UNU Geothermal Training Programme 1979-2019:  

The Legacy in Africa  

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ABSTRACT  

The United Nations University Geothermal Training Programme (UNU-GTP) was established in Iceland in late 1978. After a cooperation of over 41 years, the Government of Iceland and United Nations University (UNU) severed their connection at the end of 2019. Instead a new Category 2 Centre under the auspices of UNESCO, named GRÓ, was established in Iceland over the four Icelandic former UNU programmes. With this new affiliation they are expected to continue their operations in a similar way as before, whilst keeping the UN ties. UNU-GTP was established to provide 6-month geothermal postgraduate training in Iceland, for professionals from developing countries selected for UNU Fellowships, to strengthen their skills in developing geothermal resources. The initial annual groups of UNU Fellows, who came to Iceland, were small but gradually increased to about 20 at the turn of the century. Increased financial support in the 2000’s opened new pathways for UNU-GTP. The groups of 6-month Fellows grew to about 30, on average during the last decade, with more focus on Africa. As of 2000, MSc Fellowships were awarded to UNU Fellows, thus opening an opportunity of return to Iceland for higher academic studies in geothermal science or engineering. Annual Short Course series in support of the UN Development Goals were initiated in E-Africa in 2005, with more than 700 Africans to date receiving this 3-week training given in Kenya. Awarding of PhD Fellowships was initiated in 2008. In the last 6 years, UNU-GTP has awarded five new MSc Fellowships and one PhD Fellowship annually. Finally, since 2010, UNU-GTP has offered Customer Designed Training Activities, if financed independently, of which 44 different events have been held in four continents over last decade.  

In recent years, the countries of East Africa have been the most important partners of UNU-GTP. In all, 281 Africans completed the 6-month training from a total of 718 UNU Fellows. Kenya leads the way, with 134, while large groups were also trained from Ethiopia, Djibouti, Tanzania and Uganda. In academic studies, Africa has had an even larger representation. During the same period, geothermal development has really taken off in Africa. Kenya with more than 850 MWe online from geothermal resources at the end of 2019 and new power plants in the pipelines, is now one of the world leaders in geothermal power production. In this paper the activities of UNU-GTP are summarized, with emphasis on East Africa. The effect on geothermal development is discussed, especially in Kenya. This is a strong foundation for the new GRÓ GTP to build on for its future operations.
1. Introduction

The Geothermal Training Programme (GTP) was established in Iceland at the end of 1978, and celebrated its 40th anniversary in 2018 (Georgsson, 2018). It was a cooperative programme between the Government of Iceland (GoI) and United Nations University (UNU), and usually referred to as UNU-GTP. The task was to help developing and transitional countries with geothermal potential to establish groups of specialists in geothermal exploration and development, by giving university graduates, engaged in geothermal work, intensive training in their chosen field of specialization. Its regular budget came from the Government of Iceland, through the Ministry for Foreign Affairs (MFA) with some support from UNU during the first decades but fading out in the early 2000s.

Since 1979, annual 6-month training was offered in 8 or 9 different lines in geothermal science and engineering, for professionals from developing countries. The MSc programme, in geothermal science and engineering, was initiated in 2000 in cooperation with University of Iceland, and extended to PhD studies in late 2008. In 2013, a similar contract was signed with Reykjavík University, which consequently also joined in as a cooperation partner (Georgsson et al., 2015a; 2020).

From 2005, funding was also secured for additional training efforts, taking the training to the partner countries. The funding came from the Government of Iceland, as Iceland’s official contribution to the UN Millennium Development Goals (UN MDG), and was implemented through regular Workshops/Short Course series (UN MDG Short Course Series) hosted in selected countries on different continents, in cooperation with local energy institutions/companies. In line with the newly established UN Sustainable Development Goals (UN SDG), the annual series were reorganized in 2016, into the UN SDG Short Course Series, given in Kenya for East Africa, and in El Salvador for Latin America and the Caribbean (LAC) (Haraldsson, 2018; Haraldsson et al., 2020; Georgsson et al., 2015b).

The need for geothermal training in developing and transitional countries was usually well beyond what UNU-GTP was able to fulfil and service, through its regular budget. This led to requests for additional services, backed up by local or international financial sponsorships. It should also be noted that a lot of quality teaching material had been prepared through the UN MDG/SDG Short Course Series. These factors played a major role in the decision of UNU-GTP to take its training activities one step further in 2010, and offer courses or training fulfilling special needs of a sponsored customer. In recent years, this was an important part of UNU-GTP’s operations (Haraldsson, 2018; Haraldsson et al., 2020; Georgsson et al., 2020).

After a cooperation of over 41 years, the Government of Iceland, through the MFA, and UNU decided to sever their cooperation from the start of 2020. Instead MFA sought cooperation with UNESCO. This led to the formation of the new so-called Category 2 Centre named GRÓ – Centre for Capacity Development, Sustainability and Societal Change, and under the Auspices of UNESCO. GRÓ acts as an umbrella over the four Icelandic former UNU programmes. Thus, UNU-GTP has become GRÓ GTP, and under this new affiliation it is expected to continue its operations in a similar way as before.

In this paper, the activities of UNU-GTP through these 41 years are reviewed, with special reference given to the programme’s legacy in capacity building for geothermal development in East Africa. This is the foundation the new GRÓ GTP is built on.
2. The Organization of UNU-GTP

UNU-GTP was operated at Orkustofnun (OS) - the National Energy Authority of Iceland (www.os.is), which was an Associated Institution of UNU since 1978. The Icelandic budget came from the MFA through its Official Development Assistance (ODA). In 2004, ÍSOR – Iceland GeoSurvey, was separated from OS, as a separate independent but state-owned geothermal research institution. ÍSOR became the closest cooperation partner of UNU-GTP, where the majority of its teachers were employed full-time. UNU-GTP also had a close cooperation with University of Iceland (UI), and Reykjavík University (RU), where several of its key lecturers and project supervisors were based. Similarly, many of Iceland’s main engineering and energy companies contributed significantly to teaching and supervising at UNU-GTP, not forgetting many smaller companies active in geothermal research or development.

During the last few years, UNU-GTP had five full time staff members employed by Orkustofnun, but lecturers and supervisors were hired or contracted from its cooperative partners, in line with the needs of the trainees and students at each given time. Every year, about 100 staff members of these institutions/companies rendered services to UNU-GTP under informal contracts which gave the necessary flexibility required to provide the highly specialized training offered at UNU-GTP.

