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A Comparative Analysis of Policies, Technologies, and Future Opportunities in Türkiye and Texas for Geothermal Energy Development

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INTRODUCTION

Türkiye and Texas represent two geothermal frontiers at different stages of maturity: Türkiye with an established, incentive-driven geothermal market and Texas as a resource-rich yet nascent player. This study provides a comparative analysis of policy frameworks, technological advancements, and strategic opportunities in both regions, with the goal of identifying transferable insights to accelerate geothermal development.

Drawing on policy reviews, industry data, and expert interviews, the research investigates how Türkiye's geothermal sector expanded rapidly through targeted government incentives introduced in 2005, including feed-in tariffs and domestic manufacturing credits. In contrast, Texas is currently exploring regulatory pathways and market mechanisms to support its emerging geothermal initiatives, leveraging its oil and gas infrastructure and workforce. Technological and infrastructural challenges, such as drilling costs, resource characterization, and power plant adaptation, are examined in both contexts. Türkiye's experience with low to medium enthalpy systems and binary cycle technologies offers valuable lessons for Texas, particularly in optimizing production from these resources.

The study also explores opportunities for bilateral collaboration in research, workforce training, and investment. It argues that Türkiye's mature ecosystem and Texas' innovation capacity create a complementary foundation for advancing geothermal energy within and beyond their borders. By drawing parallels and proposing cooperative strategies, this work contributes to the global discourse on geothermal scaling and highlights the mutual benefits of transnational knowledge exchange.

1.TÜRKIYE

Türkiye's complex geological setting has enabled the formation of a wide range of natural resources. Located along the Alpine–Himalayan Orogenic Belt, Türkiye possesses high potential for geothermal resources, natural mineral waters, and geothermal-origin gases as a result of intensive orogenic, magmatic, and volcanic activity. Furthermore, due to its active primary and secondary fault systems and well-developed horst–graben structures, significant geothermal resource potential is observed, particularly in the Aegean Region, as well as in Northwestern, Central Anatolia, and Southern Anatolia, based on existing data and documentation. This strong geological potential has been successfully translated into large-scale deployment, with Türkiye reaching an installed geothermal electricity capacity of **approximately 1.7 GW**, ranking as the **fourth-largest geothermal electricity producer worldwide and the leading country in Europe** (Mertoğlu et al., 2024).

Turkish Geothermal Law No. 5686, enacted in 2007, together with its implementing regulation, largely filled a legal gap and has enabled these previously underutilized subsurface resources to become accessible to both domestic and foreign investors since 2008. Under the current legislative framework, domestic and foreign companies with legal personality established in accordance with the laws of the Republic of Türkiye, as well as natural persons, are entitled to obtain an unlimited number of licenses. Here, natural persons refer to individuals who are not civil servants, while legal persons refer to corporate entities. This legal structure creates a favorable investment climate for geothermal investors and entrepreneurs from outside Türkiye.

1.1 Geothermal Exploration and Operating License Process

Under Law No. 5686 on Geothermal Resources and Natural Mineral Waters, the exploration, operation, and investment processes for geothermal resources are carried out through specific licensing stages.

1.1.1 Exploration License

The exploration license is initially granted for a period of three years and may be extended for an additional one year if necessary (3+1 years). During this period, the license holder is responsible for identifying the geothermal resource, assessing its potential, and conducting all required studies within the designated license area. If a geothermal resource is discovered by the end of the exploration period, the license holder may apply directly for an operating license, which is valid for 30 years. Exploration activities must be carried out in accordance with the project schedule defined in the approved exploration project. The studies planned for the first three years are mandatory. In cases where exploration activities are considered insufficient, the license holder may request a one-year extension. If the project does not progress during the exploration period or if the license is abandoned before its expiration, the license may be revoked.

