Geothermal Energy (Magma Reservoir) and Green Finance

Background

Geothermal energy is widely recognized by advanced economies as a key renewable energy option and has been actively developed globally. Unlike weather-dependent renewable sources such as wind and solar power, geothermal energy is a subsurface resource that functions as a stable baseload energy source, capable of providing continuous electricity supply on a 24-hour basis. Owing to its relatively high capacity factor, geothermal power can complement variable renewables, facilitate efficient integration of energy storages and support a wide range of energy applications, making it one of the most effective options for reducing reliance on fossil fuels and lowering carbon emissions.

Located along the Pacific Ring of Fire, Taiwan experiences active tectonic and volcanic processes beneath the surface, endowing the island with comparatively abundant geothermal resources. In recognition of this potential, Taiwan has established geothermal installed capacity targets of 20 MW by 2025, 1.2 GW by 2030, and 6 GW by 2050. The country's geothermal development strategy focuses on clearly delineating geothermal potential zones, expanding drilling capacity in the short term, and pursuing the long-term deployment of emerging next-generation geothermal extraction technologies to support sustained and scalable geothermal development.

Global Outlook and Domestic Progress

Geothermal energy is playing an increasingly important role in the global energy transition. Governments and enterprises around the world are actively investing resources to promote innovation and application in geothermal power generation technologies in order to achieve sustainable development goals. To reduce financial burdens and encourage private-sector participation in geothermal development, many countries have introduced extensive policy support measures, including the enactment of dedicated legislation, regulatory streamlining, the deployment of financial instruments, direct funding subsidies, and tax incentives. Through these mechanisms, capital is guided toward investment, fostering a positive cycle that supports green and sustainable industrial development.

The Taiwanese government has gradually introduced relevant policy measures in recent years. In addition, state-owned enterprises, including CPC Corporation, Taiwan (CPC) and Taiwan Power Company (Taipower), set to lead in developing domestic deep geothermal resources. CPC has actively collaborated with international leading geothermal companies to introduce deep geothermal technologies, with the objective of establishing a 25 MW large-scale deep geothermal demonstration project. Meanwhile, Taipower is conducting geothermal exploration in the Tatun Mountain area and will continue to collaborate with internationally recognized geothermal developers and technical service providers to assess the feasibility of project development and plant construction.

In the academic and research sector, Academia Sinica primarily focuses on geophysical surveys and geochemical analysis, serving as a key academic advisor for geothermal development in Taiwan. The Industrial

Technology Research Institute (ITRI) possesses leading domestic geophysical exploration capabilities and has assisted in the investigation of major geothermal potential zones within Taiwan. Universities such as National Taiwan University (NTU), National Central University (NCU), and National Cheng Kung University (NCKU) are engaged in research covering geophysical exploration, geological surveys, geological modeling, environmental impact and risk assessment, production simulation, and economic analysis related to geothermal development.

In terms of financial support, the government provides a risk-sharing mechanism covering up to 50 percent of eligible costs through the "Geothermal Power Generation Demonstration Incentive Program," thereby offering more attractive financing conditions for geothermal development. In addition, commercial banks have begun offering financing for geothermal power plant equipment. For example, Bank SinoPac provided exclusive financing for the construction of a geothermal power plant in the Jinlun area of Taimali Township, Taitung County. Similarly, the Land Bank of Taiwan extended financing of NT$720 million to Jie-Yuan Energy, a subsidiary of the Fabulous Group, to support the development and operation of the "New Taipei City Liuhuangziping Geothermal Power Demonstration Zone." Through investment and financing support from financial institutions, the barriers to geothermal development have been further reduced.

Strategic Planning Framework

As a stable baseload power source, geothermal energy plays a pivotal role in Taiwan's journey toward a green transition. By reviewing Taiwan's geothermal potential and current policy support, while drawing on successful international experiences, it is evident that effective policy tools and innovative financial mechanisms are essential drivers for geothermal advancement.