Since 2015, UNU-GTP was governed by a Board, with representatives from Orkustofnun, the MFA, and UNU, adding the director of UNU-GTP ex-officio. The Director General of Orkustofnun served as the Chairman. The Board of UNU-GTP met 2 times a year.

Academically, UNU-GTP was governed by a Studies Board, composed of high-level experts (from ÍSOR, UI and RU, etc.) responsible for each of the specialized study lines. They were appointed by the Director of UNU-GTP, who also served as its chairman. The Studies Board met every 3-4 months and served an important role in setting academic standards.

3. 6-Month Training in Iceland

3.1 The Structure of the 6-Month Training

From its start in 1979, the 6-month training in Iceland was the basis of UNU-GTP’s activities with 8 study lines, extended to 9 in 1997. This set-up was restructured in 2015, with four of the older study lines combined into two lines, and a new line on project management and finances added, for a total of 8 study lines. Furthermore, more attention was given to group work and interdisciplinary work among the UNU Fellows. The emphasis on the other study lines in geothermal science and engineering, however, remained high, since these are the basis of every geothermal project in the world.

Training usually started in late April and ended in October each year. All participants attended the introductory lecture course (6 weeks), including about 4 weeks of lectures and 2 weeks of group project and seminars, which aimed at ensuring good basic knowledge on most aspects of geothermal energy resources and technology, and to generate an appreciation for the interrelationship between the various disciplines necessary in geothermal projects. After the introductory course there were lectures and practical training in the respective specialized fields (6 weeks). Excursions were arranged to main geothermal fields under exploration and utilization in Iceland (2 weeks), with seminars held and case histories studied. The final part was the execution of the individual research project (10-12 weeks) with supervision from an expert / s in the field of research which was concluded with a research project report. Table 1 shows a detailed time schedule for the 6-month training in Iceland after the revision of 2015.
The main emphasis of the training was to provide the participants with understanding and practical experience to permit the independent execution of projects within a selected discipline when they returned home. A detailed description of the recently active study lines of GTP can be found on the GRÓ GTP web page (www.grogtp.is), including the following:

- Geothermal Geology
- Geophysical Exploration
- Reservoir Engineering and Borehole Geophysics
- Chemistry of Thermal Fluids
- Environmental Science
- Geothermal Utilization
- Drilling Technology
- Project Management and Finances.

Participants in the line of Project Management also had the chance to apply for certification by IPMA (International Project Management Association), to receive D or even C IPMA certificates in project management.

The final research project topic was selected with respect to the conditions of the home country of the participant. If possible, and especially in later years, the participants brought data from geothermal projects in their home countries to use as a basis for the project. In 2019, 20 of the 24 projects dealt with geothermal systems in the Fellow’s home countries.

An important part in the 6-month training was also the visit of the UNU Visiting Lecturer, with a week-long lecture series and professional discussions with the UNU Fellows.

Since 1994, all project reports were published in the annual book Geothermal training in Iceland (ISBN 978-9979-68) (printed copies can be obtained upon request). The books were mailed to libraries of universities and leading geothermal research institutions in over 50 countries. More recently, all research reports from 1979 to 2019 have been available online at the UNU-GTP website, now GRO GTP (www.grogtp.is).

### 3.2 Selection of UNU Fellows

Candidates for participation in the 6-month training in Iceland were expected to have a university degree in science or engineering, relevant for their study line, and be fluent in English. Furthermore, a minimum of one-year practical experience in geothermal work was required as well as being under 40 years of age, and having a permanent position in geothermal energy at a non-private energy company/utility, research institution, or university in their home country. However, with the recently added study line of Project Management...
and Finances mostly aimed at individuals with experience in management, here the background could be economics with the age limit also more freely implemented.

Much care was taken in selecting the participants, with personal interviews playing a key role. The traditional selection procedure was through site visits, conducted by representatives of UNU-GTP to the countries requesting training. Directors of selected institutions nominated candidates for training in the specialized fields considered relevant. All qualified candidates were interviewed personally by a UNU-GTP staff member or a representative, and the best selected for training, looking at a 2-4 year time perspective. In recent years UN MDG/SDG Short Course Series also served as important venues for selection of candidates for the more advanced training in Iceland. The courses enabled the participants to show their strength and thus promoting their opportunity for a interview, which consequently opened the possibility to be selected for the training in Iceland. Most recently, online video interviews were also carried out in a few cases, when suitable. The quality of the selection procedure played a very significant part in the success of UNU-GTP, with a drop-out rate below 1%, during its history.

Participants from developing countries normally received UNU Fellowships covering international travel, tuition fees and per diem in Iceland. In recent years (2010-2019), almost a third of the Fellowships were funded by partner countries of UNU-GTP, either directly through their institutions, or through international or bilateral agencies, such as the EFTA-funds.

3.3 African UNU Fellows during 1979-2019

In 1979-2019, 718 scientists and engineers from 63 countries completed the 6-month courses. Of these 281 were Africans or 39%, which is the biggest share of any continent, with Asia the only comparable continent with 35% participation. In 2019, 24 UNU Fellows enrolled for the training. Figure 1 shows the annual number of UNU Fellows in Iceland completing the 6-month training in Iceland as well as those studying for MSc and PhD, with African UNU Fellows shown in lighter blue colour. Figure 2 shows the number of African UNU Fellows during 1979-2019.
who annually completed 6-month training during 1979-2019, and their countries of origin, while Table 2 summarizes the number of African UNU Fellows for the different countries. The largest groups of Fellows have come from Kenya (134), China (90), Ethiopia (45), the Philippines (43), El Salvador (42), Indonesia (38) and Iran (25). Nine other countries have sent 10-20 participants, four of them are in Africa.

Table 2: Number of African UNU Fellows and their countries of origin, second number for academic studies indicates studies in progress at the end of 2019

<table>
<thead>
<tr>
<th>Country of origin</th>
<th>No. UNU Fellows</th>
<th>Academic studies</th>
<th>Country of origin</th>
<th>No. UNU Fellows</th>
<th>Academic studies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Algeria</td>
<td>4</td>
<td></td>
<td>Malawi</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Burundi</td>
<td>2</td>
<td></td>
<td>Morocco</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Comoros</td>
<td>2</td>
<td></td>
<td>Nigeria</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Djibouti</td>
<td>19</td>
<td>2+1</td>
<td>Rwanda</td>
<td>12</td>
<td>2</td>
</tr>
<tr>
<td>D.R. Congo</td>
<td>1</td>
<td>0+1</td>
<td>Sudan</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Egypt</td>
<td>4</td>
<td></td>
<td>Tanzania</td>
<td>19</td>
<td>3+1</td>
</tr>
<tr>
<td>Eritrea</td>
<td>7</td>
<td>2</td>
<td>Tunisia</td>
<td>6</td>
<td>0+1</td>
</tr>
<tr>
<td>Ethiopia</td>
<td>45</td>
<td>4+2</td>
<td>Uganda</td>
<td>17</td>
<td>1</td>
</tr>
<tr>
<td>Kenya</td>
<td>134</td>
<td>24+1</td>
<td>Zambia</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

