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GRÓ Geothermal Training Programme in Iceland – Training Activities Abroad

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ABSTRACT

The Geothermal Training Programme in Iceland was established in late 1978 under the United Nations University, but has operated within GRÓ – Centre for Capacity Development, Sustainability and Societal Change, since 2020, funded by the Government of Iceland. GRÓ GTP has run various workshops, short courses, and tailored trainings outside of Iceland in cooperation with partners since 2005. It has supported and taken part in the operation of regional geothermal training centers and in recent years offered online training courses, with plans for further development of online training components. Geothermal training is as important as ever and the potential for reaching out to the world has never been greater.

1. INTRODUCTION

GRÓ Geothermal Training Programme (established in late 1978 and operated as United Nations University Geothermal Training Programme prior to 2020) has run various workshops, short courses, and tailored trainings outside of Iceland in cooperation with partners since 2005. It has contributed to regional geothermal training centers and recently expanded its training activities to the realm of the internet. These activities are reviewed in subsequent sections, with emphasis on recent years.

2. SHORT COURSES HELD IN SUPPORT OF THE UNITED NATIONS DEVELOPMENT GOALS

For the first 26 years, GTP operations were confined to Iceland. In 2005 and 2006, workshops were held in Kenya and El Salvador, respectively, to gauge interest in local training, identify areas that would benefit from capacity enhancement, and discuss approach. These workshops were subsequently followed by a series of short courses in each country, dedicated to supporting specific targets of the UN development goals (MDGs and SDGs), and run in cooperation with local partners.

2.1 The UN Millennium Short Course Series

These series of workshops and short courses were held over the period 2005-2015, with 554 individuals trained in Africa, 412 in Latin America and the Caribbean, and 118 in Asia (Haraldsson et al., 2021).

2.2 The UN Sustainable Development Goals Short Course series

As the United Nations committed to the Sustainable Development Goals (SDGs), which took effect at the onset of 2016 and are to be realized by 2030, GTP started revamped short course series with its partners in El Salvador and Kenya. These courses are mainly intended to support SDG 7 (affordable and clean energy), with additional contributions to SDG 5 (gender equality) and 13 (climate action), as well as indirect contributions to various other SDGs (Axelsson et al., 2023; Haraldsson et al., 2021; Ómarsdóttir et al., 2023).

2.2.1 SDG Short Courses for Latin America and the Caribbean

The first SDG Short Course was held in El Salvador in cooperation with LaGeo S.A. de C.V. in September 2016, with particular emphasis on sustainability aspects, environmental management and the mitigation of climate change in the context of geothermal development. The launching of the Salvadoran SDG series coincided with the Short Course being incorporated as a component of the *Geothermal Diploma Course for Latin America* (Section 5.1). The Short Courses have accordingly been attended by the students of the Diploma Course in addition to participants who are specially invited from various entities in Latin America and the Caribbean (LAC region) (Figure 1). Information on the first four Courses in the series is shown in Table 1.

2.2.2 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 Kenya Electricity Generating Company PLC (KenGen) and Geothermal Development Company (GDC) at Lake Bogoria and Lake Naivasha in Kenya in November 2016 (Table 2), building on the solid foundations of earlier Short Courses. This Course and follow-up Courses have been attended by participants from geothermal institutions and companies in African countries with possibilities for geothermal utilization (Figures 2 and 3). As in the earlier MDG series, the Short Courses are run in much the same way from year to year. Information on the first six courses in the series is shown in Table 2.

2.2.3 Effects of COVID-19 on the SDG Short Courses

Many of GTP's normal activities were cancelled or postponed in 2020 due to the COVID-19 pandemic (Haraldsson et al., 2022). This was true of the SDG Short Courses in both El Salvador and Kenya. In 2021, the activities in El Salvador (i.e. the *Geothermal Diploma Course for Latin America* and *SDG Short Course IV*) were cancelled again due to the state of the pandemic in the LAC region, travel restrictions and health stipulations in El Salvador. However, GTP decided with its partners in Kenya (KenGen and GDC) to go ahead with *SDG Short Course V on Exploration and Development of Geothermal Resources*, which was held in Kenya during November 14th to December 4th (Figure 4).

Figure 1: SDG Short Course IV in El Salvador. Top left: Lecture in LaGeo's auditorium; Top right: Demonstration of candle making during a field trip to Ahuachapán geothermal power plant; Bottom left: Group project on conceptual models; Bottom right: Participants and organizers.

Table 2: SDG Short Courses for Latin America and the Caribbean (LAC region).