Strategy 1: Invest in Geothermal Exploration and Frontier Engineering R&D

International best practices may be referenced, whereby governments assume a greater share of early-stage exploration risks and coordinate nationwide geothermal resource assessments to reduce developers' initial exploration risks. Furthermore, enhancing high-precision, small-scale geophysical surveys will improve reservoir delineation and well targeting. On the technical front, R&D should focus on advanced deep geothermal systems, including Advanced Geothermal Systems (AGS), Enhanced Geothermal Systems (EGS), and Supercritical Geothermal Systems (SGS), alongside high-efficiency exploration and reservoir management. For volcanic/magma reservoir geothermal resources, national-level research projects should conduct cross-disciplinary studies in geophysics, geochemistry, and hydrology. Efforts should also focus on strengthening the integration of national-level databases to enhance the accuracy of geothermal exploration and the feasibility of development in volcanic regions. In parallel, long-term safety monitoring mechanisms should be established to ensure that development activities are conducted in a manner consistent with environmental sustainability.

Strategy 2: Strengthen Regulatory Frameworks and Supply Chains to Improve the Development Environment

While a domestic supply chain is emerging, it remains in its infancy. At present, exploration and drilling activities are primarily supported by state-owned enterprises and a limited number of private companies engaged in conventional geothermal development. However, high drilling costs and significant technical barriers have become major bottlenecks hindering large-scale next-generation geothermal deployment. In addition, the supply chain remains incomplete in areas such as materials and mechanical equipment manufacturing, power plant construction, grid interconnection, and operations and maintenance (O&M), thus requiring sustained support and capital input from both the government and the financial sector. It is recommended that Taiwan establish a geothermal supply chain strategy, identify key technologies suitable for domestic development, and actively expand international cooperation to build a comprehensive domestic supply chain system while strengthening indigenous core technological capabilities.

Strategy 3: Refine Green Finance and Risk Management to Attract Private Participation

Given that deep geothermal development involves high capital investment and substantial risks, making it unlikely to enter the liberalized electricity market in the short term, it is recommended that the government establish a dedicated risk-sharing mechanism or adjust the allocation of the Renewable Energy Development Fund to support early-stage geothermal exploration

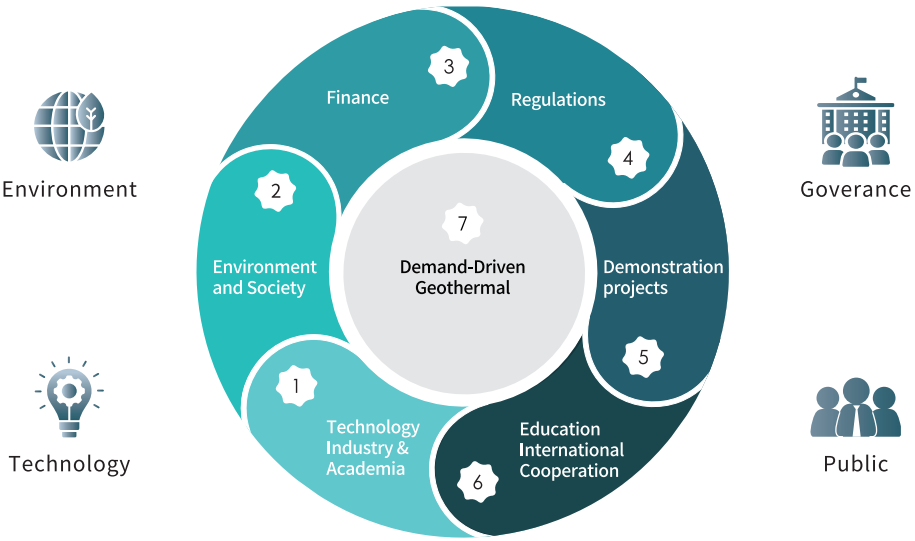

Figure 1 Strategies for Advanced Deep Geothermal Development

Source: T-STONE(2025)

and development activities. Such measures would help reduce development risks and costs, and enhance the sustainability of the geothermal industry.

