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Governance Challenges and Policy Evolution in Taiwan's Geothermal Energy Development

Ting-Jui Song[1]*, Minchen Pan[2], Tze-Luen Lin[2], Gong-Ruei Ho[3], Kotaro Yonezu[4], Yi-Chia Lu[5], Sheng-Rong Song[6] and Pin-I Lee[7]

Graduate School of Engineering, Department of Earth Resources Engineering, Kyushu University, Japan[1]*, Department of Political Science, National Taiwan University, Taiwan[2], Geology Department, National Museum of Natural Sciences, Taiwan[3], Department of Earth Resources Engineering, Kyushu University, Japan[4], Graduate Institute of Applied Geology, National Central University, Taiwan[5], Department of Geosciences, National Taiwan University, Taiwan[6], Fabulous Power Co. Ltd[7]

song.ting.jui.057@s.kyushu-u.ac.jp

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ABSTRACT

Taiwan has an estimated 30–40 GW of geothermal potential, yet as of mid-2025 only 7.49 MW is operating, with a further 12.65 MW expected by the end of 2025—far below government ambitions for gigawatt-scale deployment by 2030. This gap reflects technical, market, and governance constraints, including a framework historically shaped by the 2003 Hot Spring Act and fragmented subsurface institutions. Since 2023, Taiwan has introduced geothermal-specific regulations, amended the Renewable Energy Development Act, refined feed-in tariffs, and proposed reforms to ease land-use constraints for directional drilling, while corporate PPAs and new international partnerships signal rising commercial interest. This paper asks why progress remains slow despite these reforms and what institutional changes are needed to unlock Taiwan's geothermal potential. Drawing on a targeted review of legal instruments, policy reports, and recent scholarship, it compares geothermal governance in the United States (EGS, data infrastructure, and permitting), New Zealand (RMA, fast-track consenting, and Māori co-governance), and Japan (JOGMEC risk-sharing and hot-spring integration), and then maps these insights onto Taiwan's context. The analysis identifies four persistent barriers: fragmented land parcels and unclear rules for directional drilling; the absence of unified technical and well-control standards; disjointed and non-interoperable data systems; and slow, multi-agency permitting with limited geothermal expertise. The paper concludes by proposing reforms to establish enforceable technical codes and certification, create a federated geothermal data portal, streamline permitting, and introduce structured risk-sharing and community-benefit mechanisms that together reduce early-stage risk and create a credible pathway to scale geothermal development in Taiwan.

1 INTRODUCTION

Situated on the western edge of the Pacific Rim, Taiwan overlies active volcanic and subduction systems that generate high geothermal gradients (Song, Song, & Lu, 2025). A 2023 assessment by the Geological Survey and Mining Management Agency (GSMMA) estimates 30–40 GW of geothermal potential (Figure 1), yet by mid-2025 only 7.49 MW had been connected to the grid, with a further 12.65 MW expected by the end of 2025 (Table 1). This remains far below government ambitions for 1.2 GW by 2030 and 6 GW by 2050 (MOEA, 2025a), This disparity illustrates a persistent "geothermal paradox": abundant subsurface resources but limited commercial utilization.

Historically, Taiwan's subsurface industries have been shaped by limited domestic mineral and petroleum reserves, resulting in underdeveloped drilling services and reservoir-engineering capabilities. Until 2023, geothermal exploration and development were governed by the 2003 Hot Spring Act, a framework designed for recreational hot-spring management rather than utility-scale power generation (Water Resources Agency, 2003). Local governments, operating through hot-spring review committees, issued permits under procedures that often lacked geothermal-specific expertise, creating inconsistent timelines and high regulatory uncertainty for developers (MOEA, 2025a). Since 2023, the government has pursued reforms to better align policy with geothermal development. Amendments to the Renewable Energy Development Act (REDA) and the 2024 Regulations Governing Permission and Management of Geothermal Exploration and Development exempt geothermal projects from the Hot Spring Act, centralize permitting, and standardize reviews, while revised feed-in tariffs (FITs) aim to stabilize revenues through options such as front-loaded tariffs and a 1% uplift in indigenous areas (MOEA, 2023, 2024a, 2025; Energy Administration, 2025; Baseload Capital, 2025). These measures are