Name	Dates (dd.mm.yy)	No. countries	No. particip.	No. women	Particip. Days[1]
SDG SC[2] I on Sustainability and Environmental Management of Geothermal Resource Utilization, and the Role of Geothermal in Combatting Climate Change	4-10.9.16	14[3]	68	23 (34%)	408
SDG SC II on Feasibility Studies for Geothermal Projects	17-23.09.17	14[4]	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
SDG SC IV on the Future of Geothermal Energy Utilization in Latin America: Maintaining and Increasing Production and the Role of Geothermal Energy in Sustainable Development	18-24.09.22	17[5]	46	20 (43%)	276
	Total:	**19[6]**	**256**	**104 (41%)**	**1,536**

1: Number of participants multiplied by number of active days of training; 2: SC = Short Course; 3: As well as representatives from the World Bank; 4: As well as a representative from the Organization of Eastern Caribbean States; 5: As well as a representative from the Federal Institute for Geosciences and Natural Resources in Germany (BGR) based in Nicaragua; 6: Argentina (7), Bolivia (11), Chile (4), Colombia (21), Costa Rica (6), Dominica (3), Dominican Republic (1), Ecuador (9), El Salvador (109), Guatemala (3), Honduras (5), Jamaica (1), Mexico (19), Montserrat (4), Nicaragua (28), Peru (8), St. Kitts and Nevis (6), St. Lucia (3), St. Vincent and the Grenadines (5), Others (3).

Figure 2: SDG Short Course VI in Kenya. Mapping geological structures in the Olkaria geothermal field.

Participants in *SDG Short Course V* were required to submit documentation showing at least one inoculation against the SARS-CoV-2 virus, and ideally two, before being given the green light for the Course. Furthermore, the Kenyan health authorities requested a PCR test being taken within 96 hours prior to arrival in Kenya. Fifty participants took part in the Short Course, including 20 from 13 African countries outside of Kenya. Masks were mandatory and sanitizers were readily available. Plastic gloves were required at buffet meals. In spite of measures being taken to have rooms available for isolating infected participants or lecturers, and the omicron subvariant surfacing in South Africa during the Short Course, no participant or lecturer tested positive on rapid tests during the Course

nor in PCR tests at the end of the Course. However, one participant needed to stay in Kenya for about 10 additional days at the end of the Course due to restrictions on entering his home country that were put in place with the rise of the omicron variant.

Figure 3: SDG Short Courses V and VI in Kenya. Top left: Lecture at the Short Course venue (V); Top right: Inspection of geophysical exploration equipment (VI); Bottom left: An all-female group of Icelandic organizers / lecturers (VI); Bottom right: Test 2 (V).

Table 2: SDG short courses for Africa.

Name	Dates (dd.mm.yy)	No. countries	No. particip.	No. women	Particip. days
SDG SC I on Expl. and Developm. of Geoth. Resources	10-30.11.16	16	61	21 (34%)	1,220
SDG SC II on Expl. and Developm. of Geoth. Resources	09-29.11.17	17	63	22 (35%)	1,260
SDG SC III on Expl. and Developm. of Geoth. Resources	07-27.11.18	13	32[1]	11 (34%)	640
SDG SC IV on Expl. and Developm. of Geoth. Resources	13.11-03.12.19	13	38[1]	15 (39%)	798
SDG SC V on Expl. and Developm. of Geoth. Resources	14.11-04.12.21	14	50	18 (36%)	1,050
SDG SC VI on Expl. and Developm. of Geoth. Resources	13.11-03.12.22	11	43	15 (35%	903
Total:		**21**	**287**	**102 (36%)**	**5,871**

1: GDC did not participate, resulting in fewer participants; 2: Algeria (1), Burundi (2), Cameroon (3), Comoros (11), Djibouti (14), Democratic Republic of the Congo (DRC) (4), Egypt (1), Eritrea (4), Ethiopia (24), Kenya (152), Madagascar (2), Malawi (10), Morocco (5), Mozambique (2), Nigeria (7), Rwanda (7), Sudan (3), Tanzania (14), Uganda (13), Yemen (1), Zambia (7).

Figure 4: Participants and organizers of SDG Short Course V in Kenya.

By 2022, the SDG Short Courses had resumed in both El Salvador and Kenya, with masks still mandatory in the former country.

3. TAILORED TRAINING ON SITE

Since 2010, GTP has conducted various on-site short courses and long-term training efforts in cooperation with local partners in 4 continents (Haraldsson et al., 2021). At the end of 2022, 46 training programmes of short, medium and long duration had been conducted. Twenty-five of those had been run in African countries (Kenya (12), Ethiopia (5), Djibouti (4), Rwanda (3), and Eritrea (1)), 17 in Europe (Portugal/Azores (8), Iceland (5), 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 training in Iceland.