3.3 Evaluation

Figure 1 shows how the number of UNU Fellows gradually increased. This was mainly controlled by available financing from MFA, which in the early 2000s was on-average sufficient to cover the costs of about 20 annual UNU Fellowships, with perhaps 1-2 additional UNU Fellowships funded through other financial mechanisms. A significant change was seen in 2010-2019, with an increasing number of UNU Fellowships funded through other financial mechanisms, allowing the number of available UNU Fellowships to grow to about 30 on average for this period. A clear recognition of the quality of the training offered at UNU-GTP
was seen, when institutions/companies in countries like Kenya and the Philippines were ready to finance UNU Fellowships in Iceland.

Internal assessments of the training, in the past, mainly took the form of interviews with former trainees and their directors during site visits or in connection with international geothermal conferences. Some changes were made in the detailed contents of some of the specialized courses, based on the feedback from the trainees and their institutions. During the training, anonymous questionnaires were also used to obtain the Fellows’ opinion on the content of the lectures and the performance of the lecturers, and general support. Finally, anniversary workshops were used to evaluate the contribution of UNU-GTP in their partner countries, through papers presented, usually with a very positive response.

UNU-GTP was evaluated twice as a part of the UNU system – in 1996 and 1998. Both evaluations were favourable to UNU-GTP.

In 2017, at the request of the MFA and supported by UNU, the four UNU sister programmes in Iceland (UNU-GTP, UNU-FTP, UNU-LRT and UNU-GEST) went through a very detailed and comprehensive evaluation process, carried out by the Swedish firm *Nirás indevelop*, which specializes in such evaluations. The following is a short quote from the executive summary: *The UNU programmes in Iceland provide training that is of high quality. Theory, professional skills training and project work are combined, which gives fellows a unique edge. With regards to cost efficiency it says: …the cost comparison with other capacity development efforts in developed countries shows that the cost per fellow and day of the UNU Iceland programmes is at a reasonable and generally competitive level* (Nirás indevelop, 2017).

Generally speaking, the effort to have the training tailor-made to the abilities of the individual and the needs of the recipient country/institution seems to have been successful. Our records indicate that 80% of all our trainees have continued working in the geothermal sector for five years or more, and for most of them working in geothermal or at least in renewable energy development becomes the career of a lifetime. In many countries, not least in Africa, UNU-GTP graduates have been among the leading specialists in geothermal research and development. They have been successful, and have contributed significantly to energy development in their region, as will be discussed in a later section.

4. Academic Studies in Iceland

The aim of establishing the MSc programme (later extended to a PhD programme) in cooperation with UI and RU was to go further in assisting partner countries to strengthen their specialist groups and increase their geothermal research capacity. The MSc Fellowships were restricted to former 6-month UNU Fellows. The 6-month training could fulfil 25% of the MSc programme credit requirements (30 of 120 ECTS) at UI and RU, if requested. In 2001-2019, 67 UNU Fellows completed an MSc degree in geothermal science or engineering on a UNU-GTP MSc Fellowship. In total, 60 received their degree from UI, the first one in 2001, while 7 received it from RU, the first one in 2016. Figure 3 shows a world map with the origin of all MSc and PhD Fellows. All 67 of the MSc Fellows received UNU-GTP Fellowships funded by the MFA, but 2 Fellowships were co-sponsored by the home-country. Forty MSc Fellows (60%) were Africans, with Kenyans most numerous, 24. At the start of 2020, 10 additional MSc Fellows were pursuing their MSc studies in Iceland, of whom 6 were Africans.

The MSc theses were published in the UNU-GTP publication series, and can also be obtained from the GTP webpage (now www.grogtp.is).
In addition, 8 former UNU Fellows, all but one coming from Africa, were admitted to the PhD programme at UI (7) and RU (1) on UNU-GTP Fellowships. All of these have been sponsored by GoI. The first two started in the academic year 2008-2009. On February 15, 2013, a milestone was reached when the first UNU-GTP PhD Fellow defended her PhD dissertation. The second defended her dissertation in 2016 and the third one in late 2019. All three come from Kenya. At the start of 2020, five were pursuing their PhD studies. Of these, three are from Kenya, while one each comes from China and Tanzania.

5. The UN Millennium and SDG Short Course Series

The UN Millennium Short Course series in 2005-2015, superseded since 2016 by the UN SDG Short Course Series, were an important addition to the activities of UNU-GTP, allowing it to bring considerable part of the training to East Africa and Latin America, in cooperation with local energy institutions/companies (Fridleifsson, 2004; Georgsson et al., 2015b; Haraldsson et al., 2020). The original series saw annual events / short courses held in Kenya from 2005 to 2015, and semi-annual for Central America – later extended to the whole of Latin America and the Caribbean Islands (LAC) – in El Salvador, from 2006 to 2015. A lot of material presented and papers written for these events were published on CDs, also available on the website of GTP (www.grogtp.is).

In line with the goals set forward by UN through the SDGs, two new series of annual short courses were introduced in late 2016, held in Kenya and El Salvador, replacing the old series, and taking their inspiration in the UN Sustainable Development Goals. Four events were run in the East African Series in Kenya under the banner of UNU-GTP, but three in the LAC series in El Salvador. In Africa (including also Yemen), about 745 participants had the opportunity to attend events of these series since their start in 2005, while 622 attended the LAC events, starting in 2006. With these short course series, UNU-GTP was able to reach a far larger number of geoscientists and engineers in East Africa than through its conventional training in Iceland. Thus, it was possible to spread geothermal knowledge to a wider region and audience, and contribute strongly to potential geothermal development in new countries. The Short Courses were also an important element in catalysing increased cooperation between the countries in East Africa. Their reputation has also spread outside E-Africa with temporary participation from both Nigeria and Cameroon. A detailed description of the UN Millennium Short Course Series is given in Georgsson et al. (2015b) and Haraldsson (2018), and of the succeeding UN SDG Short Course Series in Haraldsson et al. (2020).
6. Sponsored Customer-Designed Short Courses and Training Activities

The possibility for customer-designed short courses or training offered to partner countries was opened in 2010. This service was triggered by the urgent need for training in countries planning fast-tracking of geothermal development, while it was also an offspring of the regular training, and the Millennium Short Course Series and the material prepared there. This proved a good opportunity for some countries/institutions in need of a rapid capacity building process, which had themselves the strength or the support of external sources (e.g. multilateral or bilateral aid agencies) to finance such events. The paying customer defined the outline of the event, while UNU-GTP was responsible for the details and quality of the contents. In 2010-2019, 44 different events were given for various customers, with 23 of these held in Africa, and many of these for Kenya. For further information, see Haraldsson (2018) and Haraldsson et al. (2020).