beginning to catalyze commercial momentum: in 2025, Baseload Capital announced a 10 MW corporate PPA with Google to supply a local data center, a project that would roughly double Taiwan's installed geothermal capacity upon commissioning (Baseload Capital, 2025). Yet the project pipeline remains thin, constrained by four governance barriers in land access, technical standards, data systems, and multi-agency permitting. Against this backdrop, this paper reviews the geothermal policy environments in the United States, New Zealand, and Japan and, using this comparative lens, identifies the key barriers that persist in Taiwan and proposes targeted policy reforms. The analysis is based on a targeted review of legal instruments, policy reports, and recent academic literature in each jurisdiction, with particular attention to permitting, risk-sharing mechanisms, and data governance.

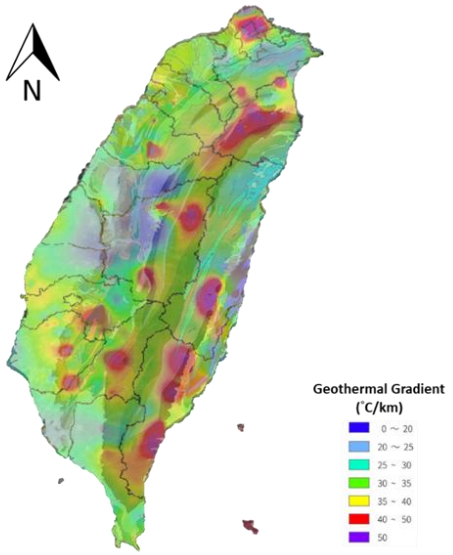


Figure 1: Taiwan geothermal heat flow map (Modified from GSMMA database)

Table 1: Current operational and expected complete in 2025 geothermal power plants in Taiwan

Name	Location	Installed Capacity (MW)	Commissioned year / expected completion (2025)	Unit Type	Supplier
Chingshui	Yilan	0.3	2018	ORC	HanPower
Chingshui	Yilan	4.2	2021	ORC	ORMAT
Jinlun	Taitung	0.499	2022	ORC	HanPower
Chingshui	Yilan	0.45	2022	ORC	HanPower
Sihuangziping	New Taipei City	1.2	2023	ORC	ORMAT
Renze	Yilan	0.84	2023	ORC	HanPower
Honglun + Taiyi	Taitung	1+1	EST. 2025	ORC	ORCAN
Tuchang	Yilan	5.45	EST. 2025	ORC	Turboden
Hungyeh	Taitung	1	EST. 2025	ORC	Enogia
Liuhuangziping	New Taipei City	4.2	EST. 2025	ORC	ORMAT

Total installed capacity expected by the end of 2025: 20.139 MW

2 LITERATURE REVIEW: INTERNATIONAL GEOTHERMAL POLICY FRAMEWORKS

2.1 United States: EGS, NGDS, and Federal–State Governance

- Enhanced Geothermal Systems (EGS) and Advanced Drilling

Recent U.S. literature frames EGS as a means to decouple geothermal deployment from conventional hydrothermal provinces. Utah FORGE, the Department of Energy's flagship EGS field laboratory, has been used to characterize in-situ stress, rock fabric, and stimulation response in granitic reservoirs, with detailed stress profiling, temperature logs, and fiber-optic monitoring providing constraints on fracture orientation, permeability creation, and circulation behavior (Xing et al., 2020; Xing, England, Moore, & McLennan, 2025; Khankishiyev et al., 2024). Multi-stage hydraulic stimulations and circulation tests between deviated wells demonstrate that engineered fracture networks can sustain high flow rates under intensive monitoring.