Some of the trainings have been called for by geothermal companies in order to strengthen employee skill sets, some have been carried out in cooperation with local education establishments, while others have been implemented in response to requests from development donors. Ten trainings were requested by the Icelandic International Development Agency (ICEIDA) prior to 2016, 11 have been sponsored by the Icelandic Ministry for Foreign Affairs (MFA) from 2016 onwards, 12 have been held in cooperation with entities within the European Economic Area funded by EEA Grants, 8 have been procured by either of the two Kenyan geothermal companies (KenGen and GDC), and 5 have been requested by others. A total of 975 participants have benefitted from these trainings (but fewer individuals as some have attended more than one training), accounting for around 14,400 participant training days.

4. ON-LINE TRAINING

The COVID-19 pandemic catalyzed increased online activity at GTP including the offering of online short courses (Haraldsson et al., 2022). On November 2nd – 3rd, 2020, GTP ran one of the ARGeo-C8 pre-conference short courses at the request of the conference organizers, i.e. *Virtual Short Course I on Direct Use Applications of Low- to Medium-Enthalpy Geothermal Resources*, held entirely online. This was GTP's first full online offering, although some experiments in incorporating virtual lectures (either pre-recorded or live) into onsite courses (SDG Short Courses in El Salvador and Kenya) had taken place in previous years.

GTP followed up with *Online Course on Geothermal Energy*, which was targeted towards participants from African countries in April 2021. This was a 2-day overview course consisting of about 3 hours of pre-recorded lectures each day, followed by approximately 1 hour long live discussion where the lecturers responded to questions submitted by participants. The course was repeated for the LAC region in March 2022, and for the Asia-Pacific region in September 2022 (Table 3; Figure 5).

Table 3: Online short courses.

Name	Target region	Dates (dd.mm.yy)	No. countries	No. particip.[1]	No. women	Particip. days
Virtual Short Course I on Direct Use Applications of Low- to Medium-Enthalpy Geothermal Resources	Africa	02-04.11.2020	14+[1]	46	12 (26%)	92
Online Course on Geothermal Energy	Africa	20-21.04.2021	11+[2]	64	9 (14%)	64
Online Course on Geothermal Energy	LAC[3]	08-09.03.2022	19+[4]	146	60 (41%)	146
Online Course on Geothermal Energy	Asia-Pacific	06-07.09.2022	14	140	46 (33%)	140
		Total:	**50+[6]**	**396**	**127 (32%)**	**442**

1: Three participants from outside of Africa took part (India (2), Italy (1)); 2: One participant attended on behalf of an international institution (IRENA); 3: LAC = Latin America and the Caribbean; 4: One participant outside of LAC took part (France (1)); 6: Fifty countries in the target regions in addition to France, Italy and IRENA.

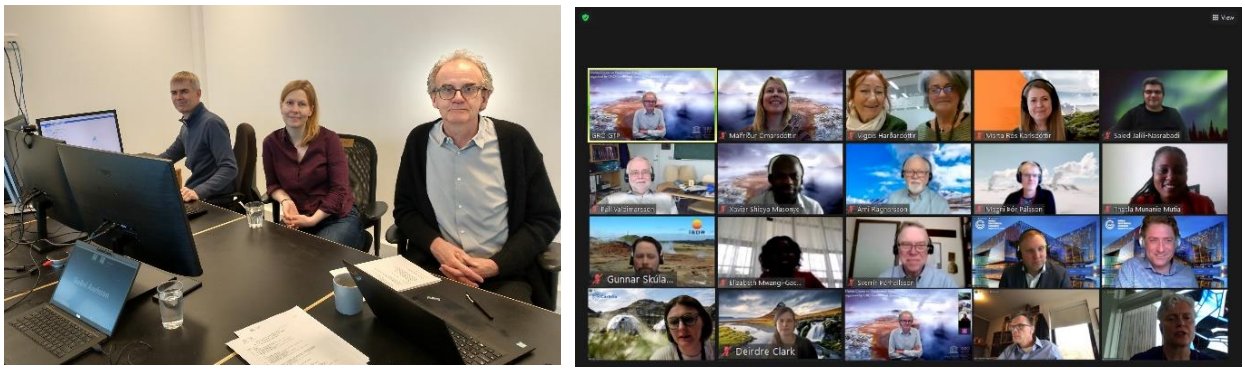

Figure 5: Organizers and lecturers of Online Course on Geothermal Energy.