In the future, it is further recommended that the Ministry of Economic Affairs, in coordination with relevant ministries and agencies, provide technical risk assessments and related information on geothermal resources. This would assist the Financial Supervisory Commission in formulating more comprehensive criteria and scope for recognizing geothermal technology R&D and financing activities, thereby supporting financial institutions in their project evaluation processes and accelerating investment and financing decisions.

Strategy 4: Establish Talent Cultivation and International Cooperation Platforms

The development of geothermal energy requires expertise in resource assessment, drilling production, and environmental management. Because this work relies heavily on professionals familiar with Taiwan's unique local geological structures—experience that cannot be easily outsourced—cultivating a local workforce with practical geothermal experience is critical for long-term growth and risk mitigation.

Strategy 5: Implement Community Engagement and Social Awareness Mechanisms

According to the Indigenous Peoples Basic Law, developers applying for geothermal exploration or development projects involving indigenous lands, tribal territories, or adjacent areas must conduct prior consultation and obtain consent before submitting their applications. Indigenous communities are entitled to share in the related benefits. Taiwan could model its approach after New Zealand's partnership with the Māori people in geothermal power development. Through benefit-sharing arrangements, developers can share the economic returns of geothermal projects while ensuring environmental protection and meeting the needs of local communities. With appropriate institutional design, such mechanisms can strengthen public participation and build broader social awareness and acceptance of geothermal development.

Strategy 6: Utilize State-Owned Enterprises to Pilot Deep Geothermal Demonstrations

CPC and Taipower are leading domestic deep geothermal efforts. CPC has actively collaborated with international leaders to introduce deep geothermal technologies, and at the end of 2024, drilling commenced in Yuanshan, Yilan, for Taiwan's first 4-kilometer-deep geothermal well, with the goal of developing a 25 MW large-scale deep geothermal demonstration project. Meanwhile, Taipower is currently exploring the Tatun Mountains area and plans to partner with international developers and technical service companies to assess the feasibility of future power plants.

Strategy 7: Guide High-Tech Industries to Invest in Self-Built Geothermal Power

Taiwan's high-tech industries—particularly the semiconductor, cloud data center, and electronics sectors—are among the largest electricity consumers, and their power demand is expected to continue growing in the coming years. At the same time, many enterprises

have committed to RE100 and carbon neutrality targets, creating an urgent need for long-term, stable, and low-carbon renewable electricity. Geothermal energy, characterized by a high capacity factor and baseload capability, is well suited to meet the needs of such industries. With appropriate policy incentives and institutional support, companies could be encouraged to develop captive geothermal power plants, thereby accelerating industry growth.

Given that geothermal projects require substantial upfront investment in exploration and drilling, it is recommended to establish supporting measures for corporate participation, including streamlined administrative procedures (e.g., a green channel mechanism) and the provision of long-term financing through policy banks and green finance instruments. By encouraging domestic and international high-tech enterprises to invest in geothermal development, policy measures can stimulate demand-driven market growth, alleviate the government's fiscal and policy burden, accelerate commercialization, and help meet the renewable energy needs of industry.

Expected Benefits

As a stable baseload energy source, geothermal power can provide continuous electricity, reducing Taiwan's reliance on fossil fuels and enhancing energy independence. These efforts align with Taiwan's net-zero transition and sustainable development goals. By introducing and effectively utilizing green finance instruments, capital can be guided into the geothermal sector, expanding industry scale and promoting green economic growth. Drawing on international experience, advanced technologies, and proven development models, and through collaboration with mature international developers, Taiwan can further enhance the technological maturity and development efficiency of its geothermal sector, ultimately positioning geothermal energy as a cornerstone of the nation's green transformation.

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Taiwan Science and Technology Office for Net-zero Emission (T-STONE)
Email: T-STONE@niar.org.tw