

Impact of Geothermal Capacity Building for Sustainable Development in Latin America: Insights from the GRÓ Geothermal Training Programme

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ABSTRACT:

The GRÓ Geothermal Training Programme (GRÓ GTP) in Iceland has, for over four decades, played a pivotal role in geothermal capacity building for developing countries. Since its inception in 1978, GTP has trained 816 fellows from 67 countries, offering specialized six-month training in Iceland as well as MSc and PhD scholarships at Icelandic universities. While the technical aspects of the training are vital, the Programme also emphasizes leadership development, international cooperation, and the strengthening of soft skills such as communication, gender equality, and cross-cultural understanding. In addition to the training in Iceland, in-country training such as the SDG Short Courses and the Diploma Course, are focused on sharing knowledge and strengthening cooperation in geothermal development for Latin America. This paper focuses on the experiences and long-term impacts of Latin American fellows within the Programme, exploring how the training in Iceland has contributed to geothermal development at national and institutional levels. Examples are presented of fellows who have returned to their countries to conduct and lead research on geothermal systems for exploration and utilization, lead geothermal initiatives, reduce project costs, introduce innovations in procurement, and environmental monitoring, and promote gender equality within the energy sector. The GTP model is shown to be effective in fostering professional networks that transcend national boundaries, thereby supporting increased collaboration and knowledge exchange within the Latin American region. The paper concludes that sustained investment in capacity building, particularly through immersive training experiences abroad, is essential for accelerating geothermal development and achieving the United Nations Sustainable Development Goals in Latin America and the world.

1. Introduction

The Geothermal Training Programme (GTP) in Iceland has been in continuous operation for almost 50 years, specializing in geothermal capacity building for developing countries. It is fully funded by the Government of Iceland through its

Official Development Assistance (ODA), although participants can be trained by their own or other funding means. Previously known as United Nations University Geothermal Training Programme (UNU-GTP), as of 2020, it operates as GRO GTP, under GRO - International Centre for Capacity Development, Sustainability and Societal Change, under the auspices of UNESCO. GTP's core activity is the Six-Month Training Programme in Iceland which covers all aspects of geothermal research and development, starting with introductory general geothermal education, then specialized training in one of the eight lines of specialization on offer; Geothermal Geology, Geophysical Exploration, Reservoir Engineering and Borehole Geophysics, Chemistry of Thermal Fluids, Environmental Science, Geothermal Utilization, Drilling Technology, and Project Management and Finances. The final stage is a full-scale research project under the guidance and supervision of leading geothermal experts in Iceland. Through 2024, 816 fellows from 67 countries have graduated from the Programme, with 23 currently enrolled to graduate in end of 2025. Additional support was introduced in 1998 and again in 2008, allowing graduates of the Six-Month Training to apply for MSc and PhD Scholarships to further their knowledge at universities in Iceland. This MSc and PhD-level support has proven to be highly influential in strengthening the geothermal capacity in the partner institutes and countries, contributing greatly to the advancement of local expertise and sustainable energy development in the world [1].

Since 2005, GTP has offered short courses and workshops in other countries, on a regular basis such as in El Salvador for the Latin American countries and Caribbean islands, and in Kenya for African countries to further increase the geothermal advancement in those regions. Other courses and workshops have been offered based on needs and demand, along with online courses. More than 3000 participants having benefitted from participating in these events. GTP has also contributed to regional training programmes in El Salvador, Kenya and China. Most of GTP's activities have been financed by the Government of Iceland, while a small part has been additionally financed through international support, or by local companies [2].