7. Gender Equality

Gender equality and gender politics are a key element in Icelandic foreign policy as well as for the United Nations. Gender equality is also a part of the UN Sustainable Development Goals. In line with its Strategic Plan for 2016-2019, in recent years UNU-GTP actively promoted gender equality, through a gender balanced candidate selection, cooperating with UNU-GEST on special gender and energy lectures, as well as increasing the share of female lecturers in its programmes (UNU-GTP, 2016). The disadvantage is that energy related research and development is still quite male dominated, not at least in the developing part of the world. Hence, limited nomination of female candidates was a hindrance in reaching the gender balance UNU-GTP sought. This is well reflected in the statistics, as through the 41 years of 6-month training at UNU-GTP in Iceland, only 24% of UNU Fellows were women. The ratio, however, improved significantly in recent years. It grew to 33% for the 2010s, 41% for the last 4 years and was at 46% in 2019. For Africans this was reflected in 22% of female candidates from the beginning (61 out of 281). Looking only at the last decade (2010-2019), the ratio increased to 27% (44 out of 163).

Looking at the academic studies, only 12 of those who have completed an MSc degree were women (18%), which is rather low. However, the last few years have seen a considerable improvement – in line with increased emphasis on gender equality. On the other hand, 2 of 3 PhD graduates to date are women, and 1 of 5 pursuing PhD studies at the end of 2019.

The aim in recent years was clear, to increase the share of women selected for training, studies and teaching, with the ultimate goal to reach gender equality in the activities as soon as possible, referring to SDG 5: Achieve gender equality and empower all women and girls (Georgsson et al., 2020).

8. The UNU-GTP Website

Open publication was always the motto of UNU-GTP, in line with the general policies of the United Nations University, supporting free access to scientific material for everyone. The project reports and post-graduate theses of the UNU Fellows in Iceland were distributed free of charge to geothermal institutions worldwide, and the same applied to publications of study material. With the internet becoming more and more important in spreading information, since the early 2000s, the reports were also published in a pdf-version on the UNU-GTP website. Older reports were also made available there. The same applies to the UNU-GTP Workshops and Short Courses, and the UNU-GTP Anniversary Publications. Papers written
for these events and published in books and/or on CDs were also made available in open and accessible publications on the GTP website (now www.grogtp.is).

With all the material accessible on its website, UNU-GTP created one of the largest open databases in the world on geothermal exploration, development and utilization. This is easy to verify by searching for material on geothermal on the internet, through one of the available search engines, with material published by UNU-GTP inevitably reaching high view scores. It is also interesting to look at some statistics. Table 3 shows the most viewed publications in 2019 and their number of views. The Millennium Short Course Series are obviously attracting much attention as papers presented there are in 3 of 5 top seats. The number of views can also be considered very high for such specialized literature. Three of these are written by Africans.

Table 3: Most viewed online publications of UNU-GTP for the year 2019.

<table>
<thead>
<tr>
<th>No.</th>
<th>No. views</th>
<th>Title and author of publication</th>
<th>Publication year and type/event</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>170,287</td>
<td>Directional well design …, by Farah Omar Farah</td>
<td>2013 – Report 27</td>
</tr>
<tr>
<td>2</td>
<td>140,590</td>
<td>Piping design: the fundamentals, by José Luis Henriquez and Luis A. Aguirre</td>
<td>2011 – ES SCIII</td>
</tr>
<tr>
<td>3</td>
<td>81,350</td>
<td>Introduc. to types and classif. of rocks by Geoffrey Mibei</td>
<td>2014 – K SCIX</td>
</tr>
<tr>
<td>4</td>
<td>39,267</td>
<td>Design and select. of deep well pumps by Udom Kunaruk</td>
<td>1991 – Report 8</td>
</tr>
<tr>
<td>5</td>
<td>39,130</td>
<td>Environmental Impact Assessment, general procedures, by Pacifica Ogola</td>
<td>2007 – K SCII</td>
</tr>
</tbody>
</table>

9. Financial Basis

The primary source of funding for UNU-GTP was from the budget of the MFA. The four UNU programmes in Iceland generally enjoyed strong support from the Icelandic Government, which identified them as key implementing entities in its development cooperation agenda. Annual contributions from the MFA used to be close to 200 M ISK, influenced to some extent by a fluctuating exchange rate of the Icelandic krona (ISK), especially in the times of the financial crisis of 2008 and its aftermath. The last few years saw annual contributions of about 215 M ISK increasing to about 250 M ISK in 2018 and 2019.

Prior to 2010, only minor additional funding came from other sources, with UNDP and IAEA or bilateral agencies (ICEIDA) financing a few UNU Fellowships through the years. The last 10 years saw quite a big change in this. Foreign funding came in through the customer designed short courses and training as well as an increasing number of UNU Fellowships for 6-month training financed by partner countries, sometimes with assistance from multilateral or bilateral aid agencies. In total, about 30-40% of the finances of UNU-GTP in 2011-2016 came from these sources, on average about 140 M ISK annually, and 15-20% in the years 2017-2019. This was very positive for UNU-GTP, especially in the period following the financial crisis in 2008, a difficult time for the geothermal industry in Iceland when local geothermal projects were scarce (Georgsson et al., 2020).

10. Support to Geothermal Training Centres in the Developing Countries

10.1 The Geothermal Diploma Course for Latin America in El Salvador

Since the start of the UN MDG Workshops/Short Courses in 2005/6, the long-term aim was for the courses to develop into sustainable regional geothermal training centres. A Geothermal Diploma Course in geothermal energy was run in El Salvador in 2010-2015, initially with Italian support and cooperation with LaGeo S.A. de C.V. (LaGeo) – the main local
geothermal company, and University of El Salvador (UES). Later the Nordic Development Fund (NDF) partnering with the Inter-American Development Bank (IDB) came in to secure its financial basis, with UNU-GTP, monitoring its activities. The situation changed again in 2016, with NDF continuing to finance the Diploma Course, but now with the ICEIDA department of the Icelandic MFA (MFA/ICEIDA) as a partner. At the same time, UNU-GTP assumed a direct role in the management of the programme with a cooperative agreement with the local partner, LaGeo, valid for 3 years. As a result, the UN SDG Short Course Series in El Salvador also became an integral part of the Diploma Course, and 2-3 experts from Iceland came in on an annual basis as guest lecturers to strengthen its lecture series (Haraldsson et al., 2020). In January 2019, NDF decided to discontinue its cooperation in this project. Instead, a two-year additional financial agreement was reached with MFA/ICEIDA which secured the continuation of the course.

