

# D2.6 Market Visit Four - Costa Rica

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lssue	November	Dissemination	Public
Date:	2022	level:	



The GEO-ENERGY EUROPE project was funded by the European Union's COSME Programme under Grant Agreement N° 951195. The content of this deliverable represents the views of the author only and is his/her sole responsibility; it cannot be considered to reflect the views of The European Commission and/or the Executive Agency for Small and Medium-sized Enterprises

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### 1) Introduction

In 2019, a GeoEnergy Europe market outlook report with a country screening process identified Costa Rica as a GEE2 target country rather than Indonesia or Mexico, having been considered economically more stable with moderate inflation, and with a moderately high growth in GDP. Costa Rica total area is just over 51,000 square kilometres and has population of about 5 million people, and is at the forefront of renewable energy production in Central America which was made possible due to the country's natural resources and to the strong commitment to renewable energy sources with more than 99% of the energy used to power the nation's electrical infrastructure coming from renewable sources such as hydropower, geothermal and wind (see Figure 1). In parallel and as a consequence of the high use of renewable sources for energy production, the country is also at the forefront of ecologically responsible growth.

The National Centre for Energy (CENCE) directs and manages the operation of the National Electric System (SEN), in order to meet the country's electricity demands.



Figure 1 – <u>CINDE Presentation</u> of during GEE2 Costa Rica Market Visit, November 2022

The country's installed geothermal power generation capacity is 262 MW, which is run by the state power utility *Instituto Costarricense de Electricidad* (ICE). The geothermal resource potential of the nation is believed to be circa 1,000 MW. When it comes to the use of geothermal energy, it is the largest nation in Central America and the second largest in all Latin America; the natural resources are primarily directed to electricity generation and supply.

Geothermal energy can also be applied in a variety of ways to help achieve the Sustainable Development Goals (SDGs), especially SDG 7 - *Ensure access to affordable, reliable, sustainable and modern energy for all*. The connections between the application of geothermal energy and heat and the SDGs in areas such as: food security and nutrition, climate change adaptation and mitigation, heating and cooling of residential areas, industrial applications, and the creation of sustainable cities and communities, represent clear benefits to Costa Rica population and growth.

Notwithstanding the above, the direct use applications are limited for some of the productive activities, in the industrial, agricultural, commercial, and residential sectors, and overall, are not yet well developed, although a new programme to address this has been launched this year (2022).

### 2) Preparatory Work

Geoscience Ireland participation in PDAC - Prospectors & Developers Association of Canada during the Canadian Market Visit, allowed the consortium to develop a network of contacts in Costa Rica, namely within ICE, the main player in the geothermal market in Costa Rica.

After PDAC, Geoscience Ireland held an exploratory online call with ICE, the state company which manages the Costa Rica electricity system, on the 29th of July 2022. It was learned that the country grid is based on 99% Renewables, with geothermal being about 15% of the total (262MW, soon to be 305MW). A recent study of the geothermal capacity is scheduled to be released soon, although to date there was no private sector involvement in this sector.

At this web meeting, ICE expressed interest in learning more about the European capacity building and knowledge exchange regarding drilling (targeting typically 2km depth), in geophysical logging of boreholes, exploration techniques, software, and conceptual modelling. In addition, ICE was invited to present an overview of Country's state-of-the-art at the planned Training Session for the meta-cluster SMEs, and to participate in the GEE2 Joint Innovation Workshop, that would provide an update on key technologies which might be of interest to ICE for both exploration and resource optimisation.

### 3) Training Session

The programme content of the training session was aligned with Costa Rica's focus on transition to a sustainability and decarbonised use of geo-energy with due regard for the protection of the environment (see annex 1 for the training session agenda). During the training session the attendees where informed that, after Mexico, Costa Rica has the 2<sup>nd</sup> largest installed geothermal capacity at 262Mwe (operational). The potential capacity supported by reserves and resources is of the order of 3200Mwe.