Commercial-scale pilots in Nevada adapt horizontal wells and multistage hydraulic fracturing—techniques borrowed from unconventional oil and gas—to achieve field-scale circulation in low-permeability formations, highlighting the transferability of directional drilling, completion design, and reservoir simulation tools into geothermal contexts (Norbeck et al., 2023). Reviews of deep and super-hot EGS emphasize that challenging drilling environments in hard, abrasive rocks and high bottom-hole temperatures will require further advances in high-temperature tools, lost-circulation management, and real-time downhole monitoring (Khankishiyev et al., 2024; Elshehabi & Alfehaid, 2025).

- Well Construction and Well-Control Concepts

Technical and roadmap studies stress that geothermal drilling presents distinctive well-control challenges: rapid pressure transients, steam-dominated kicks, and thermally induced casing stresses demand robust blowout-prevention systems, high-temperature drilling fluids, and conservative well designs (Rehm, 1978; Price et al., 2023). Comparative accident-risk assessments argue that systematic monitoring, inspection regimes, and well-control measures—alongside cross-learning from hydrocarbon incidents—are critical for managing deep geothermal projects, particularly EGS and super-hot concepts that stretch existing drilling envelopes (Spada et al., 2021; Elshehabi & Alfehaid, 2025). While detailed curricula are mainly embedded in industry standards, frameworks such as IWCF and IADC WellSharp reflect an emerging consensus on the need for specialized well-control training in geothermal (Bavadiya, Becker, & Korre, 2019; IADC, 2025).

- Federal–state governance and geothermal regulation

Governance in the United States is shaped by interactions between federal land and resource statutes, environmental review requirements, and diverse state regimes. Young et al. (2014) analyze NEPA documents and Bureau of Land Management (BLM) decisions for geothermal projects, showing that environmental assessments and impact statements often introduce multi-year delays; stacked across leasing, exploration, and drilling, total timelines of seven to ten years are not uncommon. Programmatic environmental impact statements and tiered Determinations of NEPA Adequacy can shorten timelines for subsequent site-specific actions, while early scoping and comprehensive plans of development help manage uncertainty.

Using the GeoRePORT socio-economic assessment tool, Levine and Young (2017) classify permitting as a multi-attribute barrier and model how different regulatory configurations affect geothermal deployment scenarios. They argue that a centralized federal geothermal permitting office, expanded use of categorical exclusions for low-impact activities, and clearer guidance on NEPA implementation could collectively reduce timelines by several years and materially increase projected capacity additions by 2030 and 2050. Levine and Young (2018) further map how the Geothermal Steam Act, the Energy Policy Act of 2005, BLM and U.S. Forest Service regulations, and overlapping state regimes jointly shape project pathways.

- Data Integration

On the information side, the National Geothermal Data System (NGDS) is widely cited as a governance innovation. NGDS is a distributed network of data nodes, using common web services and metadata standards to integrate geological, geophysical, geochemical, and well data from state geological surveys, federal agencies, and research projects into a searchable platform (Anderson et al., 2013; Patten, 2013).

Anderson et al. (2013) highlight interoperable content models and ISO-style metadata as key to multi-disciplinary data discovery and machine-readable access, with the explicit goal of reducing exploration risk and transaction costs.

The DOE Geothermal Data Repository (GDR) functions as DOE's primary NGDS node. Weers and Anderson (2013) and Weers (2015, 2022) describe how the GDR couples project deliverables to persistent digital objects with standardized metadata and quality checks, supporting reproducible research and long-term curation of experimental and reservoir datasets. NGDS and the GDR thus operate not merely as archives but as enabling infrastructure for spatial analytics, resource assessment, and institutional transparency.

Taken together, U.S. experience illustrates how advances in EGS and drilling are intertwined with data infrastructure and regulatory reform—an interplay highly relevant to Taiwan's emerging geothermal governance.