The Geothermal Diploma Course in El Salvador offered new possibilities for aspiring geothermal experts in Latin America, as the programme was conducted in Spanish. In most years the course hosted about 30 participants, with 20 on full Fellowships, covering all basic costs. Ten were awarded to participants from the Latin American Region, 10 to Salvadorians, and in addition about 10 to independently financed participants. The courses, which have lasted 4-5 months, have been rather general in scope. They have not offered specializations in particular geothermal disciplines, except through the 4-6 week long project work. The success of the Diploma Course through the years has rested on the strong expertise found within LaGeo, strengthened in recent years with the cooperation of UNU-GTP.

10.2 African Geothermal Centre of Excellence for Capacity Building

The increased emphasis on development of geothermal resources, currently experienced in East Africa, and especially in Kenya in association with the goals set forward in Vision Kenya 2030 (e.g. Omenda et al., 2020), created challenges to capacity building activities on offer by various training institutions, such as UNU-GTP in Iceland, Auckland University in New Zealand, US Power Africa / USAID, JICA of Japan, and local universities. To keep the momentum of development going, it has therefore been urgent to take the local training to a new level. For some time, it had been discussed that the next step should be the establishment of a Regional Geothermal Training Centre for East Africa, located in Kenya. In 2014, the Geothermal Development Company – GDC got the support of the Kenyan Government to establish a centre of excellence in geothermal capacity building. The African Union also emphasized its support for such a centre in collaboration with regional and international stakeholders. The same applied to UNU-GTP.

The formal establishment of the African Geothermal Center of Excellence (AGCE) in Kenya is still in an interim phase, and under the guidance of United Nations Environment Programme – UNEP through their Nairobi office. MFA/ICEIDA and NDF have declared that they could be ready to step in to secure the financial background for such a centre. The programme prepared for implementation aims at offering courses at 3-4 different stages and of varying time-lengths, at a postgraduate study level. Hopefully we will see the centre formally established soon.

10.3 Sino Icelandic Geothermal Training Program

In recent years, plans on geothermal training in China in cooperation with UNU-GTP have been discussed on and off without it leading to conclusive results. In late 2019, new plans were put forward which may materialize into a geothermal training centre in China. Behind it is Sinopec Green Energy Company, which was given the task to lead development of new
major geothermal district heating projects in China. The first step was a 5-week Short Course on Geothermal Exploration and Development, for 40 participants, held in Beijing in late 2019. Teaching and supervision was shared between Icelandic and Chinese experts, including a few former UNU Fellows in Iceland. This may lead to a future formal cooperation between the GTP and Chinese partners in geothermal training with the high expected need.

11. Impact of the UNU Geothermal Training Programme in Africa

11.1 Status of Renewable Energy Development in E-Africa

In recent years the focus of UNU-GTP was on Africa. Most of the countries in Sub-Saharan Africa acutely need to develop their indigenous energy sources, especially the renewables. The E-African countries have similar energy production and consumption characteristics. Traditional biomass represents by far the largest part of the energy produced (Georgsson and Haraldsson, 2019). The extensive use of combustible waste and biomass causes deforestation and contributes to environmental degradation. All the East African countries import petroleum products, mainly for transport but some for electricity production, which is not desirable in times of environmental awareness. Instead indigenous renewable energy sources should be preferred, at least as far as they are available. Renewable energy sources have only represented a small portion of the total primary energy production (TPES). When looking at numbers for Eritrea, Ethiopia, Kenya and Tanzania, they averaged only 7% in 2017 for hydropower, wind, solar and geothermal production combined (Georgsson and Haraldsson, 2019). In this context, the East African Rift System (EARS) (Figure 4) can play a major role with its volcano-tectonic activity and high-temperature geothermal resources which have the potential to drive a considerable part of the electric production needed in the region. Kenya is the leader, but Ethiopia, Tanzania and Djibouti are also in a good situation to follow their example. Eritrea, Uganda, Rwanda, Burundi, Malawi and Zambia also have significant geothermal resources which can be developed for the benefit of their nations, if not for electricity production, then at least for direct use.

UNU-GTP put a heavy emphasis on E-Africa in recent years. This was seen in all its activities, including the 6-month training and academic studies in Iceland, in the UN MDG/SDG Short Course Series in Kenya and the customer-designed short courses and training activities, of which the majority of events was located in E-Africa. The drive behind was a strong desire to make as much impact as possible in assisting the E-African nations to develop their geothermal resources for the benefit of their people.
11.2 Kenya – leading the way in Africa

With today’s modern technology, E-Africa has a very high potential to generate energy from geothermal power. Despite that, Kenya is still the only country in the region harnessing this valuable resource to a significant extent. It has been assessed to have the largest potential, evaluated at over 7000 MWe (Simiyu, 2010). But more importantly, in 2014 Kenya put forward a very ambitious plan to reach a total of 2000 MWe of geothermal power online in 2018 and 5000 MWe in 2030 (GoK, 2014). This may have proved to be overly ambitious, but still illustrates the strong intention of the Government of Kenya to develop their geothermal resources.

Starting in the early 1980s, Kenya slowly increased its geothermal electric power generation from the Olkaria geothermal system to 202 MWe in 2010, mainly through exploration and development by the Kenya Electricity Generating Company, PLC (KenGen), and its predecessors. Since then development has been faster. OrPower 4, a power plant built by Ormat, started producing in 2000, but was enlarged in 2009 and 2014, which took its capacity to 110 MWe. Two new power plants, Olkaria IAU and Olkaria IV, built by KenGen came online in Olkaria in 2014, with a capacity of 140 MWe each. Together with smaller units (wellhead generators) and enlargements this took Kenya’s production capacity to almost 600 MWe at the end of 2014. With the enlargement of OrPower 4 (to 139 MWe), and Olkaria IAU (by 83 MWe), and the new Olkaria V power plant (160 MWe) coming on line, Kenya reached 865 MWe in late 2019 (Omenda et al., 2020). Additional power plants are on the drawing board in Olkaria.

