Costa Rica

Geothermal Energy Market Overview

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THINK GEOENERGY

Key Facts

- Current installed geothermal power generation capacity of 262 MW (as of April 2021)
- Development and operation of geothermal assets by state power company Instituto Costarricense de Electricidad (ICE)
- Geothermal resource potential estimated at around 1,000 MW
- The largest plant complex are the combined Miravalles geothermal plants with 162 MW of capacity
- Additional capacity under development is 110 MW
- No private development of geothermal projects at the moment

Abstract:

Geothermal development and exploration in Costa Rica for electrical generation purposes have grown exponentially since the last country update report presented in 2015. Since the country's energetic policies are mainly based on renewable energy sources in order to decrease the CO2 emissions, and face climate change effects, geothermal energy continues to provide a base load for the electrical system in Costa Rica and to date is producing around 16% of the total electrical generation of the country. The Instituto Costarricense de Electricidad (ICE) leverages commercial high enthalpy geothermal resources for power generation; distributed from the Miravalles Geothermal Field, consisting of three flash technology plants, a backpressure unit and a bottoming binary technology; and the Las Pailas Geothermal Field unit I and unit II using mixed cycle binary technology. In addition, the Borinquen Geothermal Field is in the development phase with a 110 MWe generation capacity. Considering the important investment 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 - continuous strategies are being developed in order to secure the commercial exploitation through repowering the geothermal fields by extending the useful life of the reservoir. The portfolio of geothermal projects was designed to comprise areas around the country to fulfill the electricity expansion requirements until 2040.

Country Overview

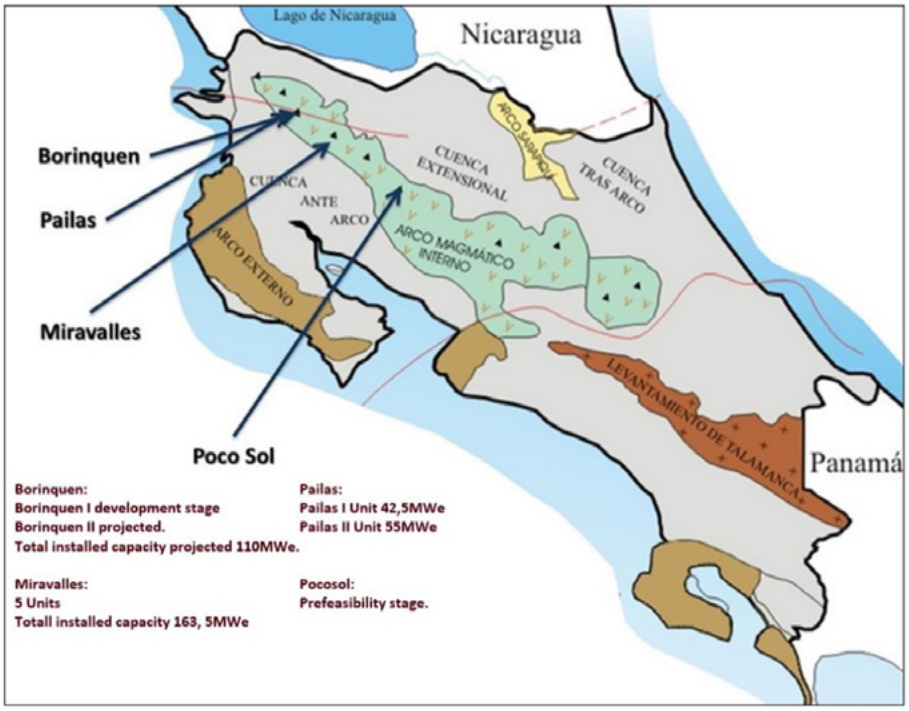
Costa Rica is a country in Central America, bordered by Nicaragua to the north, the Caribbean Sea to the northeast, Panama to the southeast, the Pacific Ocean to the southwest, and Ecuador to the south of Cocos Island. It has a population of around 5 million in a land area of 51,060 square kilometers. The country has been considered economically stable with moderate inflation, estimated at 2.6% in 2017 and moderately high growth in GDP. The Gross Domestic Product (GDP) in Costa Rica was worth 61.77 billion US dollars in 2019, according to official data from the World Bank and projections from Trading Economics. The GDP value of Costa Rica represents 0.05 percent of the world economy. Costa Rica is at the forefront of renewable energy production in Central America and is one of the countries that has invested the most on a global scale. This has been possible due to its natural resources and also due to the strong commitment to energy renewables made in the Central American country. Costa Rica, has the most modern National Center for Energy (CENCE) in Central America, which directs and manages the operation of the National Electric System (SEN) to meet the country's electricity demand and make effective energy exchanges (import and export) with the Regional Electricity Market (MER). Today, 78.26% of the electricity used nationally comes from water, 10.29% from wind energy, 16% from geothermal energy, and 0.84% from solar and biomass. The price of electricity is 0.152 U.S. Dollar per kWh for households and 0.200 U.S. Dollar for businesses which includes all components of the electricity bill such as the cost of power, distribution and taxes.