2.2 New Zealand: RMA, Fast-track Consenting, and Māori Co-governance

- RMA Framework

New Zealand's Resource Management Act 1991 (RMA) establishes an effects-based regime in which regional councils serve as consent authorities. In the Taupō Volcanic Zone (TVZ), geothermal resources are managed through regional policy statements and plans that classify fields into development, limited-development, research, and protected categories, each with specific allocation limits, pressure or drawdown targets, and reinjection requirements (Burnell et al., 2016; Parson, 2021). Sustainability is framed on decadal–centennial timescales; monitoring of reservoir pressures, enthalpy trends, and surface feature responses informs adaptive consent conditions at fields such as Wairakei, Kawerau, and Mokai (Burnell et al., 2016).

The Rotorua geothermal system has been described as an "experiment in environmental management," where shallow abstraction for bathing and space heating caused declines in geyser activity, prompting bore closures and abstraction caps under the RMA. Recovery of iconic geysers has been linked to adaptive management linking consented take limits to observed changes in surface features and reservoir pressures (Scott, 2016). Parson (2021) emphasizes that geothermal regulation functions as a specialized sub-regime within the RMA, characterized by long consent durations (up to 35 years), strong reliance on regional plans, and explicit recognition of geothermal renewability limits and cumulative effects (Parson, Luketina, & Barton, 2025).

- Fast-Track Consenting

More recently, New Zealand has introduced fast-track mechanisms to accelerate "nationally significant" infrastructure. The COVID-19 Recovery (Fast-track Consenting) Act 2020 created a parallel pathway where eligible projects are referred to expert panels operating under compressed statutory timeframes, with limited appeal rights (Counsell, 2020). Counsell (2020) and the New Zealand Geothermal Association (NZGA, 2024) note that this approach can reduce transaction costs and policy uncertainty but raises concerns about truncated participation and scrutiny of long-term environmental and climate risks. Subsequent proposals further entrench a "one-stop-shop" philosophy (MfE, 2024; Parson et al., 2025), illustrating the ongoing balancing act between speed, due process, and Treaty obligations.

- Māori partnership and co-governance

Geothermal resources are recognized as taonga guaranteed to Māori under Te Tiriti o Waitangi. Historical work documents how Crown appropriation and power-station siting eroded tribal authority and spurred legal and political efforts by iwi and hapū to reassert ownership and governance (Tutua-Nathan, 1992; White, 2012). Treaty settlements and Waitangi Tribunal findings have progressively legitimized co-management arrangements and created expectations of substantive Māori roles in resource governance.

Recent scholarship has increasingly highlighted Māori participation not only as rights-holders but also as active geothermal developers and enterprise leaders, and, grounded in Mātauranga Māori, has formulated culturally informed communication strategies, management frameworks, and development approaches that integrate Indigenous knowledge systems with contemporary geothermal governance practice. Bargh (2012) analyses Māori-owned geothermal enterprises as "indigenous economies" that align commercial development with collective well-being, cultural continuity, and environmental guardianship.

Taute et al. (2022, 2023) identify Māori values—such as mauri, kaitiakitanga, mana, and manaakitanga—relevant to geothermal management and propose both qualitative and quantitative frameworks (including cultural sustainability thresholds) to embed these values in planning and consent processes. Parson et al. (2025) situate these dynamics within a "just transition" lens, emphasizing that geothermal governance must address decarbonization, resource renewability, and distributional justice.

For Taiwan, New Zealand demonstrates how long-term field management, clear consent structures, fast-track mechanisms, and Indigenous co-governance can be integrated into a coherent regulatory system. This offers a useful template for Taiwan as it seeks to streamline geothermal consents and expand development while safeguarding the rights and interests of Indigenous peoples and local communities.

2.3 Japan: JOGMEC Risk-sharing and Hot Spring Integration

- JOGMEC risk-sharing architecture

Post-Fukushima reforms expanded the remit of the Japan Oil, Gas and Metals National Corporation (JOGMEC) to geothermal, creating a distinctive risk-sharing architecture for exploration and development in a legal environment still dominated by the Hot Spring Law and related land-use statutes. These instruments target the long lead times and high upfront capital costs typical of 30 MW geothermal plants (Tosha et al., 2016). JOGMEC offers phase-gated instruments: exploration subsidies for desk studies and surface surveys; equity participation covering a large share of exploration drilling and flow-test costs; and liability guarantees for development-phase investments, including production wells, pipelines, and power-plant facilities (Tosha et al., 2016; JOGMEC, 2025). Subsidy rates are differentiated, with more generous support for local or community-based developers, linking risk-sharing to embedded ownership and local benefit.

