Chile

Geothermal Energy Market Overview

April 2021

THINK GEOENERGY

Key Facts

- Current installed geothermal power generation capacity of 48 MW (as of April 2021)
- Development and operation of geothermal assets private entities
- Geothermal resource potential estimated at 16,000 MWe
- Over 300 geothermal areas identified
- Initial development push slowed due to low electricity prices
- Ongoing development by three private sector entities

Abstract:

Geothermal exploration in Chile was first conducted in 1907 in a geyser field in the northern region of Chile. Soon after, Italian pioneers started the first geothermal exploration program in Antofagasta in the 1920s. Chile has over 15% of the world's active and dormant volcanoes which form a continuous line about 4,000 km long. As a result, over 300 geothermal areas have been identified throughout the country. In late 2017, Chile eventually joined the geothermal club. The first geothermal power plant in Chile is Cerro Pabellón, a 48 MWe capacity which began its operation through Geotérmica del Norte (GDN) in the altitude (4500 m a.s.l.) of the High Andean Mountain. With ongoing activities to expand the capacity of the power plant with an additional 33 MWe. The low-enthalpy geothermal fields are used for recreational purposes and occasionally in demonstrative projects like district heating using geothermal heat pumps. The nature of the Chilean electricity market and the remote location of geothermal resources create high up-front costs for the development of any projects. Currently, the government is actively mobilising different state agencies and engaging international cooperation to form an unprecedented support for geothermal in Chile, which finally moved projects into operation. In January of 2000, the Law 19.657 that regulates geothermal energy was enacted which states that geothermal energy is a good susceptible of exploration and exploitation after the proper concession is granted. Important advances were made during 2017 on the base of the "Geothermal round table", a public-private initiative supported by the Ministry of Energy and funded by the Global Bank.

Country Overview

Chile is a country located in western South America bordered by Peru to the north, Bolivia to the north-east, Argentina to the east, and the Drake Passage in the far south. It occupies a long, narrow strip of land between the Andes to the east and the Pacific Ocean to the west. Chile covers an area of 756,096 square kilometres (291,930 sq mi) and has a population of 17.5 million as of 2017. The capital and largest city is Santiago and the national language is Spanish. Since July 2013, Chile has been considered by the World Bank as a "high-income economy". In 2006, Chile became the country with the highest nominal GDP per capita in Latin America. Copper mining makes up 20% of Chilean GDP and 60% of exports. The Gross Domestic Product (GDP) in Chile was USD 282.30 billion in 2019, according to official data from the World Bank and projections from Trading Economics. The GDP value of Chile represents 0.24 percent of the world economy. Approximately 58% of Chile's electric capacity is attributable to thermoelectric generation, 32% to hydroelectricity, and 10% to other renewable energy sources. Geothermal power has great potential to help Chile in meeting its sustainable energy ambitions. At this point in time, geothermal energy is the only proven renewable power source in Chile able to deliver power 24/7, whenever it is required. Other renewable sources, such as hydro, solar PV and wind, are intermittent and are prone to great daily and seasonal variations. To compensate for this, backup power is delivered by mainly fossil fuel sources, with adverse effects on the environment.

The Country's Energy Market

The total installed capacity, according to data provided by the Ministry of Energy, is 23,590 MWe with almost 50% dominated by fossil fuels (12,723 MWe, coal, oil and natural gas). The vast majority of these resources are imported from overseas. Renewable energy accounts for the other 50% of the electricity matrix, which is dominated by hydropower and followed by the huge increase in solar energy production. The extraordinary increase of the non-conventional renewable energies including solar, wind, mini-hydro (< 20 MWe), biomass, and geothermal, has been noticed by the international markets.

Geothermal resources and potential

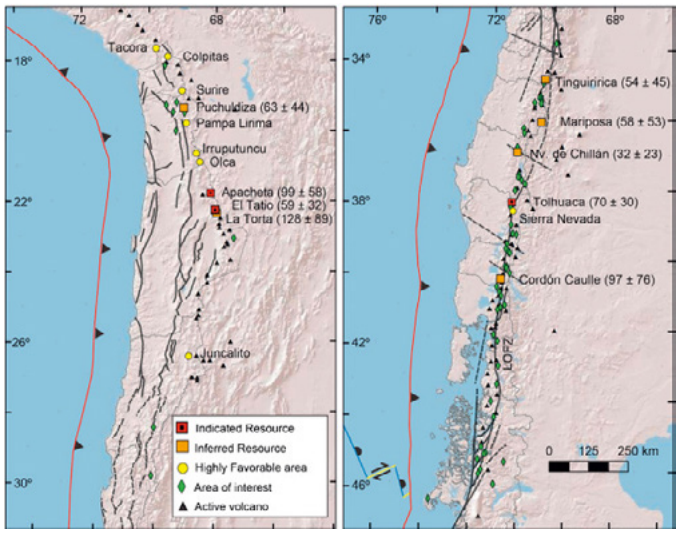
About 15 percent of the world's active and dormant volcanoes are in Chile, forming an almost continuous line about 4,000 km long. With that, the country has an estimated geothermal potential of 16,000 Mwe with over 300 geothermal areas identified. Geothermal exploration in Chile was begun in the early 20th century at a place called the Andean Mountain Range of northern Chile. At the end of the 60s and early 70s, several production wells were drilled by the national geothermal company in El Tatio-La Torta geothermal field. The main reason that huge geothermal potential exists in the Andes is Chile's geological conditions which is placed on one of the most active subduction zones, and having the highest concentration of active volcanoes under the continental crust. The distribution of active volcanism controls the two main Chilean geothermal-volcanic zones - i.e. the Northern Geothermal Zone (17°S – 28°S) and the Central-Southern Geothermal Zone (33°S – 46°S), as shown in the figure, both in the high Andean Mountain Range, where high-temperature spring areas and other surface manifestations are present.