The Country's Energy Market

Costa Rica is a totally committed environmentally friendly country. The national electrical sector has a matrix of more than 98% of production from renewables like hydroelectric, geothermal and wind power plants which are significantly unexploited resources for power generation. Costa Rica's geographic advantage of a high concentration per capita of rivers and dams allows for an 80% hydroelectric power renewable energy output. Geothermal also represents around 16% of the total energy delivered to the national electricity grid despite the fact that the total electrical installed capacity is 7%. The wind power total capacity in the country was planned to grow from 194 MW in 2015 to 393 MW by 2017, an increase that aimed to represent approximately 10.5% of total electricity production. Fossil fuel energy consumption in Costa Rica was 49.48% as of 2014, with demand for oil increasing in recent years. The substitution of the most expensive generation sources with geothermal is considered as an issue of high importance for the economy of the country.

Geothermal Resources and Potential

Based on the available information and subsequent study interpretations, the possible Geothermal potential for Costa Rica reaches 1,000 MWe. There are six currently active volcanoes and dozens of inactive volcanoes. The North



Volcanic Mountain Ridge in Guanacaste is the most beneficial for geothermal power generation. Volcanoes in the region include Miravalles, Rincón de la Vieja, and Tenorio. The Miravalles Field is the highest developed and most productive of the geothermal fields in Costa Rica, although it has already reached its maximum extraction rate. On the other hand, Pailas Geothermal field (the second most developed field) is located on the southern flank of the 600,000 year old Rincon de la Vieja volcano and the largest in the northwestern region of Costa Rica. Furthermore, Borinquen Geothermal field located on the southwestern flank of the Rincon de la Vieja volcano is the third active site at present. Other Geothermal interests under exploration phases include Arenal-Poco Sol which is located 12 km south of the Arenal volcano. Arenal-Poco Sol is in an advanced pre-feasibility phase, for which a geochemical study, geological-structural mapping, recommendation of sites for perforating geothermal gradient wells and geophysical surveys are performed. North of the Rincón de la Vieja volcano and North of the Tenorio volcano are additional sites of interest where surface reconnaissance studies have been due.

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) established on April 8, 1949 under the umbrella of the Ministry of Environment and Energy of Costa Rica (MINAE). ICE also participates for Costa Rica as the 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 the other electric companies. As private companies are also part of the electricity generation program, a Law 7200 ("Ley que Autoriza la Generación Eléctrica Autónoma o Paralela") is approved by the Legislative Assembly of Costa Rica in 1990 to regulate private utility projects. On the other hand, in 2014, the government approved legislation for a $958 million geothermal project in the region to offset the country's reliance on hydropower.

Geothermal Energy Utilisation Today

Today the main geothermal potential in the country is used for electrical generation by the power plants located in the Miravalles and Pailas fields. The total installed geothermal power generation capacity of Costa Rica is 262 MW - the largest in the Central American region and the second largest in Latin America after Mexico.

The Miravalles Geothermal Field, opened in 1994, consists of five plants with a combined installed power generation capacity of 161.5 MW MWe. The Miravalles Complex comprises five power units in four different powerhouses, seven separations stations, 48.5km of pipelines, 61 wells (production, injection, and observation) and

a series of artificial ponds aimed for cold injection, maintenance operations and containment of emergencies. In addition, ICE operates the Pailas Geothermal Power Plant (Plant I + Plant II), established in July 2011 and July 2019 respectively, with a combined generation capacity of 97.5 MWe, and is located just outside Rincón de la Vieja National Park. With the exception of small domestic applications in hotels and individual pools and spas, the use of low temperature geothermal direct utilisation is limited.

Geothermal Market & Industry

Electricity generation in Costa Rica, is in the hands of 6 public companies including ICE, Radiográfica Costarricense (RACSA), the National Company of Power and Illumination (Compañía Nacional de Fuerzay Luz, CNFL), and 32 private companies including ACOPE, CONELECTRICAS R.L. and ACESOLAR. ICE which is an autonomous institution of the government of Costa Rica, vertically integrated into generation, transmission and distribution divisions. Besides having the largest capacity in generation plants, its transmission network manages and distributes about 40% of the total electrical energy generated. In the generation business, there are other companies involved. Private or independent generation through long-term contracts provides electricity to the ICE's generation system, while five of the other seven distributors in the country have their own generation plants to supply part of the demands of their customers. The private sector provides ICE nearly a quarter of the electricity generation capacity available and 10% of generated electricity.

Current Project Development

At present, activities are being carried out at Borinquen Geothermal Field which is located on the west flank of the volcano Rincon de la Vieja. This field is projected to have a generation of 110 MWe gross. Intensive development started by 2018 with funds from JICA (Japan International Cooperation Agency). The final commissioning of Borinquen I unit (55 MWe flash plant) comprising seven production wells and four injection wells is expected by 2026. This plant unit was designed with the newest concept for operational flexibility - i.e each production pad connects directly to a separation unit and its own reinjection pad, optimization of infrastructure to minimize the footprint in order to preserve the majority of biodiversity of the area. At this moment, 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.

Outlook

Some actions taken by ICE in order to stabilise Miravalles field production and reach the maximum field productive levels are currently implemented or will be implemented in the near future, such as repowering the Miravalles units on 2028, 2029 and for 2030 (Units I, II and II, respectively). The intention is to extend the life of the different geothermal fields and repowering the power plants. If and how projects will develop will have to be seen as there currently seems to be a sufficient supply of electricity in the market.

Sources

World Geothermal Congress 2020+1, Costa Rica Country Update Report.
UNU-GTP Short Course, 2014, Geothermal Energy Situation in Costa Rica.
Renewable energy in Costa Rica - Wikipedia