The Geothermal Development Company (GDC) has also been drilling with at least 3-4 rigs in action in the Menengai geothermal area. After some disappointments in the early phases, it has got promising results. To date, 49 wells have been drilled with 25 tested providing an estimated potential of about 170 MWe, so steam is now available for power production. Three 35 MWe power plants are in the pipelines, with GDC supplying the steam and IPPs contracted to install the power plants (Omenda et al., 2020). Recently, GDC has also drilled 3 deep exploration wells in the Paka geothermal field with good results, the first geothermal wells drilled north of the equator in Kenya. Drilling is also being prepared in Korosi in the Baringo-Silali geothermal field (GDC, pers. comm.).

Geothermal power production has really taken off in Kenya. With 865 MWe online, Kenya is now one of the world leaders in geothermal power production, as the 8th largest producer of geothermal electricity – having passed Iceland (with 755 MWe) in 2019 (Ragnarsson et al., 2020).

Direct use of geothermal is also being promoted in Kenya. The Oserian greenhouse farm close to Olkaria uses steam and carbon dioxide from a geothermal well for heating and increasing plant photosynthesis in an extensive complex of greenhouses for growing roses. The Oserian farm is the biggest geothermal greenhouse farm in the world, with 50 ha. of greenhouses being heated with geothermal to produce high-quality cut flowers (Omenda et al., 2020). Olkaria is also the location of the geothermal spa, built by KenGen, to some extent modelled after the Blue Lagoon in Iceland (Mangi, 2015). The Olkaria Spa has certainly created an increased interest in public bathing in Kenya and has been popular among tourists in the Naivasha area.

GDC has developed a pilot direct use facility at the Menengai geothermal field. In the project, geothermally heated water from a well at 90°C is cascaded through a laundry, milk pasteurizer, aquaculture and finally a greenhouse with tomatoes and capsicum after which the
water is recirculated. GDC has also installed a grain dryer to demonstrate use of geothermal heat in drying agricultural produce (Omenda et al., 2020).

11.3 Geothermal development in other E-African countries

Reviewing briefly the current status of geothermal development in other E-African countries, geothermal power has only been produced for a limited period in Ethiopia, at the Aluto-Langano pilot plant, despite strong exploration efforts. Other countries are all at an exploration stage, with only a few having drilled exploration wells. The following is a short summary of the current status in the different countries.

Djibouti
Djibouti with its strategic location at the triple point, where the EARS, the Red Sea, and the Aden Gulf meet, is certainly expected to have good geothermal resources, though somewhat hampered by difficult chemistry through extreme salinity, at least in the Assal field. Exploration and drilling of 6 wells was carried out there in the 1980s. Exploration and plans for development have been ongoing periodically since then, without reaching production stage. In 2014, Office Djiboutien de Développement de l’Énergie Géothermique (ODDEG) was formed, directly under the Office of the President, and given the responsibility of developing geothermal resources in Djibouti. Three deep exploration wells (2600-2700 m deep) were drilled in the Assal-Fiale system in 2018-2019 (Ahmed Aden, A., 2019). Further drillings are needed to verify the resource.

Eritrea
The tectonic setting and geological makeup of the Danakil region of Eritrea is favourable for geothermal resources. There is potential for electrical generation and but also direct use applications. The Geothermal Survey of Eritrea (GSEr) under the Department of Mines has been in charge of the development. The Alid and Nabro-Dubbi fields appear to be the best prospects with ample high-temperature geothermal manifestations. Surface exploration has focused on Alid. The results are promising with exploration drilling being the next major step (Yohannes, 2020).

Ethiopia
The EARS (Figure 4) divides Ethiopia into two halves with many promising geothermal prospects located along the rift. Besides geothermal, Ethiopia is also rich in hydropower. Early on, geothermal exploration focused on the Aluto-Langano and Tendaho high-temperature fields, with 8 exploration wells drilled in the former in the 1980s, and 6 in the other (3 deep and 3 shallow) in the 1990s. The Aluto-Langano pilot power plant went online in 1998, scheduled to produce about 7.3 MWe. Full production from the power plant proved elusive. For some years its production was limited to about 3 MWe with long intervals when it was not producing. In the 2010s, 2 additional wells were drilled. In recent years, Aluto-Langano has been targeted as a site for a new 70 MWe power plants, with development in the hands of Ethiopian Electric Power (EEP) and the Geological Survey of Ethiopia (GSEt), with the support of JICA and other international financial stakeholders (Kebede et al., 2020). Other fields are also ready for development by the same stakeholders.

Reykjavik Geothermal (RG) has also been very active in Ethiopia, exploring their concessions in the Corbetti, Tulu Moya and Abaya geothermal fields. All are now ready for deep exploration, and assessed to be good enough for about 500 MWe production each. RG has also negotiated an agreement of power purchase with the Ethiopian Government. Corbetti Geothermal is preparing for drilling in Corbetti at the first feasible opportunity (RG, 2020).
Ethiopia is on the threshold of major geothermal development with the resources needed to succeed.

**Tanzania**
With the establishment of the *Tanzania Geothermal Development Company (TGDC)* in 2014, a subsidiary of TANESCO, the state electricity company, Tanzania looked to Kenya for a role model. TGDC has focused exploration on four geothermal fields, the Ngozi, Kiejo-Mbaka, Songwe and Luhoi prospects. Drilling programmes are set for implementation starting with 3 deep slim wells at the Ngozi prospect. Exploration indicates good probabilities of success (Kajugus et al., 2020).

**Rwanda**
Rwanda embarked on exploration of their geothermal resources in the 2000s. Two deep exploration wells were drilled in 2013 in the Karisimbi prospect, with the project carried out by the *Ministry of Infrastructure, the Energy, Water and Sanitation Authority (EWSA)*. The results indicate that there is no geothermal reservoir under south Karisimbi. In 2016, serious investigations for geothermal exploration started again, and four prospects were identified, Karisimbi, Gisenyi, Kinigi and Bugarama. Currently, detailed surveys are planned for Gisenyi and Bugarama, through the *Rwanda Energy Group (REG)* (Rutagarama, 2020).

**Uganda**
Geothermal exploration has been ongoing in Uganda since the early 1990s, under the *Department of Geological Survey and Mines (DGSM)*. Focus has been on four main fields: Katwe, Buranga, Kibiro, and Panyimur. The geothermal activity in all areas appears to be fault-controlled with deep circulation systems, rather than magmatically heated systems associated with volcanoes. This is consistent with the revised view on geothermal prospects in the Western Branch of the EARS. Subsurface temperatures of approx. 100-160°C are predicted, in most cases good enough for binary electricity production, or direct use for industry, agriculture and tourism (Bahati and Natukunda, 2020).