These financial tools are coupled with technology programs in airborne geophysics, advanced electromagnetic methods, and drilling/production engineering, so that fiscal de-risking and capability building advance in tandem (Tosha et al., 2016).

- Multi-layered legal framework and the Hot Spring Law

Japan's geothermal projects navigate a fragmented legal system comprising the Hot Spring Law, Natural Parks Law, Forest Law, and Electricity Business Act, administered by multiple ministries (Kaneko, 2012, 2016; Tosha et al., 2016). Under the Hot Spring Law, large geothermal wells fall under the same category as small bathing wells, requiring hot-spring permits for each production and reinjection well, often under municipal rules originally designed to protect onsen resources (Kaneko, 2012). Kaneko (2012, 2016) argues that this configuration creates "inconveniences": overlapping procedures, absence of area-based concessions, and weak alignment between long-term reservoir management and license design. Natural-park regulations historically constrained development in areas that host most of Japan's geothermal potential, but post-2012 reforms have gradually allowed carefully conditioned projects in some zones, indicating incremental adaptation rather than comprehensive legal redesign (Tosha et al., 2016; Hymans, 2021, 2022).

- Social acceptance, onsen stakeholders, and co-existence models

Societal acceptance by hot-spring stakeholders is widely regarded as Japan's central non-technical barrier. Surveys and interviews show that opposition from onsen operators and tourism actors mediates financial and political risks via perceived threats to discharge volume, water quality, and cultural landscapes (Kubota, Hondo, Hienuki, & Kaieda, 2013; Hymans, 2021, 2022). Integrative work demonstrates that credible geochemical monitoring and transparent communication about interference risks are prerequisites for trust in volcanically active regions (Yasukawa, Kubota, Soma, & Noda, 2018).

Modelling and monitoring studies explore geothermal–onsen co-existence. Masuda, Bahr, Tsuchiya, and Takemori (2022) use agent-based simulations for Tsuchiyu Onsen to show that social acceptance is highly sensitive to economic revitalization signals and local opinion leaders' positions. IoT-based monitoring at sites such as Futamata hot spring in Hokkaido quantifies discharge mechanisms and precipitation-driven variability, providing a basis for more informed management (Suzuki & Asanuma, 2021). Overall, Japanese experience highlights the importance of public risk-sharing (JOGMEC), a hot-spring-centered legal framework, and participatory, data-rich monitoring—features that offer both positive and cautionary lessons for Taiwan.

3 TAIWAN'S CURRENT GEOTHERMAL GOVERNANCE CHALLENGES

3.1 Land Parcel Fragmentation and Directional Drilling Barriers

Article 767 of Taiwan's Civil Code stipulates that land ownership extends to subsurface depths "within the range advantageous to the exercise of such ownership," but offers no clarity on rights to drill deviated wells beneath neighboring parcels (MOJ, 2024). Developers must therefore negotiate surface or subsurface easements—typically by creating superficies or pursuing expropriation under the Land Expropriation Act (MOI, 2000)—a process designed for broad land takings rather than the narrow subsurface corridors required for directional drilling.

In practice, directional drilling has no clear legal basis. There is no statutory compensation formula or exemption for drilling beneath other landowners or government properties, and courts have yet to establish standards for subsurface "tunnels." Early projects in Taitung illustrate this challenge: multiple operators targeting the same reservoir encountered protracted land negotiations that increased costs and undermined investor confidence.

