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UNU Geothermal Training Programme in Africa: Short Courses held in support of the UN Sustainable Development Goals and the ICEIDA/NDF Geothermal Exploration Project

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ABSTRACT

After running a series of annual Short Courses on Exploration for Geothermal Resources in Kenya in support of the UN Millennium Development Goals (MDGs) over the period 2006-2015, a new series of short courses was started in support of the new UN Sustainable Development Goals (SDGs) in 2016. While this new series – SDG Short Courses on Geothermal Exploration and Development – rests on the solid foundations of the former series, some modifications have been made in response to the evolving needs of African countries and to better reflect the SDGs. Going forward, the courses, run cooperatively by the United Nations University Geothermal Training Programme (UNU-GTP), Kenya Electricity Generating Company, and Geothermal Development Company, may become an integral component of the activities of the African Geothermal Center of Excellence.

Over the period 2013-2017, UNU-GTP implemented 13 tailor-made short courses on various topics in Djibouti, Ethiopia, Kenya and Rwanda in cooperation with local geothermal institutions and companies, procured and financed by the Icelandic International Development Agency, the Icelandic Ministry for Foreign Affairs and the Nordic Development Fund. In addition, a workshop for donors interested in supporting geothermal development in Africa was held in Iceland in 2014, financed by ICEIDA.

The paper outlines the set up of these activities and the impact UNU-GTP hopes to achieve with them for geothermal development in Africa.

1. Introduction

In November 2005, United Nations University Geothermal Training Programme (UNU-GTP), in cooperation with Kenya Electricity Generating Company Ltd. (KenGen) and other partners, held *Workshop for Decision Makers on Geothermal Projects and their Management* by Lake Naivasha in Kenya. The workshop marked the beginning of UNU-GTP on-site training efforts. A similar workshop was held in El Salvador the following year and both of these 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As the MDGs ran their course and were superseded by the Sustainable Development Goals (SDGs) at the start of 2016, UNU-GTP initiated a new series of short courses in cooperation with its partners in Kenya and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. Three SDG short courses have been held in El Salvador and two in Kenya, with the third planned for 7-27 November 2018.

Due to demand for short courses on specific topics and other site-based training, UNU-GTP introduced the possibility for tailor-made training in 2010, with the first such efforts taking place that same year, two in Kenya and two in Indonesia. The Icelandic International Development Agency (ICEIDA), later the Directorate for International Development Cooperation of the Icelandic Ministry for Foreign Affairs, and the Nordic Development Fund (NDF) recognized the possibilities inherent in such tailor-made activities and supported various courses and training events, beginning in 2013 – many of these through the Geothermal Exploration Project which ran from 2013 to 2017.

The paper presents an overview of these trainings, which have supported geothermal capacity building in African countries (see also Haraldsson, 2018).

2. Workshops and Short Courses Held in Support of the United Nations Millennium Development Goals

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). 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 *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, in addition to Yemen. The participation is broken down by country in Table 2. 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 customer-designed training. The papers have been published on CDs and are openly available on UNU-GTP's website: *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
Workshop for Decision Makers on Geothermal Projects and their Management	14-18 Nov, 2005	5	30	
Short Course I on Surface Exploration for Geothermal Resources	13-22 Nov, 2006	6	23	
Short Course II on Surface Exploration for Geothermal Resources	2-17 Nov, 2007	11[1]	30	6 (20%)
Short Course III on Surface Exploration for Geothermal Resources	24 Oct – 17 Nov, 2008	11[1]	37	6 (16%)

Name	Dates	No. countries	No. particip.	No. women
Short Course on Geothermal Project Management and Development	20-22 Nov, 2008	10[1]+2[2]	24	2 (8%)
Short Course IV on Surface Exploration for Geothermal Resources	1-22 Nov, 2009	11[1]	45	9 (20%)
Short Course V on Surface Exploration for Geothermal Resources	29 Oct – 19 Nov, 2010	13[1]	56	13 (23%)
Short Course VI on Surface Exploration for Geothermal Resources	27 Oct – 18 Nov, 2011	15[1]	58	10 (17%)
Short Course VII on Surface Exploration for Geothermal Resources	27 Oct – 18 Nov, 2012	14[1]	61	17 (28%)
Short Course VIII on Surface Exploration for Geothermal Resources	31 Oct – 23 Nov, 2013	18[1,3]	70	20 (29%)
Short Course IX on Surface Exploration for Geothermal Resources	2-23 Nov, 2014	18[1]	58	15 (26%)
Short Course X on Surface Exploration for Geothermal Resources	9-30 Nov, 2015	18[1]	62	19 (31%)
	Total:	**22[1]+2[2]**	**554**	**116+ (~23%)**

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[1]	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[2]	3	1	2	3	3	1	3	3	3	3	3	**35**
Kenya	6+9[2]	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**
Nigera									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**
Total	**30**	**23**	**30**	**37**	**24**	**45**	**56**	**58**	**61**	**70**	**58**	**62**	**554**

1: Held in Uganda. All other courses held in Kenya.; 2: Added number shows lecturers.