**Other countries in the region**
Surface exploration is also on-going in Burundi, D.R. Congo, Malawi, Zambia and Sudan. Good prospects are certainly found in Malawi and Zambia, probably fault-controlled and hence limited to intermediate- or low-temperature activity. Most likely, similar applies to Burundi and D.R. Congo, Mozambique and Sudan. Hence, development should focus on direct use or binary electrical production.

**11.4 The UNEP ARGeo project**
To strengthen geothermal development and cooperation among the main geothermal countries in E-Africa a regional platform was needed. This led to the launching of the African Rift Geothermal Development Facility (ARGeo) in 2003 (Mwangi, 2008). ARGeo is a project funded by the Global Environment Facility (GEF), but implemented by United Nations Environment Programme (UNEP), through its office in Nairobi. The founding nations were six, Djibouti, Eritrea, Ethiopia, Kenya, Tanzania and Uganda. In November 2010 ARGeo was relaunched, but this time Djibouti chose to leave the project, but instead Rwanda joined as the 6th member state. Additional 7 countries were also targeted under the framework of “Regional Networking and Capacity Building Components” including Burundi, Comoros, Djibouti, DR Congo, Malawi, Mozambique and Zambia (UNEP, 2020).

The UNEP ARGeo project aims at supporting the development of the large untapped geothermal resource potential in E-Africa with the main objective of reducing risks associated
with the resource exploration. ARGeo also aims to reduce greenhouse gas (GHG) emissions by promoting the adoption of geothermal energy in the region. It will also help demonstrate that the resource is reliable, cost effective and indigenous as compared to other sources of power in the Eastern Africa region. The utilization of the resource in agriculture and industry will also be promoted (UNEP, 2020).

ARGeo has also been the organizer of biannual geothermal conferences in E-Africa, carrying its name and held for the first time in Addis Ababa, Ethiopia, in 2006, and soon (November 2020) heading for its 8th conference in Nairobi, Kenya. The ARGeo conferences have provided an important platform for scientists and engineers working in geothermal in E-Africa to present their work, and for their partners to monitor the geothermal scene in Africa, and present their possible cooperation.

ARGeo, under the able leadership of Dr. Meseret Teklemariam Zemedkun, has been an important partner for UNU-GTP. Besides the ARGeo conferences, this applied to some of the events UNU-GTP has hosted and financed in E-Africa, such as Short Courses and Workshops, as well as several customer-designed events, which were financed through The Geothermal Exploration Project, initiated jointly by Iceland and the World Bank, and financed by the MFA/ICEIDA and NDF.

11.5 Capacity Building for Geothermal Development in E-Africa

The geothermal exploration and development in E-Africa has certainly demanded a large effort in capacity building, especially in Kenya. UNU-GTP has played an important role in this by training many of the leading geothermal scientists and engineers through the years. The first African UNU Fellows (Kenyan) came to Iceland for training in 1982. Since then Africans were a part of all the annual groups of UNU Fellows trained in Iceland by UNU-GTP. After the formation of GDC in Kenya in early 2009, the need for training of Kenyans increased dramatically, both at the newly established GDC but as well at KenGen, which saw some key staff members leave for GDC. This need was seen in the large effort put into geothermal capacity building of Kenyans during the next decade (2010-2019), both by sending 5-10 UNU Fellows annually to Iceland for 6-month training, many sponsored by KenGen or GDC, adding also many local short courses and training activities conducted by UNU-GTP in Kenya. In all, 134 Kenyans completed the 6-month training at UNU-GTP during 1982-2019. Kenya itself partially financed about half of these. This is by far the highest number of UNU Fellows for any country. Other E-African countries were not forgotten, with 45 UNU Fellows from Ethiopia trained in Iceland during the same period, 19 from each of Djibouti and Tanzania, 17 from Uganda, adding also individuals from Rwanda, Burundi, Malawi, Eritrea, Zambia and Sudan (see Table 2). Many of them came later back to Iceland for MSc studies in geothermal science or engineering, offered from 2000, and a few for PhD studies, offered from 2008.

Table 4 lists some of the African leaders in geothermal exploration and development, who were trained in Iceland at UNU-GTP. Their affiliation and highest position status is based on GTP’s best available information. Years for MSc and PhD degrees refer only to studies in Iceland supported by UNU-GTP.
Table 4: Some of the E-African leaders in geothermal development who were trained at UNU-GTP