Topographically constrained areas further highlight the stakes. In Yangmingshan National Park, protective zoning limits surface disturbance, making directional drilling the only practical means to access high-grade reservoirs beneath park boundaries. Yet without explicit legal exemptions and standardized compensation mechanisms, such projects face high legal risk and may be abandoned or heavily redesigned, sacrificing resource potential for surface compliance (ECCT Euroview, 2025).

Draft provisions circulated by MOEA in 2024 propose that directional wells drilled below a "safe-depth threshold"—for example, 200 m beneath aquifers and 300 m beneath building foundations—could proceed without individual landowner consent, subject to integrity and monitoring requirements (MOEA, 2024b). However, these proposals remain stalled, pending broader amendments to the Land Act and Water Act to harmonize subsurface access with environmental protection.

3.2 Absence of Unified Codes of Practice

Taiwan's geothermal regulations emphasize procedural compliance (for example, staged survey plans for geology, geochemistry, geophysics, and well testing) but lack enforceable technical standards for drilling design, well control, and reservoir monitoring. In contrast to international practices that mandate IWCF or IADC WellSharp certification for critical personnel (Bavadiya et al., 2019; IADC, 2025), Taiwan has no statutory training requirements or standardized well-control procedures.

Recent incidents illustrate the risks. In the Tatun Volcanic Group within Yangmingshan National Park, a government-funded exploration well experienced blowouts during drilling, leading to uncontrolled steam release, vegetation damage, and public backlash. The absence of a traffic-light monitoring system and inadequate well-control planning contributed to the incident; improper abandonment later resulted in persistent gas leakage. These failures highlight systemic weaknesses in project management and regulatory oversight.

The lack of unified codes also undermines investor confidence and complicates collaboration with international partners used to standardized frameworks. It makes it difficult for banks, insurance companies and project finance analysts to price risk or apply standardized due-diligence criteria, which in turn slows capital deployment and keeps most Taiwanese geothermal projects small, single-developer ventures. In practice, many plants operate well below their nameplate capacity, so developers struggle to fully capture the benefits of FIT incentives that implicitly assume higher utilization levels.

3.3 Fragmented Information Systems

Geothermal information in Taiwan is dispersed across multiple platforms that lack interoperability. GSMMA's GeoTEX system provides interactive maps and prospect pages, but limited batch-download functions and non-standardized metadata force developers to manually extract information from static PDF reports. Access to raw survey data often requires proposal reviews, creating barriers despite public funding. The Single Service Window operated by the Energy Administration and ITRI focuses on administrative guidance rather than hosting geoscientific datasets, and the Government Research Bulletin provides only high-level summaries without structured fields for key parameters like temperature logs or well trajectories.

This fragmentation leads to duplicated surveys and wells, inflating costs and delaying projects. In contrast, federated architectures like NGDS demonstrate how distributed repositories can be integrated via common metadata and APIs, enabling automated queries, GIS integration, and large-scale resource screening

(Anderson et al., 2013; Weers, 2015, 2022). Taiwan's current approach falls short of this standard, limiting transparency and investor confidence.

3.4 Multi-agency Coordination Issues

Taiwan established a single service window for geothermal development in 2022 to improve inter-agency coordination, but permitting remains slow and repetitive. Review boards often lack geothermal-specific expertise and standardized criteria, leading to inconsistent evaluations and long timelines. Shortages of specialists in drilling and well design further complicate review of casing programs and operational plans.

Inter-agency disagreements also generate operational risk. Disputes between the Energy Administration and the Ministry of Environment over chemical inhibitor use, for example, have delayed decisions crucial for managing calcite scaling that can quickly clog wells and pipelines. In sensitive areas such as the Tatun Volcanic Group, earlier blowout incidents have heightened caution; however, in the absence of clearly defined traffic-light systems, emergency protocols, and technical guidance, this caution can translate into indecision rather than robust risk management.