All geothermal resources are associated with volcanic activity in the ring of fire; the two existing geothermal fields are near the geographical usable limit, adjacent to a National Park where geothermal exploration and drilling is forbidden. The lifting of such restrictions has been and continues to be a contentious topic debated by environmentalists and pro-renewable energy groups in the country's National Congress. To finance the development of the geothermal field in Miravalles, the Costa Rica National Congress required the completion of an EIA – Environmental Impact Assessment, to demonstrate the environmental feasibility of the project (this was the first EIA to be compiled and written back in 1988). As a result, an extensive reforestation and fauna sampling plan was implemented; a proper management of the actions carried out by ICE over approximately 12 years have had visible results and are clearly evident in the landscape (see Figure 2).



Figure 2: ICE reforestation campaign led to remarkable level of success

### 4) The Market Visit

The main goals of the market visit were discussed at the training session, with a follow-up through email and agreed by GEE2 partners and European SMEs participating; there are summarised below:

- To meet with representatives from ICE (Instituto Costarricense de Electricidad);
- Provide an overview of Costa Rica Geothermal Context;
- B2B meetings with local service providers;
- Presentation of tailored strengths of the meta-cluster member companies to the target market;
- Enhancement of business development and capacity building activities through engagement;
- Supporting transition to the green economy, using existing skillsets in subsurface geoscience;
- New sustainable services, drawing knowledge from more traditional subsurface activities;
- Supporting the expansion of employment in niche scientific and engineering related disciplines;
- Sustainable application of subsurface knowledge, supporting the harnessing of geothermal energy.

The meta-cluster SMEs members that attended the Market Visit revealed a great interest in the geothermal market of Costa Rica. The Market Visit was a great opportunity for networking for all the SMEs that attended it.

Attendees participating in San Jose seminar	Stakeholder affiliation
Cluster partners that attended (3).	Geoscience Ireland, GEODEEP, CAPES
SME's that attended from GEE2 (7)	<u>STEAM, Enertime, Mustang Services</u> , <u>Novohydro, GEOCHEM.</u> <u>Radial Drilling, Halfway</u>
SME's that attended from the target country (9)	<u>GRUPO ICE</u> , <u>CINDE</u> , <u>Green Building Council</u> , <u>EY Costa Rica</u> , <u>Zero Waste Costa Rica</u> , <u>Holcim</u> , <u>Pegasus Logistics</u> , <u>SFera Legal</u> , <u>Green Building Council</u>
Embassy officials & Government support bodies from GEE2-E.U. (2)	EEAS Europa France Costa Rica Chamber of Commerce & Industry
Embassy officials & Government support bodies from target country (1)	Vice Minister Economy, Industry & Commerce

#### Table 1 – Consortium partners and SMEs that attended the Costa Rica Market Visit

#### 4.1 Costa Rica's Energy mix

Costa Rica is a nation that is firmly committed to environmental protection. More than 99% of the electricity produced in the country comes from renewable sources such as hydroelectric, geothermal, and wind power facilities, which are largely underutilized sources of energy. The geographic advantage of Costa Rica's high concentration of rivers and dams allows for a hydroelectric power output that corresponds to 80% of renewable source. Despite the fact that the total installed electrical capacity is only 7%, geothermal energy accounts for around 16% of the total energy delivered to the national electricity system.

The substitution of the more expensive hydropower sources with geothermal is considered as an issue of high importance for the economy of the country.

#### 4.2 Geothermal Resources and Potential

The best location for producing geothermal energy is on Guanacaste's North Volcanic Mountain Ridge, where the Miravalles Field is located; although the most developed and productive is currently in decline. ICE has been repowering the Miravalles units to stabilise the field production to maximum levels.

The Pailas Geothermal Field is the second most developed plant and is situated on the southern flank of the Rincon de la Vieja volcano (see Figure 3). The third active location is the Borinquen Geothermal Field which is situated on the southwest flank of the Rincon de la Vieja volcano. This field is projected to have a generation of 110MWe gross. Intensive development started in 2018 with funds from JICA (Japan International Cooperation Agency), the final commissioning of Borinquen unit I (55MWe flash plant), comprising seven production wells and four injection wells, is expected by 2026. This plant unit was designed to minimize the plant's footprint and to preserve the majority of the area's biodiversity. Currently, 8 wells have been drilled, of which three wells are producers and four re-injectors. Borinquen Unit II (expected to be commissioned by 2030) is planned to comprise 12 production wells and 9 injection wells, located in 6 pads.