<table>
<thead>
<tr>
<th>Name</th>
<th>Spec.</th>
<th>UNU Fellow</th>
<th>MSc degree</th>
<th>PhD degree</th>
<th>Company/affiliation* and highest position</th>
</tr>
</thead>
<tbody>
<tr>
<td>Djibouti</td>
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<tr>
<td>Eritrea</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Ermias Yohannes</td>
<td>Chemist</td>
<td>2004</td>
<td></td>
<td></td>
<td>GSE: Head of Geothermal Group</td>
</tr>
<tr>
<td>Ethiopia</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dr. Meseret Teklemariam</td>
<td>Geologist</td>
<td>1985</td>
<td></td>
<td></td>
<td>UNEP: ARGeo project manager</td>
</tr>
<tr>
<td>Dr. Berhanu Gizaw</td>
<td>Geochemist</td>
<td>1985</td>
<td></td>
<td></td>
<td>GSE: Senior Expert</td>
</tr>
<tr>
<td>Solomon Kebede</td>
<td>Geologist</td>
<td>2005</td>
<td></td>
<td></td>
<td>GSE: Head of Geothermal Group</td>
</tr>
<tr>
<td>Dr. Yohannes Lemma Did.</td>
<td>Geophysicist</td>
<td>2007</td>
<td>2010</td>
<td></td>
<td>GSE: University of Adelaide: Researcher</td>
</tr>
<tr>
<td>Kenya</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zack Muna</td>
<td>Chemist</td>
<td>1982</td>
<td></td>
<td></td>
<td>KenGen: Chief Geothermal Scientist</td>
</tr>
<tr>
<td>Martin Mwangi</td>
<td>Geophysicist</td>
<td>1982</td>
<td></td>
<td></td>
<td>KenGen: Chief Geothermal Developm. Manager</td>
</tr>
<tr>
<td>Geoffrey Muchemi</td>
<td>Geologist</td>
<td>1985</td>
<td></td>
<td></td>
<td>KenGen: Geothermal Development Manager</td>
</tr>
<tr>
<td>Dr. Silas Simiyu</td>
<td>Geophysicist</td>
<td>1990</td>
<td></td>
<td></td>
<td>KenGen: Chief Geothermal Development Manager</td>
</tr>
<tr>
<td>Peter Ouma</td>
<td>Engineer</td>
<td>1992</td>
<td></td>
<td></td>
<td>KenGen: Steamfield Manager</td>
</tr>
<tr>
<td>John Lagat</td>
<td>Geologist</td>
<td>1995</td>
<td>2004</td>
<td></td>
<td>KenGen: GDC: Regional Manager North Rift</td>
</tr>
<tr>
<td>Martha Mburu</td>
<td>Res. Eng.</td>
<td>2003</td>
<td></td>
<td></td>
<td>KenGen: GDC: Manager</td>
</tr>
<tr>
<td>Dr. Pacifica Ogola</td>
<td>Env. Science</td>
<td>2004</td>
<td>2013</td>
<td></td>
<td>KenGen: Min. Env. &amp; For., Director Climate Change</td>
</tr>
<tr>
<td>Dr. Thela Mutia</td>
<td>Env. Science</td>
<td>2010</td>
<td>2016</td>
<td></td>
<td>GDC: Geothermal Expert</td>
</tr>
<tr>
<td>Evans Bett</td>
<td>Drill. Eng.</td>
<td>2010</td>
<td></td>
<td></td>
<td>KenGen: Drilling and Logistics Manager</td>
</tr>
<tr>
<td>Malawi</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Tufwane Mwagomba</td>
<td>Engineer</td>
<td>2013</td>
<td>2016</td>
<td></td>
<td>Malawi Energy Regulatory Authority: Engineer</td>
</tr>
<tr>
<td>Rwanda</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Uwera Rutagarama</td>
<td>Res. Eng.</td>
<td>2009</td>
<td>2012</td>
<td></td>
<td>EWSA, Head of Geothermal Development Unit; REG</td>
</tr>
<tr>
<td>Tanzania</td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Taramacli Mnjokava</td>
<td>Geochemist</td>
<td>2007</td>
<td></td>
<td></td>
<td>Geol. Survey of Tanzania; TGDC: Project Manager</td>
</tr>
<tr>
<td>Shakiru Kajugus</td>
<td>Res. Eng.</td>
<td>2012</td>
<td>2015</td>
<td></td>
<td>TANESCO; TGDC: Manager Research and Innovation</td>
</tr>
<tr>
<td>Uganda</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dr. Fred Tugume</td>
<td>Geophysicist</td>
<td>1995</td>
<td></td>
<td></td>
<td>DGSM: Commissioner Geological Survey</td>
</tr>
<tr>
<td>James Francis Natukunda</td>
<td>Geologist</td>
<td>2005</td>
<td></td>
<td></td>
<td>DGSM: Geologist</td>
</tr>
</tbody>
</table>

* Most abbreviations of affiliations are explained in Sections 11.2-11.4.

12. GRÓ GTP and COVID 19

At the start of 2020, the connection of the four training programmes in Iceland with UNU in Tokyo was severed. Instead they were united under the umbrella of GRÓ – Centre for Capacity Development, Sustainability and Societal Change, operating within the MFA. At the same time, GRÓ was accepted as a Category 2 Centre under the Auspices of UNESCO. With this new affiliation the Icelandic programmes are expected to continue their operations in a similar way as before, and also keep their ties to the UN system. Hence, UNU-GTP has now become GRÓ GTP. The MFA is fully committed to the future support of GRÓ GTP, with GRÓ GTP currently being the only international programme offering specialized postgraduate training in all main fields of geothermal science and engineering. Director of the new GRÓ GTP is the reservoir engineer, Dr. Gudni Axelsson,
GRÓ GTP has certainly had a testing first year of operations, with the COVID 19 pandemic dominating world events from March 2020. All international activities have been difficult in operation, with travelling between countries more or less closed down. This has of course hampered the activities of GRÓ GTP, as with other institutions dealing with international cooperation. Eventually, the 6-month training in 2020 was cancelled. Same applied to the UN SDG Short Course in Kenya, scheduled in November, as well as the Geothermal Diploma Programme in El Salvador, and the associated short course. On the positive side, it has been possible to keep the academic programme running as scheduled. The GTP is determined as possible to make up for this interruption, when the world has seen the end of the COVID 19 pandemic, starting hopefully in 2021.

13. GTP Focusing on a Geothermal Future

The UN Sustainable Development Goals are a roadmap for the world to follow in the coming years, and the Geothermal Training Programme (GTP) must make a serious effort, aiming at harmonizing its operations better with these. Goal 7: Ensure access to affordable, reliable, sustainable and modern energy for all; and Goal 13: Take urgent action to combat climate change and its impacts, should be at the heart of the programme’s activities; not forgetting Goal 5: Achieve gender equality and empower all women and girls. Utilization of indigenous renewable energy resources as a replacement for fossil fuels is a must in a world where ever-increasing emission of greenhouse gasses associated with global warming is one of the greatest threats to mankind. This is what makes geothermal resources so valuable today. Here, the restructuring of the two annual short course series for E-Africa, and for Latin America and the Caribbean in 2016, was important, putting a strong focus on the UN Sustainable Development Goals.

With the continued support of the MFA in Iceland, the GTP will be able to continue its efforts to build capacity in developing countries around the world, endowed with geothermal potential, and E-Africa will certainly continue to benefit from that. The ties with UNU have been severed, but the Government of Iceland is strongly committed to continuing its support to the Geothermal Training Programme, through the new umbrella institution in Iceland GRÓ. The ties to UNESCO mean that the GTP’s ties with the UN system remain and the intention is to continue along similar lines as before.

GTP’s core activity has been the 6-month training which is expected to continue. In 2019, 24 UNU Fellows completed the training, including 11 Africans, taking the total number to 718. A similar number is expected to be trained annually at GRÓ GTP in the coming years. Increasing the number of Fellowships in Iceland for MSc studies (currently 5 new are awarded on an annual basis) and PhD studies (currently one new awarded annually) is a feasible path for improvement.

The same applies for support for regional centres in the developing countries with continued emphasis on E-Africa. GTP could come in as an active partner in the running of AGCE – the African Geothermal Center of Excellenc, in cooperation with UNEP, GDC, KenGen, and other serious stakeholders on its academic development, and the African Union, NDF, MFA/ICEIDA and other willing stakeholders on the financial aspects.

Capacity building and transfer of technology are key issues in the sustainable development of geothermal resources. The Geothermal Training Programme expects to continue to successfully support geothermal development in Africa through its activities.
REFERENCES