Regulatory framework

The Chilean government passed the "Chilean Geothermal Law (law 19.657)" in 2000, allowing private developers to explore and exploit geothermal energy for power production and direct use purposes which reduces or even removes some administrative barriers. During the first decade of the 21st century, up to 14 private companies were exploring for geothermal resources in the Chilean Andean Mountain Range. However, a dramatic decrease in the electricity prices in Chile combined with unsuccessful geothermal exploration programs and the strong entry of solar energy in the Chilean electricity market, resulted in a progressive reduction of companies exploring for electricity generation using geothermal energy. However, along with the starting production of the geothermal power plant in November 2017, Chile declared a new policy for energy generation, pointing to a 100% renewable matrix by 2050, moving progressively towards a coal-free country. Different laws and institutions, mainly controlled by the Ministry of Energy, control the accomplishment of production, transmission, and distribution of electricity along with the country. Considering the climate change phenomenon, the unpredictable global scenario of the near future will force the Chilean state to implement public policies aimed to assure electricity independence.

Geothermal Energy Utilisation today

At the turn of the century, there was increasing interest in the country's geothermal potential. In 2006, after a surveying campaign, a consortium formed by the National Petroleum Company (ENAP) and Enel requested a concession to develop geothermal resources in the El Tatio region in the North. In 2017, Chile had 48 MWe of installed geothermal generating capacity (Cerro Pabellón power plant), which accounts 0.2% of the national generating capacity. A total of 13 wells were drilled during the exploration and development phases. These drilling works took place in the Pampa Apacheta graben, at 4.500 m.a.s.l. and 120 km away of the Calama city, in the Antofagasta Region of northern Chile. Six production and four reinjection wells are connected to the power plant. This power plant has the capacity to provide electricity to an equivalent of 165.000 houses, saving CO2 emissions for a total of 166.000 tons/year.



On the other hand, Chilean geothermal resources have been traditionally used for recreational (bathing and swimming) and touristic purposes. A plethora of thermal spring resorts and Spas are distributed along the country. Whilst some of them are equipped with sophisticated touristic infrastructure others have a rather rustic display. The total heat capacity estimated for the main thermal springs arises up to 14.68 MWt, which equals an annual energy use of 228.91 TJ/yr. The only two cases known for using geothermal energy for touristic heating cabins or the hotel installations are the Centro Termal Armada Liquiñe (Los Rios region) and the Puyuhuapi Lodge (Aysén region). Furthermore, the use of geothermal heat pumps in Chile began in 1996. Twenty nine (29) projects are identified that use geothermal heat pumps in 2015, mostly in the Metropolitan and Bío-Bío regions, with a total power capacity of 6.9 MWt. Finally, different industrial uses in aquaculture, greenhouses, and the wine industry have included the use of geothermal heat pumps, mainly due to its high efficiency.

Geothermal Market & Industry

The Chilean electricity market is controlled by private companies, where the State only works as a regulatory entity. There are 26 companies that participate in generation, although three main economic clusters control the sector: Endesa group, AES Gener and Tractebel (Colbún). The situation is similar in the distribution sector, with approximately 25 companies, in which the major companies include CGE Distribu-

ción S.A., Chilectra S.A., Chilquinta Energía S.A., and Inversiones Eléctricas del Sur S.A. (Grupo SAESA). In transmission, there are 5 players. In the Central Interconnected System (SIC), the most important player is Transelec, a pure transmission company which controls almost the entire transmission grid that serves the SIC. In the other interconnected systems, the large companies generation or the large clients are the owners of the transmission systems while the largest generating company in the North Interconnected System is Electroandina, owned by Tractebel and Codelco. The main companies involved, in terms of installed capacity are; ENDESA (35%, 6,085 MW), AES Gener (18%, 3,157 MW), Colbún S.A. (15%, 2,621 MW), Suez Energy Andino (12%, 2,176 MW), E.E. Guacolda (3%, 610 MW), Pacific Hydro (3%, 551 MW) and other companies combinely account for the remaining 14% (2418 MW).

Current Project Development

By March of 2018, 9 exploration licenses were active with 12 exploitation areas in force. However, the more active geothermal development activities carrying out currently at three different fields - i.e. Cerro Pabellón(Northern Chile), Mariposas (central Chile) and Peumayén (Southern Chile). Cerro Pabellón comprises two twin binary units (ORC) with a total installed capacity of 48 Mwe, a 33 MW expansion is currently being set up with planned COD in 2021. The Mariposas geothermal field in Central Chile is in exploration stage by EDC and an inferred capacity of 160 MWe, while the Peumayén-Tolhuaca geothermal field in Southern Chile is currently being developed under permit by Transmark with an inferred capacity of 70 MWe.

The Geothermal Center of Excellence for the Andes (CEGA) at the University of Chile, led by Prof. Diego Morata, is doing a lot of work on promoting geothermal direct use applications and concrete project efforts have been made both in low-temperature and shallow geothermal applications.

Outlook

Along with the starting production of the first South American geothermal power plant (November 2017), Chile declared a new policy for energy generation, pointing to a 100% renewable matrix by 2050, moving progressively towards a coal-free country. Based on a recent report by Chilean Ministry of Energy and collaborative work together with developers, private companies and the academia, and supported by the World Bank, outlined a total of 599 MWe that could be incorporated to the electricity matrix by 2030, and an additional 1487 MWe during the period between 2030 and 2050. Following these estimations (based on the real declared potential of the most developed and explored Chilean geothermal fields), a total of 2000 MWe could be in operation along Chile if economic barriers such as very low electricity prices are to be addressed.

Sources

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