Figure 3: Geothermal resources of the country in relation to volcanoes and protected areas

#### 4.3 Regulatory framework

The energy policy of Costa Rica is guided by the concept of energy sustainability with low emissions. The "VII Plan Nacional de Energía 2015-2030" was designed according to the priorities of the National Development Plan 2015-2018. Fulfilling the country's electricity needs relies on a legally established company called Instituto Costarricense de Electricidad (ICE), on April 8, 1949, under the umbrella of the Ministry of Environment and Energy of Costa Rica (MINAE).

According to Law No 5961, ICE has the right and duty to investigate, explore and exploit the country's geothermal resources. "The investigation, exploration, and exploitation of the geothermal resources of the country is declared of public interest and the activities concerned will be in the charge of the Costa Rican Institute of Electricity...."

ICE also participates as Costa Rica single agent in the Regional Electricity Market (Central America joined market). The regulatory authority for public services, known as Autoridad Reguladora de los Servicios Públicos (ARESEP), ensures the quality and price of public services provided by ICE and other electric companies. In 2014, the government approved legislation for geothermal projects in the region to offset the country's reliance on hydropower.

ICE, a separate entity but under the control of the Costa Rican government, is vertically integrated into the production, transmission, and distribution sectors. In addition to possessing the most generation capacity, its transmission network controls and distributes around 40% of the entire amount of electrical energy produced. There are other businesses participating in the generation industry; electricity for the ICE's generation system is provided by private or independent generation through long-term contracts, while five of the other seven distributors in the nation have their own generation facilities to provide a portion of the needs of their consumers. 10% of the generated electricity and over a quarter of the available electricity producing capacity are provided by the private sector to ICE.

A continuous strategy is being developed to ensure the commercial exploitation through repowering the geothermal fields by extending the useful life of the reservoir in order to secure the significant investment made for geothermal development. The main challenge has been the sustainability of the reservoir, not only during the initial planned development period but also for any possible future expansion. The portfolio of geothermal projects was created to include regions with geothermal potential across the nation to meet the demand for increased electricity through 2040.

#### 4.4 Financial Supports

In August 2016, Japan supported the country's geothermal energy projects and agreed with a loan to finance part of the construction of a geothermal project in Liberia, Guanacaste; representatives of the Japan International Cooperation Agency (JICA), the Costa Rican Electricity Institute (ICE) and the Finance Ministry signed this agreement. JICA granted the loan under favourable conditions for ICE, including a 40-year term with a 10-year grace period at 0.6% interest. The project consisted of building three geothermal power plants – Pailas II, and Borinquen I and II – in an area near Rincón de la Vieja Volcano National Park (see Figure 4). The plants are expected to generate 55MWe each. The Las Pailas II plant operations commenced in 2019, the Borinquen I plant is expected to be operational in 2024, while Borinquen II is expected to start operations in 2030.



Figure 4: Geothermal Plant evolution in Costa Rica (ICE May 2022)

ICE estimated that Costa Rica's total installed geothermal capacity, once all three plants are fully operational, will be circa 372MWe. The agency reported that Costa Rica generated 99% of its electricity from renewable sources in 2015, using sources such as hydroelectric, geothermal, wind, biomass and solar power and has continued at roughly that level since. In July 2022, ICE reported that over 96% of its energy generation for the first half of this year came from renewable sources. <u>Source: Tico Times</u>

#### 4.5 Environmental Considerations

Conservationists and officials in ICE work to implement environmental measures to minimize the impacts from the geothermal plant. While Costa Rica's volcanoes are a huge wellspring for geothermal energy, most are located within national parks, which were created to protect natural resources. The 11,000-hectare Rincón de la Vieja National Park and the neighbouring Guanacaste Conservation area were declared a "World Heritage Site" by the United Nations.

Going forward, the challenge for Costa Rica is to create better sustainable clean energy solutions while in parallel protect the natural resources it has worked so hard to preserve. To this end, the Costa Rica Legislative Assembly has been examining a bill to allow exploration and production of geothermal energy inside the Rincón de la Vieja National Park. Costa Rica law prohibits the extraction of resources from national parks, so lawmakers would either modify park boundaries and compensate in other locations or reform the National Parks Law.