Online training opens up new possibilities in GTP operations. Some advantages compared to training on site include: 1) The potential for reaching larger groups of people; 2) The possibility for drawing on a large pool of experts irrespective of their location; 3) Reduced costs. Some drawbacks include: 1) Lower quality interaction; 2) Potentially reduced motivation for participants in following the training and/or greater distraction (e.g. if participants take part in the training within busy office environments or lively homes); 3) Reduced opportunities for project work; 4) Elimination of field visits and on-hands experiences; 5) Time differences between trainers and trainees; 6) Reliance on internet connectivity and speed.

Pre-recorded lectures have the potential for being accessible at any time and hence being viewed by trainees at a convenient time within a given training period. Some possibilities also exist for administering unsupervised exercises and exams. These attributes are taken advantage of in massive open online courses (MOOCs) and other types of courses on various online education platforms. This kind of training is largely independent of trainer/trainee location, as long as access to the internet is readily available.

Live online training offers the possibility of interaction between trainers and trainees in real time. Organizers must be mindful of time differences between trainers and participants, which make it impractical to train a group of participants widely distributed around the globe at once.

Messaging platforms come in between scripted recordings and live interaction, with certain characteristics of both. A recording of text, voice, picture or a mix of these takes place, while the content of the message responds to particular comments or queries. An interaction takes place, albeit with a time delay.

Pre-recorded lectures are ideal for getting basic knowledge across, and can often be accompanied by reading material, while an interaction is usually beneficial or required to develop a deeper understanding of the subject material, clarify concepts etc. Interactions can be on different levels, e.g. Q/A between trainers and trainees, discussions, sharing of experiences, group work, live exercises, exams etc.

Some of these possibilities were taken advantage of in GTP's *Online Course on Geothermal Energy*, with both pre-recorded and live components. Lectures were pre-recorded, with a live introduction of each session by the organizers. Each day was capped by a live Q/A session where participants could submit written questions through a messaging system, which were filtered by the organizers and then addressed live by the lecturers. The course was held separately in the three different geographical regions, mainly because of time differences, but also allowing for minor differences in content. Most lectures were only recorded at the outset and then repeated in subsequent courses. However, some lectures benefitted from a change of presenters as the course moved from one region to another. In those cases, the overall lecture theme was unchanged between courses, with altered approaches based on regional context. The courses were managed from GTP's premises in Iceland. Table 4 shows the start time and variation in time zones between participating countries.

As evident from Table 4, Iceland's location is better suited for live interaction with some geographical regions than others – as is bound to be the case for any given host country.

Table 4: Different geographical target regions called for different timings of Online Course on Geothermal Energy.

Target region	Start time Iceland (UTC[1])	UTC offset			
		Min	Average[2]	Max	Spread[3]
Africa	06:00	1.0	2.6	3.0	2.0
LAC	15:00	-6.0	-5.2	-3.0	3.0
Asia-Pacific	06:00	3.5	7.6	11.0	7.5

1: Coordinated Universal Time (UTC); 2: Weighted by participant numbers; 3: The range of UTC offsets of participating countries (excluding Iceland, hours).

5. REGIONAL TRAINING CENTERS

5.1 Geothermal Diploma Course for Latin America

A Specialized Geothermal Diploma Course was initiated at the University of El Salvador in 2010, with a second implementation in 2012. These were held mostly for Salvadorans, with financial support from Italy, implemented in cooperation with Salvadoran and Italian partners (de Velis and Montalvo, 2011; Caprai et al., 2012; Haraldsson et al., 2013; Axelsson, 2013; Haraldsson, 2015; Haraldsson et al., 2021). 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. 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. During this period 10 scholarships were reserved on an annual basis for Salvadorans, another 10 for Latin American participants from outside of El Salvador, and up to 10 additional places were offered to participants who could attend without scholarships.

In early 2016, NDF pledged further funding to support the continuation of the Diploma Course in 2016-2017, with the Icelandic Ministry for Foreign Affairs (MFA) as the implementing agency. GTP also became a direct implementing partner along with LaGeo and the University of El Salvador. 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 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 GTP / LaGeo Short Course as an integral part of the Diploma Course curriculum (Section 2.1.1). 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 GTP and LaGeo in both.

In 2019 MFA assumed total responsibility for the direct financing of the Diploma Course, with LaGeo and the University of El Salvador contributing in-kind. A two-year agreement was signed between MFA, GTP and LaGeo. The Diploma Course was held in 2019 in much the same way as in earlier years (Haraldsson et al., 2021), with the aim of repeating it in 2020. COVID-19 postponed this second year for which financing had been secured by two years. In 2022, the Diploma Course was held again for participants from 8 countries in Latin America (Table 5, Figure 6).