Beyond horizontal coordination among central agencies, the vertical division of responsibilities between central and local governments also remains unclear. Local authorities are expected to manage community relations, land-use disputes, and environmental concerns, but their experience is not systematically fed back into central rule-making or project review. By contrast, Japan's Ministry of the Environment has seconded officials with local administrative experience to central geothermal review teams, helping to bridge frontline knowledge and national-level decision-making. In New Zealand, the central government sets the statutory framework and national environmental standards, while regional councils manage consents and adapt rules to local geological conditions—reducing central–local turf conflicts and providing a more predictable pathway for geothermal developers.

4 POLICY IMPLICATIONS FOR TAIWAN

Building on the four governance challenges identified above, this section outlines reform directions in four corresponding domains: (1) technical standards, (2) data systems, (3) permitting and coordination, and (4) risk-sharing finance and community benefits. If implemented in a coordinated manner, these measures would convert Taiwan's current patchwork of geothermal rules into a coherent governance regime capable of supporting both conventional hydrothermal projects and future EGS/AGS/SGS pilots. At present, Taiwan's geothermal strategy sets capacity targets but lacks a clear, staged roadmap that links those targets to minimum viable packages of wells, data, infrastructure, and institutional reforms in specific fields. The measures below are framed to provide such an implementation pathway rather than just additional policy aspirations.

4.1 Establish Unified Technical Standards and Certification

Taiwan urgently needs enforceable technical standards to ensure safety, reliability, and investor confidence. Regulations should be revised to mandate recognized well-control certification frameworks, such as IWCF and IADC WellSharp, for key drilling and operations personnel, embedding structured training and incident-response protocols (Bavadiya et al., 2019; IADC, 2025).

In parallel, Taiwan can develop a Code of Practice for Geothermal Well Drilling modeled on New Zealand's NZS 2403:2015, which has been applied internationally (for example, in Kenya's Menengai field). Such a standard would specify requirements for casing depth, material selection, load calculations, and barrier philosophies, providing a benchmark for deep, high-temperature wells while allowing adaptation to local geological conditions. A national code, referenced in permits and enforced through inspections, would reduce project-by-project negotiation of basic engineering assumptions.

Beyond technical training, Taiwan also needs a broader geothermal talent pipeline that spans law, finance, and public policy. Without professionals who can translate technical standards into bankable contracts, regulatory decisions, and community agreements, improved engineering codes will not fully resolve the underlying governance and financing bottlenecks.

4.2 Create a Federated Geothermal Data Portal

To overcome fragmented information systems, Taiwan should federate existing repositories—GeoTEX, the Single Service Window, the Government Research Bulletin, and other relevant databases—under standardized metadata protocols and API access, drawing on the NGDS/GDR model (Anderson et al., 2013;

Weers, 2015, 2022; Patten, 2013). Funding eligibility for public geothermal programs could be conditioned on depositing survey and well data into this portal, with clear rules on timing and confidentiality.

Regulatory design can combine open-data requirements for projects benefiting from public incentives with mandatory record-keeping and reporting obligations for all developers, inspired by New Zealand's Geothermal Energy Regulations 1961. Even for non-subsidized projects, daily drilling logs, bore specifications, and key monitoring data should be maintained and made available under defined conditions (for example, after specified embargo periods). A federated data ecosystem would enable more efficient prospect screening, reduce redundant surveys, and support evidence-based policymaking.

4.3 Streamline Permitting and Strengthen Inter-agency Coordination

New Zealand's RMA experience suggests that long consent durations, clear allocation limits, and robust monitoring can support both investment and sustainability (Burnell et al., 2016; Parson, 2021). Taiwan should institutionalize a single-window consent system with:

- Statutory deadlines and standardized review criteria.
- Standing technical panels with geothermal expertise to evaluate drilling programs and well designs.
- Integrated environmental safeguards, including traffic-light systems and pre-agreed emergency protocols for blowouts and induced seismicity (NZGA, 2024; Boffa Miskell, 2025; MfE, 2024).
- Inter-agency agreements should clarify roles (for example, between energy, environment, indigenous affairs, and land authorities) and establish mechanisms to resolve technical disputes—such as over chemical inhibitor use—using independent expert review rather than ad hoc negotiation.