According to reports in <u>La Nation</u>, Grupo ICE, Costa Rica's power utility, declared in February 2020 that due to stagnant electricity demand, it would not pursue any new projects and would instead, when reviewing the situation in 2027, probably concentrating on working on geothermal power projects instead of pursuing any further hydropower. Grupo ICE will then re-evaluate the market conditions, however, the decision is viewed favourably because it would relieve pressure on the nation's electricity rates. While hydropower development is constrained by geography, according to ICE's current expansion plan for 2018 to 2034, the same does not apply to the expansion of six of its own geothermal sites that are already operational, as well as a wind farm and two private sector projects.

The Institute regularly updates its Generation Expansion Plan (PEG), which is released every two years, with information on how Costa Rica's energy demand is behaving. This document is a dynamic tool that,

in its most recent revision, postponed projects that had been planned for earlier years, including the geothermal projects Borinquen I and Borinquen II, to a later time.

The Tico Times, citing a news release from the governmental institution, stated in mid-October 2022 that the Ministry of Environment and Energy was categorically opposed to the production of geothermal energy in National Parks. Reiterating MINAE's opposition to the exploration, exploitation, and use of geothermal resources for energy generation in national parks or protected wildlife areas, such as Guanacaste National Park, Tenorio Volcano National Park, and Arenal Volcano National Park, the Minister of Environment and Energy addressed the Legislative Assembly. The Ministry opposes Bill 21244, a bill that was submitted in February 2019 and is presently being considered by lawmakers; this law would allow ICE to use geothermal resources. The ministry further believes that the construction of subsurface infrastructure constitutes a change of land use, further compromising the National Parks.

Recreation and tourism, nature preservation, academic research, public awareness, preservation of historical and archaeological sites, and watershed protection are all advantages of national parks. Commercial exploitation is not allowed because they can be used for scientific, social, cultural, economic, recreational, and other purposes. National Parks are also subject to use, domain, and disposition restrictions because they are a component of the state's natural heritage. This infers that it is against the law to change the use of land for commercial purposes. According to the ministry, because there is already an abundance of energy, the nation cannot justify the need to supply any more of it. As a result, the nation has yet to decide how to allocate this surplus in the domestic electrical market, let alone the regional electricity market as noted by MINAE. As a result, the institution claims that there is no technical basis to support the opening of energy extraction in National Parks or to let ICE to produce more energy than is required. Source: <u>Tico Times.</u>

#### 4.6 Direct Use and district heating plans

Due to several obstacles, including the lack of a national regulatory framework that permits it, Costa Rica's significant geothermal resource potential has only been partially utilized, so far. Geothermal resources have the advantage of being a clean, renewable, and national source of energy that can aid in the economic development of the country's different regions and the reduction of greenhouse gas emissions. They can be used in a wide range of productive activities, in the industrial, agricultural, commercial, and residential sectors, among others. However, to the exception of small domestic applications in hotels and individual pools and spas, the use of low temperature geothermal direct utilisation is still limited.

The Ministry of Environment and Energy (MINAE) met in December 2021, to discuss this issue and to submit a proposal of legislation for the direct use of geothermal resources for consultation. Other stakeholders who would eventually be involved in the processes outlined in the new legislation, as well as interested industries, took part in discussing of the law relating to direct use of low temperature geothermal energy for direct use. The Deputy Minister of Energy and Environmental Quality stated, "*We believe that this law will favour not only the process of decarbonization of the national energy matrix, but also the green economic reactivation, especially in rural areas that will be able to take advantage of the resource in many different ways to increase the added value of their products, contributing to their economic and social development. The dialogue workshop on the use of hydrothermal resources, which took place in 2019, was the beginning of the process that led to the proposed law for the direct use of geothermal resources (low temperature geothermal energy)".* 

This workshop's goal was to discuss the geothermal policy with various stakeholders while considering the traits of this resource, its potential, and its dangers. With the conclusions and considerations from the discussions in the workshop, a proposal for the regulatory framework's content was developed. This

proposal served as the foundation for a legal study, which produced the data needed to create a bill for the direct use of geothermal resources.