5.2 African Geothermal Center of Excellence

GTP has from time to time supported the African Geothermal Center of Excellence (AGCE). The 5-day long *Introductory Short Course on Geothermal Project Management* was one of two short courses held in 2017 to mark the initiation of an interim development phase supported by the Icelandic Ministry for Foreign Affairs (Figure 7).

Table 5: Geothermal Diploma Course for Latin America in 2019 and 2022.

Year	Direct funding	GTP role	Dates (dd.mm)	Countries	No. particip.	No. women	Participant days
2019	MFA	Implementation partner	24.06-15.11	8[1]	29[1]	15 (52%)	2,871[2]
2022	MFA	Implementation partner	20.06-18.11	8[3]	27[3]	11 (41%)	3,132[4]
			Total:	**11**	**56**	**26 (46%)**	**6,003**

1: Argentina (1), Chile (1), Colombia (2), Ecuador (2), El Salvador (19), Mexico (1), Nicaragua (2), Peru (1); 2: Rough estimate of 99 active days based on the academic calendar; 3: Argentina (1), Bolivia (1), Colombia (2), Dominican Republic (1), El Salvador (17), Honduras (1), Mexico (2), Nicaragua (2); 4: Rough estimate of 116 active days based on the academic calendar. SDG Short Course IV accounted for 5 of those days (the DC students did not participate in the short course field trip).

Figure 6: Participants of Geothermal Diploma Course for Latin America 2022. Left: A uniform selfie at the Berlin geothermal power plant; Right: Graduation. Courtesy of LaGeo S.A. de C.V.

Figure 7: Participants, organizers and lecturers of Introductory Short Course on Geothermal Project Management held in Kenya in cooperation with AGCE in May, 2017.

5.3 Sino-Icelandic Geothermal Training Program

In 2019, GTP took part in the 5-week long Sino-Icelandic Geothermal Training Program along with Sinopec Green Energy Company / Sinopec Management Institute and Orkustofnun – the National Energy Authority of Iceland (Figure 8).

6. FUTURE OPPORTUNITIES

The Geothermal Training Programme in Iceland started operations in 1979 as an oil crisis rocked the world in the wake of the Iranian revolution. The years prior had been tumultuous with respect to availability and prices of energy, especially oil, and many governments and world bodies were looking towards alternatives such as geothermal energy. In today's environment, the drive to harness alternative energies is even greater, as security of supply, prices, and climate considerations make reliance on fossil energy ever more problematic. Increased emphasis is placed on environmentally benign and secure resources. For many countries, geothermal energy is such a resource.

Geothermal training is as important as ever and the potential for reaching out to the world has never been greater. In coming years, GTP places emphasis on the following:

Figure 8: GTP staff and former fellows at the Inauguration of the Sino-Icelandic Geothermal Training Program in 2019.

- Continued core operations in similar fashion to earlier years, albeit evolving in tandem with the times, with even increased emphasis on in-country and online training.
- Short courses on site in cooperation with partners in the same locations as in earlier years. Additional locations will also be considered.
- Offering tailored training in cooperation with partners, given alignment with GTP's objectives.

There is great value in carrying training out on site, in settings that are familiar to participants. The Diploma Course in El Salvador has provided important opportunities for aspiring geothermal professionals in Latin America, and the African Geothermal Center of Excellence has made its mark in East Africa. Regional training centers can bring benefits elsewhere as well and GTP is ready to support such undertakings within the limits of its capacity. In order for geothermal energy to truly reach its potential, more training of aspiring geothermal professionals is needed, far beyond what GTP can offer.

Online training has developed tremendously in recent years, with increased potential as different platforms mature and internet connections become ever more reliable and fast. Initial steps have been taken at GTP to make use of opportunities associated with this development. In coming years it is expected that GTP will further harness the potential inherent in online training, both in a supplementary and complimentary way to traditional training in Iceland and on site in the partner countries. The true potential of online training in GTP operations will probably be realized when used in conjunction with traditional training in person / on site. Since 2020, GTP has broadcast the introductory lectures of its six-month training programme to fellows who have for some reason not been able to arrive in Iceland on time. This has allowed them to interact with lecturers and classmates from the start, building familiarity and class-spirit, and enabled them to keep up with the training schedule. These lectures have also been recorded for those who have not been able to follow the lectures live, due to time differences or other reasons. Live online lectures and recordings have also been used to some extent in the SDG Short Courses in El Salvador and Kenya, with good results. One of the tasks of coming years is to explore further such complementarity between online and traditional training, with the aim of increasing the reach and quality of the different facets of GTP training, while reducing costs.

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