3. The United Nations Sustainable Development Goals and the SDG 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 post-2015 Sustainable Development Goals (SDGs) were unanimously adopted as targets to be reached by 2030 (United Nations, 2015a). UNU-GTP has supported the overall aim and targets of Goal 7 of the SDGs 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.

In response to this, UNU-GTP and its cooperating partners decided to start 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, 2015b):

- 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).

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.
- *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.

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 and Haraldsson, 2017).

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. 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. 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 Short Course was attended by 61 participants from 16 African countries, including 21 women (Figure 1). The second SDG Short Course in Kenya was held during 9-29 November

Figure 1: Participants and lecturers of SDG Short Course I in the Olkaria geothermal field. Mt. Longonot in the background.

Figure 2: Lecture at SDG Short Course II on Exploration and Development of Geothermal Resources.

2017 and was attended by 63 participants (22 women) from 16 African countries, in addition to Yemen (Figure 2). The third course of the series is planned for 7-27 November 2018. The SDG Short Courses have a duration of three weeks and are structured as shown in Table 3.

Table 3: Structure of SDG Short Courses

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 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).

4. Customer-Designed Training for Africa

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: 12 in Kenya for Kenyans and/or participants from neighbouring countries, 5 in Ethiopia, 3 in Djibouti, and 1 in Rwanda. In addition, a workshop was held in Iceland in 2014 for African countries. These programs have ranged from a 2-day workshop for decision makers intended to provide overview and serve as a platform for discussion, to in-depth training of experts leading to certification equivalent to the 6-month studies in Iceland.

Some of the trainings in Africa have been called for by geothermal companies in order to strengthen employee skill sets, while others have been implemented in response to requests from development donors.

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 4. Most have been supported 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 ran from 2013 through 2017, was to assist 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 3a). 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 3b). 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 in both 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 3c). 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.

Table 4: Trainings and workshops for African countries supported by ICEIDA as part of the Geothermal Exploration Project.

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

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 third event for decision makers was *Workshop for Geothermal Development Donors*, held in Iceland in May 2014 (Figure 3d). 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 4). The workshop, which was held at the Blue Lagoon and Reykjavik Energy headquarters, provided a general overview of various aspects of

Figure 3: 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.

geothermal exploration and development and included an excursion to geothermal fields and utilization facilities on the Reykjanes Peninsula.

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.

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 4a). 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 Langano geothermal field. 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 4b). 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.

Short Course on Geothermal Project Management was held in Addis Ababa in Ethiopia in February 2015 for employees of GSE, EEP and MWIE (Figure 4c). 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. 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 4d). Lecture support came from Verkís and Reykjavik 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. The exam was administered by the Icelandic Project Management Association on behalf of IPMA. The training was funded by ICEIDA and NDF.

Figure 4: 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 5a). 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.

Short Course on Geothermal Project Management was held in Djibouti in September 2015 for 16 employees of ODDEG, MERN and CERD (Figure 5b). 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.

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 5c). 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. 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 5d). 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. 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 5: 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 6a). 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 Verkís, KenGen and GDC. 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 6b). 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 Verkís, KenGen and GDC.

Figure 6: 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.

In 2018, UNU-GTP is planning two courses as pre-conference short courses of ARGeo-C7 to be held in Kigali, Rwanda from late October to early November. These short courses will be on (i) geothermal project management and (ii) direct use applications.

Considering the 40 customer-designed training programs that had been carried out by UNU-GTP and its partners by the end of 2017, it appears evident that such tailor-made activities answer a need for training that cannot easily be accommodated within the traditional framework of UNU-GTP. In particular, Africa has benefitted from these activities, with 22 events held for the benefit of African institutions and companies. Fourteen of these have been sponsored by ICEIDA and later MFA-ICEIDA, often in partnership with NDF. The remaining 8 have been requested and financed by GDC and KenGen to train employees on specific topics.

Out of the trainings sponsored by ICEIDA / MFA-ICEIDA, 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. 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 from ICEIDA to develop short courses on these topics was therefore well met at UNU-GTP and 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 very well received, both as follow-up to short courses and as an integral part of the 6-month study line.

The ratio of women in the ICEIDA and NDF sponsored short courses has been 16% (Table 4), which compares to ~23% for the MDG Short Courses (Table 1) and close to 35% for the first two SDG Short Courses (43/124). The main reason for this lower ratio compared to the MDG/SDG Short Course series is that in the case of the customer-designed courses it has been up to the beneficiary institutions to appoint the participants. While they have been encouraged to appoint women, the fact is that in many countries the ratio of women in the geothermal workforce is low. When short course participants consist of roughly the entire geothermal workforce in a country, the ratio of women in the participant group will accordingly be low. In contrast, the invitation process for the SDG Short Courses offers the possibility to selectively invite women from a pool of candidates from each country. It is the hope that through such selective invitation, women participation in the geothermal workforce of the beneficiary countries may be encouraged.