2. Results

The benefit of GTP's capacity building is clearly reflected in the progress of individual fellows, many of whom have become leading experts in their home countries, in advances in geothermal development in many supported countries, and has been documented in appraisals and external evaluations [3]. The support of GTP has made significant difference in geothermal development in many of its partner countries both on a country level and institutional level, as well as on an individual level. The Programme provides fellows with access to world-leading experts and firsthand experience in a country with a long history of geothermal utilization. Equally vital is the peer-to-peer exchange among fellows who are themselves professionals from diverse backgrounds, thus creating a global hub for interactive knowledge sharing. This unique environment has broadened participants' professional and personal perspectives and enables

international collaboration. Furthermore, the training not only enhances technical expertise, but it also promotes intercultural understanding, tolerance, and cooperation, values that are increasingly important in today's global context. Graduates often return home with strengthened leadership qualities, communication skills, and diplomatic awareness. Over the decades, many alumni have emerged as influential leaders in geothermal development, demonstrating the Programme's enduring success and impact. With Iceland having the highest gender equality index rating in the world for more than 15 years in a row, the cooperation between Iceland and its partner countries around the world, has put a big emphasis on gender equality within the sector. GTP adopted a gender balanced candidate and teacher selection in all of its activities, providing more opportunities for women to further their careers. Initiatives such as WING - Women in Geothermal are a great example of the increased emphasis within the sector on gender equality which further underlines the fact that we all need to work together to make geothermal development a success [4].

An excellent example of long-term impact of GTP support is El Salvador, which ranks among the top four countries in number of graduates, with 48 geothermal specialists trained. In 1980, a professional from CEL became the first Latin American to participate in the Six-Month Training Programme in Iceland. Furthermore, ten Salvadoran experts have also successfully completed their MSc degree in geothermal studies on a GTP Scholarship, awarded by University of Iceland or Reykjavík University. Notably, since the early participation in the Programme, the geothermal energy utilization in El Salvador has grown steadily, contributing an increasingly significant share to the country's energy matrix. The Salvadorian GTP alumni have played pivotal roles in advancing geothermal projects, including the Ahuachapán and Berlín power plants. Their expertise has contributed to increased efficiency, capacity, and sustainability in geothermal energy production. They have become educators, leading the Geothermal Diploma Course for Latin America and conducting short courses. This initiative has expanded geothermal expertise across the region. The GTP alumni at LaGeo, has led the implementation of low-enthalpy projects like geothermal-powered drying of agricultural products. These initiatives have garnered international recognition, including a UN award in 2015 [5]. Overall, the collaboration between GTP and Salvadoran institutions has been instrumental in positioning El Salvador as a leader in geothermal energy within Latin America [3] and the aim is to spread the support to more Latin American countries as they enter further into their geothermal journey. Geothermal development is a multidisciplinary field which requires extensive knowledge and expertise. From the almost half a century of geothermal training experience within the GTP, knowledge sharing and cooperation are the key elements of successful and sustainable utilization of geothermal resources.

4. Discussion

Due to the complexity of the geothermal resource and its long development time, long-term goals and continuity are essential. One of the challenges in the



geothermal sector in Latin America has been frequent changes in governments and managements that has made it difficult to establish long-term cooperation agreements. It has also led to detrimental effects on projects as they are at risk of being stopped without notice with new leadership each time and discourages specialists to have passion for the projects because they never know when they will be reassigned to something else. To better support geothermal development, greater institutional stability and long-term commitment are critical for ensuring project predictability. Furthermore, one of the biggest obstacles in the sector is the use of annually renewed temporary contracts, with some staff remaining in such conditions for over 15 years. This creates uncertainty and limits access to benefits such as salaries during training and staff motivation. Training and experience are the most important factors in the success of geothermal projects, and although widely recognized as highly valuable, many simply cannot afford the salary loss due to family circumstances, leading to inequal opportunities, and loss of institutional capacity strengthening. Latin America presents a great potential for geothermal development and utilization and if the opportunity is seized the future is geothermal.

5. Conclusions

The current interest in renewable energy and geothermal development plans in Latin America calls for capacity building in the region. More entities with new people joining are the sector and the need for training has never been greater. The long-lasting success and global impact of the GTP training demonstrate that investing in capacity building ensures technically competent personnel that can develop the resource in effective and sustainable way. Greater stability and job security in the sector enhances long-term project viability and is essential for cultivating a collaborative environment with passionate staff that is results-driven and focused on project completion.

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