines as in recent years and negotiations are currently ongoing regarding the possibility of joining with another UN entity (Georgsson et al., 2020). This may or may not affect training activities abroad, but it is likely that these activities will continue with no less vigor than before.

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