1.1.2 Operating License

When a geothermal resource is discovered, the holder of the exploration license is entitled to apply for an operating license. The operating license is granted for a period of 30 years based on an approved operating project. Upon expiration, it may be extended for up to an additional 60 years in 10-year increments through revised operating projects. If deemed necessary, this duration may be further extended by a decision of the Council of Ministers (currently exercised by the President of the Republic of Türkiye). Prior to commencing any activity under the operating license, the Environmental Impact Assessment (EIA) process must be completed, and the Resource Protection Area Study Report must be prepared and approved by the competent authority. Within licensed fields, resource protection, sustainable utilization, and reinjection practices are mandatory. The balanced and efficient operation of the geothermal system is continuously monitored in accordance with the relevant legislation. Activities permitted within an operating license area include drilling, production, reinjection, power generation, and other geothermal utilization applications. Throughout the operating license period, the license holder may drill new or deeper wells to increase geothermal potential, identify additional reservoirs, enable production in Hot Dry Rock (HDR) environments through injection, construct required facilities, and improve flow rates and temperature conditions. In addition, geothermal-origin gases (such as CO_2 and methane) and certain minerals may be produced under revised operating projects. An operating license held by a single natural or legal person may be transferred, while revoked licenses may be reassigned to investors through public tender. Accordingly, the legislation offers multiple legal pathways for obtaining an operating license.

1.2 Background of Geothermal Energy Policy Development and Support Mechanisms in Türkiye

In line with its objective to develop geothermal energy, Türkiye has established a supportive legal and policy framework to facilitate sectoral growth. A major milestone in this process was the enactment of the Geothermal Law in 2007, which defined the principles governing the exploration, development, production, and protection of geothermal and natural mineral water resources. Although renewable energy investments in Türkiye started relatively late, a rapid increase in installed capacity was achieved within a short period through the implementation of a feed-in tariff (FiT) mechanism. The first FiT scheme was introduced in 2005 and initially designed to be valid for ten years, until 2015. Its validity was subsequently extended, first until the end of 2020 and later until June 2021. While the FiT levels were comparable to market prices until 2015, the extensions resulted in tariff levels significantly exceeding market prices. Combined with declining investment costs, particularly for electromechanical components, and high guaranteed purchase prices, this mechanism substantially increased investor interest in renewable energy projects.

The second FiT scheme, which entered into force in July 2021, did not attract the same level of investor interest as the first period. This is reflected in a marked slowdown in installed capacity growth. One of the primary reasons for this decline was the replacement of a fixed, USD-denominated tariff with a Turkish Lira–based mechanism that is updated quarterly at relatively low adjustment rates. In addition, the incentive prices under the second FiT scheme were subject to a USD-denominated price cap and were set well below the levels offered during the first FiT period. In response to growing concerns over energy supply security, particularly in the aftermath of the COVID-19 pandemic, a third FiT mechanism was announced on 1 May 2023. This scheme is applicable for projects commissioned between 1 July 2021 and 31 December 2030 and provides a guaranteed maximum tariff of up to 11.5 US cents/kWh for geothermal resources, valid for a period of 15 years from the commissioning date (Kızılkaya Yıldız et al., 2024).

Within this framework, the Geothermal Development Project was launched following an agreement signed in November 2016 between the Development and Investment Bank of Türkiye (TKYB) and the World Bank. The

project aims to scale up private sector investment by reducing early-stage resource validation risks and providing access to long-term financing for geothermal development. It consists of two main components: (i) a Risk Sharing Mechanism (RSM) for resource validation, supporting exploration and confirmation drilling activities; and (ii) a Loan Facility for Resource Development, providing financing for resource development and power generation or direct-use facilities.

The RSM is capitalized through a contingent grant provided by the Clean Technology Fund (CTF) via the World Bank to the Government of Türkiye, with TKYB responsible for project implementation. Under this mechanism, a predefined share of eligible exploratory drilling costs is reimbursed to the license holder in the event of unsuccessful drilling. As such, the RSM functions as a risk mitigation tool for early-stage geothermal development and represents an effective public–private partnership mechanism to stimulate geothermal investment in Türkiye (Saltuk et al., 2021). According to available program data, the RSM was launched in 2016 and is planned to be completed by the end of 2027. To date, six projects have been completed under the program, with drilling and testing activities carried out for seven deep exploration wells. Approximately USD 14 million in grants from the Clean Technology Fund (CTF) has been disbursed for unsuccessful wells. By the end of 2027, an additional USD 22 million in grant payments is planned under ongoing projects, corresponding to a potential installed geothermal capacity of approximately 90 MW (Kızılkaya Yıldız et al., 2024).