The collaboration with ICEIDA / MFA-ICEIDA on short courses has proved fruitful over the past years, with ICEIDA and NDF sponsorship leading to more extensive offerings of on-site training compared to what UNU-GTP could have achieved through its routine operations.

5. Support to the African Geothermal Centre of Excellence

As noted by Georgsson et al. (2018), the African Geothermal Centre of Excellence (AGCE) is currently in an interim phase under the guidance of UNEP. Two courses marked the start of the implementation of the interim phase in May 2017: *Introductory Short Course on Geothermal Project Management* (see previous Section and Table 4) and a short course on the Leapfrog geothermal software conducted by GDC in Nakuru. UNU-GTP is supportive of the development of AGCE and is willing to contribute as may be termed feasible. This has already been manifested in the implementation of one of the opening short courses, with sponsorship from MFA-ICEIDA. Additionally, the SDG Short Courses may in the future be implemented within the framework of the AGCE, as the first of several levels that may eventually lead to a diploma (Georgsson et al., 2018). As such, the lecture material and experience gained through the MDG/SDG Short Courses and the tailor-made trainings in Africa may feed into offerings of the AGCE.

6. Concluding Words

There is a vast geothermal potential in Africa, in particular within the East African Rift System, but with the exception of Kenya, its utilization has been limited to date. At the same time, there is enormous need within the continent for electricity and heat to support economic growth, industrial activity, health and education services, poverty alleviation efforts, rural electrification efforts, etc. This need can be partially met with the utilization of geothermal resources. Furthermore, the potential for geothermal energy to mitigate global warming when used in place of fossil fuels and for supporting adaptation measures where climate change cannot be avoided, is well recognized. Geothermal energy offers benefits in terms of security, reliability, availability, and long-term economics.

The utilization of geothermal resources aligns well with the United Nations Sustainable Development Goals, in particular Goal 7 (Affordable and clean energy). Geothermal development is also well suited to support Goal 13 (Climate action) and many other goals directly or indirectly.

Africa has a youthful population that is posed to propel the continent forward, but in order to build a skilled geothermal workforce that can effectively explore for geothermal resources and bring geothermal projects to fruition where those resources are deemed to be of sufficient quality, it is necessary to create training opportunities. This has been the mandate of UNU-GTP since the inception of the programme in 1978.

For the first 26 years of its operation, UNU-GTP's training activities were restricted to Iceland, as manifested in the 6-month training programme and the MSc studies, but the possibility for taking the training to site was introduced in 2005 (Georgsson, 2010). The MDG and current SDG Short Course series have made it possible to impact larger groups than before, to introduce the possibilities of geothermal utilization for Africa.

Tailor-made trainings in response to customer demand have also made it possible to impact particular groups with specialized short-, medium-, and long-term training. Such efforts have been called for by employers looking to enhance the skill-sets of employees and development donors looking to support geothermal development within particular countries and regions.

It is the hope that such on-site training opportunities can continue to evolve for the benefit of Africa and geothermal development elsewhere, with due regard given to the SDGs.

REFERENCES

Georgsson, L.S.: UNU Geothermal Training Programme – Taking the Training to the Developing Countries. *Proceedings of the World Geothermal Congress 2010*, Bali, Indonesia, (2010), 9 pp.

Georgsson, L.S., and Haraldsson, I.G.: The Role of Geothermal Energy and Capacity Building in Achieving the UN Sustainable Development Goals in Latin America and the Caribbean. *Papers presented at "SDG Short Course II on Feasibility Studies for Geothermal Projects", organized by UNU-GTP and LaGeo*, Santa Tecla, El Salvador, (2017), 21 pp.

Haraldsson, I.G.: The UN Sustainable Development Goals Short Courses in Africa and Latin America. *Papers written for the 40th Anniversary Workshop of the United Nations University Geothermal Training Programme*, organized by UNU-GTP, Reykjavik (2018).

Omenda, P., Zemedkun, M., Kebede, S., and Lagat, J.: *Technical Workshop on the Geologic Development and Geophysics of the Western Branch of the Greater East African Rift System*. African Rift Geothermal Development Facility (ARGeo), United Nations Environment Programme (UNEP), Nairobi, Kenya, (2016), 60 pp.

United Nations: *Unanimously adopting historic Sustainable Development Goals, General Assembly shapes global outlook for prosperity, peace*. United Nations, (2015a), website: *https://www.un.org/ press/en/2015/ga11688.doc.htm*

United Nations: *Sustainable Development Goal 7*. United Nations, (2015b), website: *https:// sustainabledevelopment.un.org/sdg7*