In parallel, Taiwan should invest in dedicated geothermal capacity within both central and local governments. A standing coordination platform, with a small secretariat and a roster of technical, legal, and financial experts, could support agencies and municipalities in reviewing projects, mediating disputes, and communicating risks and benefits to communities. This would reduce reliance on ad hoc task forces and help ensure that procedural streamlining is matched by genuine decision-making capacity.

4.4 Implement Risk-Sharing Finance and Community Benefit Mechanisms

Exploration and drilling risks remain a major barrier in Taiwan. Because resource temperature, permeability, and sustainable capacity are highly uncertain before drilling, neither developers nor communities can easily estimate future revenue, negotiate fair benefit-sharing arrangements, or define how much risk each party can realistically bear. Well-designed incentives are therefore critical for crowding in private capital and creating durable partnership models rather than one-off transactions. A phased risk-sharing facility modeled on JOGMEC could combine grants, equity co-investment, and loan guarantees across the project lifecycle, with higher support ratios for community-based developers or projects in priority regions (Tosha et al., 2016; JOGMEC, 2025; Kaneko, 2012, 2016). Dedicated budgets for environmental and reservoir monitoring should be embedded in such schemes to ensure that risk-sharing is tied to robust subsurface stewardship.

New Zealand's experience further shows how regulatory incentives can reward strong local partnerships. Priority offtake arrangements and access to fast-track consenting have been used to support projects where developers work in genuine co-governance with Māori landowners—as in cases such as the Taheke Geothermal Project, which sought fast-track approval under the COVID-19 Recovery (Fast-track Consenting) Act 2020 (Roopu Whakarite Mahi Limited Partnership, 2022). To strengthen social license in Taiwan, incentives should similarly reward locally rooted projects that present credible plans for economic revitalization and benefit-sharing, drawing on lessons from Māori geothermal enterprises and Japanese onsen co-existence models (Bargh, 2012; Kubota et al., 2013; Masuda et al., 2022; Yasukawa et al., 2018). In Indigenous areas, financial mechanisms should explicitly align with the Indigenous Peoples Basic Law and respect local decision-making processes (MOEA, 2025b).

5 CONCLUSION

Taiwan's geothermal sector combines exceptional resource potential with significant governance challenges. With 30–40 GW of assessed potential and government targets of over 1.2 GW by 2030 and 6 GW by 2050, the island represents one of Asia's most promising geothermal markets. Recent reforms—geothermal-specific permitting regulations, refinements to FITs, and the creation of single service windows—mark an important shift away from hot-spring-based governance. Yet fragmented land rights, the absence of unified technical standards, disjointed data systems, and multi-agency coordination problems continue to slow project development and elevate risk. International experience offers practical guidance: from the United States, EGS

and drilling technology roadmaps, NGDS-style data architectures, and analyses of permitting timelines; from New Zealand, long-term consent structures, field-based sustainability management, fast-track mechanisms, and Indigenous co-governance models that embed Māori values and knowledge systems in geothermal decision-making; and from Japan, JOGMEC's risk-sharing instruments and lessons from operating within hot-spring-centered legal frameworks and socially sensitive landscapes.

By establishing unified technical standards, building a federated geothermal data portal, streamlining permitting, and implementing structured risk-sharing and community-benefit mechanisms, Taiwan can reduce development risk while safeguarding environmental values and the rights of Indigenous peoples and local communities. Rather than treating its 2030 and 2050 capacity targets as abstract numbers, Taiwan could adopt a geothermal roadmap that defines minimum viable project bundles—integrating exploration wells, data obligations, risk-sharing finance, community agreements, and Indigenous knowledge and co-management frameworks—for a small number of priority fields, and then scales up based on the lessons learned. Such reforms would not only unlock domestic geothermal resources but also create opportunities for collaboration with international partners in drilling, reservoir engineering, power plant design, and policy consulting, while positioning Indigenous communities as genuine partners in governance and contributing to a more resilient and decarbonized energy future for the island.

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