2. TEXAS

While Türkiye leveraged targeted national incentives and centralized coordination to rapidly scale geothermal power, Texas represents a contrasting case: a decentralized, market-driven energy giant with vast untapped geothermal resources. Despite lacking a unified federal strategy, Texas is increasingly positioning itself as a geothermal innovation hub, thanks to its deregulated energy market (Electric Reliability Council of Texas, 2025), mature subsurface industries, and recent policy momentum. This section examines the regulatory, technological, and public perception landscape for geothermal in Texas to identify what conditions could unlock large-scale development comparable to Türkiye's growth trajectory.

Texas's electricity market, operated by the Electric Reliability Council of Texas (ERCOT), is a deregulated, energy-only system where generators earn revenue solely from electricity sold into competitive wholesale markets (Electric Reliability Council of Texas, 2025). This design favors firm, dispatchable resources like geothermal, which can deliver resilient power and capitalize on high prices during peak demand. Because ERCOT does not require long-term procurement contracts or capacity payments, independent developers can bring geothermal projects to market more flexibly than in other more regulated states. The system's independence from federal oversight also enables faster innovation, and several geothermal startups are already piloting projects designed to compete directly with natural gas (Puttré, 2024). Sage Geosystems' EarthStore project in San Miguel exemplifies this momentum, demonstrating the world's first commercial geopressured geothermal energy-storage system capable of delivering long-duration, dispatchable power to the ERCOT grid and directly competing with conventional thermal generation (Mikus, 2024). As geothermal gains a foothold, public understanding and perception of the technology will play a critical role in shaping its future acceptance and deployment across Texas.

Texas's expansive and open-access subsurface datasets make it one of the most geologically mapped jurisdictions in the world (Bureau of Economic Geology, 2022). The Railroad Commission of Texas requires operators to file well logs, seismic data, and injection records, which typically become public within three years or sooner (Railroad Commission of Texas, 2023). Meanwhile, the Bureau of Economic Geology hosts extensive repositories of core samples, temperature gradients, and geothermal resource maps (Wisian et al., 2022). This high-resolution public data significantly lowers exploration risk and has enabled detailed geothermal modeling, such as the Presidio County development scenarios which have already attracted a signed development contract (Wisian et al., 2022). With this geological advantage, Texas has acted decisively on the policy front, enacting landmark legislation in 2023 and 2025 to turn geothermal potential into real-world development (Cariaga, 2023; Myers et al., 2025). Major state legislative actions include: **SB 785:** affirming surface ownership of geothermal resources, **SB 786:** consolidating regulatory oversight under the RRC, **SB 879:** exempting low-risk closed-loop wells from injection fees, **HB 3778**: designating geothermal as a dispatchable resource and establishing eligibility for Texas Energy Fund incentives for projects between 10–100 MW, **HB 4370:** expanding municipal authority to bond-finance geothermal systems (Texas State Energy Conservation Office, n.d.)

Texas now offers one of the most streamlined and industry-friendly geothermal permitting environments in the United States, as oversight has been consolidated under the Railroad Commission for all geothermal well types,

aligning processes with familiar oil and gas protocols (Railroad Commission of Texas, n.d.). In 2025, the RRC issued its first permit for a 3 MW geopressured geothermal well, marking a symbolic milestone for the sector (Railroad Commission of Texas, 2025). Compared to multi-agency review systems in other states, Texas's one-stop-shop permitting model has been praised by industry advocates as a competitive advantage. With a clear permitting pathway now established, the next critical milestone is the successful deployment of Texas's first utility-scale geothermal megawatts and the confidence and momentum that achievement will bring.