The Planning Secretariat of the Energy Sector (SEPSE) oversaw the formulation process. Following this consultation phase, the measure will need to be amended in order to be presented to the Legislative Assembly in March 2022 for its particular approval procedure. The German Cooperation has provided assistance throughout the process, in particular the Renewable Energy and Energy Efficiency Program (4E) project in Central America, carried out by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) on behalf of the German Federal Ministry for Economic Cooperation and Development (BMZ). <u>Source: MINAE</u>

In November 2022, a <u>pilot plan</u> to allow the implementation of two heat pumps in a company was announced for the agri-food sector, as an alternative to reduce the use of fossil fuels and increase energy efficiency. For this, conventional refrigeration equipment and combustion-based heating equipment would be replaced with one of these alternatives and using geothermal energy.\_"Heat pumps: Benefits of geothermal energy in Industry" was a proposal promoted by the Chamber of Industries of Costa Rica (ICRC) and the German International Cooperation (GIZ). "*The aim is to promote the use of heat pumps as an alternative to fossil fuel-based technology in conventional refrigeration, to increase energy efficiency, promote the use of clean energy and improve economic profitability"* according to the executive director of the ICRC. The information generated by this pilot plan would allow this technology to be leveraged and implemented in other industries in the future. The project has the technical advice of the <u>Auto University</u>.

### 5) Lessons Learnt

During the research for the Training Session and the Market Visit, the GEE2 partners learned that according to Law No 5961, ICE has the right and duty to investigate, explore and exploit the country's geothermal resources: *"The investigation, exploration, and exploitation of the geothermal resources of the country is declared of public interest and the activities concerned will be in the charge of the Costa Rican Institute of Electricity..."*. During the market visit its was learned that ICE had built enough internal capacity to source its current and foreseeable needs in terms of supply chain to service its remit under law No 5961.

Although the knowledge of law No 5961 was confirmed, some very constructive dialogue was possible during the training session, the Joint Innovation Workshop and during the Market Visit itself concerning low impact environmentally sound exploration techniques. The knowledge sharing regarding geochemistry, drilling optimisation, and stimulation techniques also received much interest as did a selection of innovative technologies from the Joint Innovation Workshop which were also discussed during the Market Visit meeting.

The back-to-back sessions allowed visiting European and Costa Rica SMEs to further explore insights into climate change and the impact that this may have on the energy mix from this point forward. The decision to concentrate on geothermal options in favour of hydropower was discussed as were options to potentially address increased demand but at the same time, minimising impacts to the environment.

### 6) Final Considerations

The Costa Rica Market Visit focused on the energy market, the resource potential, and its regulatory framework. Additionally, it looked at the current status of the geothermal development of the country and development plans to further grow the electricity production and shallow geothermal applications. The balance of geothermal development and conservation activities is possible and should potentially double of thermal power produced in the next 30 years.

It is necessary to consider the geothermal development in national parks once the protection of the natural resources has been ensured to compensate the expected production decline in Miravalles. The legislation enabling geothermal resource exploitation in national parks needs regular review to maximise resource optimisation opportunities with due regard for the environment. The application of low footprint technologies should assist in this regard. Shallow geothermal uses appear modest for heating due to the warm climate but cooling applications seem to be encouraged and are installed on a small scale. The aim is to promote the use of heat pumps as an alternative to fossil fuel-based technology in conventional refrigeration, to increase energy efficiency, promote the use of clean energy, and improve economic profitability.

The Costa Rican Government support for inward investment is outstanding. The conditions for setting up in Free Economic Zones are easy to meet. The provision of relevant information to businesses appears to be of an outstanding standard and is given at the level of both logistics and conditions for hiring a workforce in Latin American countries. In addition to providing a good background for projects to be planned here, Costa Rica can also be an excellent starting point for research activities in other countries.