DISCUSSION

Permitting Process & Timelines: Draw a direct contrast between Türkiye's structured licensing timeline and Texas's streamlined permitting. For example, note that Türkiye's Law 5686 uses a phased approach, a 3+1 year exploration license followed by a 30-year operating license with possible extensions, whereas Texas's new framework consolidates permits under the Railroad Commission, offering a "one-stop-shop" that can significantly shorten approval times. Texas's recent reforms (single-agency oversight and use of familiar oil/gas protocols) H=highlight how to expedite projects relative to Türkiye's more bureaucratic but stable timeline.

Incentives: FİT vs. Market Mechanisms allow each region to financially incentivize geothermal development in their own way. Türkiye's rapid expansion was driven in part by generous FİT and domestic manufacturing credits introduced in the mid-2000s, guaranteeing developers a fixed price for geothermal power. In contrast, Texas operates in a deregulated market without FİT; support comes from market pricing (favoring geothermal's dispatchable power in ERCOT) and new incentive programs like the Texas Energy Fund grants for mid-sized projects. Thus, a guaranteed tariff in Türkiye provides investor certainty, whereas Texas relies on competitive market signals and targeted funds to spur investment.

Licensing Rights & Resource Ownership: Comparing the fundamental legal frameworks governing who can exploit geothermal resources, in Türkiye, geothermal resources are state-regulated but made available to private investors through licenses, any domestic or foreign entity can acquire multiple geothermal licenses under equal conditions, whereas in Texas, geothermal resources were historically under-defined, but recent legislation (SB 785) affirms that the surface landowner owns the geothermal resource, meaning developers must lease or partner with owners, akin to oil and gas. This difference affects how projects are initiated: Türkiye's model centralizes authority (with the government granting licenses to all qualified parties), while Texas's model leverages private property rights and may encourage a bottom-up, entrepreneurial approach. Pointing out this distinction will underline the contrast in ownership structure and its implications for development speed and inclusivity.

Public Funding & Financial Support Mechanisms: The funding support each region offers for geothermal projects also differs. Türkiye's policy environment included public financial incentives like FiT (a form of indirect public subsidy via electricity tariffs) and soft loans or governmental support for exploration. Texas has recently unlocked public funding channels: for instance, HB 3778 makes geothermal projects eligible for state financing through the Texas Energy Fund, and HB 4370 enables municipalities to use bonds for geothermal systems. Note that Türkiye's developers benefited from nationwide tariff guarantees while Texas developers are beginning to tap state funds and local financing tools illustrate how each region supports projects financially, be it through national tariffs vs. state/local funding mechanisms.

Environmental and Safety Regulations: Under Turkish law, geothermal projects must undergo an Environmental Impact Assessment (EIA) and have strict requirements for resource protection and reinjection to ensure sustainability. Texas, on the other hand, is moving to balance safety with flexibility – for example, SB 879 exempts closed-loop geothermal wells from certain injection fees and monitoring requirements, reflecting a view that some systems carry lower environmental risk. Comparing these shows that Türkiye's regulations emphasize upfront environmental review and long-term resource management, whereas Texas is streamlining rules to lower barriers (at least for lower-risk projects) and integrate geothermal into existing oil/gas regulatory frameworks. Mentioning any groundwater protection rules or seismic monitoring (if relevant) could also strengthen this contrast.

CONCLUSION

Türkiye and Texas thus present an interesting contrast in dynamic geothermal development philosophy. While each is suited to the setting, they are in that includes firmly established power and development infrastructure that is not likely to change, there is substantial room for exchange and crosstalk on how ideas and skill might

transfer. With all electrical grids under severe strain from demand growth (particularly from AI/data centers) governments, grid operators and energy suppliers are more open to innovative ideas than ever. We propose to establish one or more specific working sessions to facilitate the vast knowledge and experience exchange that both Türkiye and Texas possess.

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