## 7) Bibliography

Tico Times – Online articles <u>Tico Times online</u> Think GeoEnergy - <u>Country overview Costa Rica</u> World Geothermal Congress 2015 - <u>IGA Costa Rica country update</u> Renewable energy in Costa Rica - <u>Wikipedia Costa Rica</u>

# 8) Annex 1 - Training Session Agenda

Time	Description
16.00	Overview of the GeoEnergy Europe Project. Ana Luisa Lavado (Geological Survey of Ireland)
16.15	Introduction to GEE Collaboration and network mapping tool (CAPES)
16.30	Introduction of the Costa Rica Country Fiche. Christian Boissavy (GEODEEP) - global structure of the energy market -geothermal market (regulation and risk mitigation scheme, if existing - market barriers -structure of the competition -key stakeholders
17.00	Presentation of ICE ( Costa Rica Institute for Electricity)
17.15	Overview of Costa Rica Market Visit. Virginie Bloch (GEODEEP)
17.20	Roundtable with participants – Q&A session

Date: 3<sup>rd</sup> October 2022, 4pm (CET)

### 9) Annex 2 - Market Visit Agenda

#### Geo Energy Europe (GEE2) Costa Rica MARKET VISIT

9<sup>th</sup> to 11<sup>th</sup> of November 2022 in San José in Hilton Hotel La Sabana

#### Day 1 - Wednesday 9th of November

Optional visit to Poas National Park in central area to assess general environmental conditions.

Team planning meeting & Dinner with Geoscience Ireland, GEODEEP, Geochem, Radial Drilling, Enertime, STEAM.

#### Day 2 - Thursday 10<sup>th</sup> of November 2022

Moderation by- GEODEEP & Geoscience Ireland

9:00	Welcoming Coffee
9:30	Welcoming words
	EU Ambassador to Costa Rica
	GeoEnergy Europe project presentation – Joe Mongan Geoscience Ireland
10.00	Costs Diss south symples at system development perspectives. Crups ICE
10.00	Papelists and Moderated by Sylvain BROGLE – GEODEEP Cluster Manager
	• Geochemical characteristics of our geothermal fields – ICE
	• Geological surveys – ICE
	• Directorate of Geology and Mines / MINAE (ministère de l'environnement)
	Followed by an open discussion with participants to include the following topics.
	RADIAL DRILLING:
	<ul> <li>Well bore cleaning of existing wells</li> </ul>
	<ul> <li>Well stimulation by increasing the capacity with environmentally friendly technology.</li> </ul>
	Steam:
	<ul> <li>Support to project development relevant to the underground/early activities: geosciences, resource characterization, pre-feasibility, environment</li> </ul>
	<ul> <li>Support to project development relevant to the above ground facilities: engineering, conceptual design, support to FEED and RFP, project management and site/commissioning assistance</li> </ul>
	<ul> <li>Support to geofluid management, for example chemical characterization, geochemical consultancy, chemical/inhibitor dosing</li> </ul>
	GEOCHEM – Ferenc FEDOR:
	<ul> <li>Head of the ICE geo-laboratories. All topics would be interesting which connected to the reservoir qualification like geochemistry, rock mechanics and petrophysics, mineralogy and petrology, as well as software modelling and education.</li> </ul>
	ENERTIME:

	<ul> <li>To discuss about the brines characteristics from their power plants separators</li> <li>To exchange about the interest of ICE in such projects and eventually which kind of contracts could suit (BOT, leasing, EPC).</li> <li>Any development possible for Organic Rankine Cycle on new sites? Are there any binary cycle projects? What is the maturity / TRL? (tested wells? What about the permitting process?)</li> </ul>
13:00	Lunch
14 :00	The Costa Rica Investment Promotion Agency, <u>CINDE</u> Agence française du Développement (AFD): Costa Rica representative.
16 :00	Roundtable discussions - Follow-up: roadmap for further cooperation between GEE II and Costa Rica
	End of DAY 2

### <u>Day 3 – Friday 11<sup>th</sup> of November</u>

organized with French Chamber of Commerce

9:00	Welcoming word:
	Vice-Minister of Economy
	B2B meeting on particular topics – session animated by Green Building Council
	- GEE II's SME presentation:
	- > RADIA DRILLING
	- > ENERTIME
	- > Halfway
	- > GEOCHEM
	- > STEAM
	- Costa RICA companies :
	->GRUPO ICE
	-> CINDE
	-> Green Building Council
	->EY Costa Rica,
	->Zero Waste Costa Rica,
	->Holcim
	-> Pegasus Logistics
	->SFera Legal
	-> Green Building Council