

Rethinking geothermal energy: Between climate solution and socio-environmental risk

By Beyrra Triasdian, Trend Asia

April 2026

Introduction

Geothermal energy development in Indonesia began gaining global momentum in 2011 when the World Bank Group (WBG) identified its vast untapped potential, shedding the stigma of it being expensive and risky.¹ At the time, Indonesia held an estimated 23.7 gigawatts (GW) in geothermal resources, yet only 1.3GW had been exploited. Framed as a low-carbon alternative, geothermal energy quickly gained support from government agencies and international financial institutions as a practical solution to the climate crisis. Today, the country has identified 356 geothermal sites along the country's ring of fire, an area with over 130 active volcanoes where the Eurasian, Indo-Australian, and Pacific tectonic plates meet, causing frequent earthquakes and eruptions.² Of these, 57 sites with capacity around 3.4GW are actively undergoing development.³

The momentum has been significantly amplified by international financial institutions (IFIs) such as the World Bank and the Asian Development Bank (ADB) in expanding geothermal projects across Indonesia.

The World Bank is primarily supporting exploration risk mitigation to attract private investment through its flagship intervention, the \$325m loan for Geothermal Resource Risk Mitigation Project (GRRMP), approved in 2019, which was further backed by \$127.5m in grants from the Clean Technology Fund (CTF) and the Indonesian government's contribution of \$150m.⁴ This initiative is specifically designed to de-risk and catalyse private investment in geothermal exploration, a phase traditionally seen as too costly and uncertain.

The ADB has deepened its involvement in Indonesia's geothermal sector by providing significant project financing to increase capacity. In 2020, it approved a \$300m loan to support PT Geo Dipa Energi (GDE), an Indonesian state-owned company, to expand its geothermal power generation capacity by 110MW in Java. In addition, the ADB administered a \$35m loan from the CTF for the project.⁵ In 2025, the ADB further committed a \$180m loan in additional financing to support GDE in completing two 55MW geothermal plants on Java Island.⁶ Earlier in the same year, the ADB also signed a \$92.6m financing agreement with geothermal power producer Supreme Energy Muara Laboh (SEML) to expand a geothermal facility at Muara Laboh in West Sumatra, and the construction, operation and maintenance of a new 83MW geothermal power plant.⁷

However, while IFIs like the World Bank and the ADB promote geothermal energy for its climate benefits, the financial and policy frameworks they champion often fail to account for the unintended consequences borne by local communities. The promise of energy transition and climate justice is too often overshadowed by the environmental and social harms that fall disproportionately on communities living in and around geothermal project areas. These are often the same areas where people rely directly on natural resources for their livelihood.

¹ Puspitasari, E. (2017). The World Bank's influences on the political economy of geothermal liberalization under President Susilo Bambang Yudhoyono administration (Master's thesis). Universitas Airlangga. <https://repository.unair.ac.id/68297/3/Jurnal%20Erlin%20Puspitasari%20071514553017.pdf>

² Badan Geologi, Kementerian Energi dan Sumber Daya Mineral. (2018). Laporan akuntabilitas kinerja Badan Geologi tahun 2018. Kementerian Energi dan Sumber Daya Mineral. <https://geologi.esdm.go.id/storage/publikasi/BZndhEYcRYSGJHh3XKSnEVsrE3HwbzDohxcs3veV.pdf>

³ Global Energy Monitor. (2026). Global geothermal power tracker. <https://globalenergymonitor.org/projects/global-geothermal-power-tracker/>

⁴ World Bank Group. (n.d.). Indonesia: Tapping geothermal for greener growth. World Bank. <https://www.worldbank.org/en/about/partners/brief/indonesia-tapping-geothermal-for-greener-growth> <https://www.worldbank.org/en/about/partners/brief/indonesia-tapping-geothermal-for-greener-growth#>

⁵ Asian Development Bank. (2020, May 28). ADB approves \$300 million loan to increase Indonesia's geothermal electricity generation. Asian Development Bank. <https://www.adb.org/news/adb-approves-300-million-loan-increase-indonesias-geothermal-electricity-generation>

⁶ Xinhua News Agency. (2025, October 31). ADB approves 180 mln USD loan to boost Indonesia's geothermal electricity generation. <https://english.news.cn/20251031/7bae4f39694c44d1bd05c66bd932000a/c.html>

⁷ Argus Media. (2025, September 26). ADB to fund Indonesia \$92.6mn for geothermal expansion. <https://www.argusmedia.com/en/news-and-insights/latest-market-news/2647266-adb-to-fund-indonesia-92.6mn-for-geothermal-expansion>

By funnelling large sums into de-risking projects for corporations, these financial models effectively transfer social and environmental risks to communities. Rather than encourage climate justice, this approach to the energy transition perpetuates inequality and exclusion.

Whether geothermal energy can become a genuine climate solution or a new source of injustice depends entirely on how it is developed. The scale, ownership structure, and financing model of Indonesia's geothermal expansion will determine whether it advances climate justice or deepens existing inequalities.

Environmental concerns: water depletion, pollution, dangerous mudflows

Geothermal exploration and operations require substantial volumes of water. According to Celios and JATAM's 2024 Report, producing one megawatt of power can consume between 6,500 and 15,000 litres of water.⁸ At the 35MW Ijen geothermal plant, financed by the ADB and WBG partners PT Sarana Multi Infrastruktur (PT SMI) and the U.S. International Development Finance Corporation (DFC) in East Java, daily water use has reached 6.5 million litres, equivalent to the needs of approximately 43,000 people. This heavy water demand has led to the depletion of local water sources, affecting community access to clean water. In 2024, more than 200 households in the surrounding area reported that their springs had turned cloudy and bitter. Affected areas included Watu Capil, Margahayu, and Kebun Jeruk, with evidence pointing to drilling waste discharged from well IJN 2.⁹

In Dieng, Central Java, local residents have faced contamination from fracking — a drilling technique used specifically for Enhanced Geothermal Systems (EGS) to enable heat extraction. The high-pressure injection of water during drilling has introduced hazardous substances such as arsenic and boron into nearby streams, affecting both domestic and agricultural water use.¹⁰

One of the most alarming issues has been the mudflow from drilling sites. The local media report of Floresa in 2023 explains that in Mataloko, East Nusa Tenggara, geothermal blowouts rising 15 to 30 metres occurred in 1998.¹¹ It is constantly creating new points of mudflow and causing damage to agricultural land. Similar incidents have been documented in the Ijen geothermal plant (2020) and a fatal one occurred in Sorik Marapi, North Sumatra (2022), where the blowouts and hydrogen sulfide (H₂S) gas erupted up to 30 metres high, causing serious safety hazards.



Abandoned exploratory wells that were left unplugged in Mandailing Natal, North Sumatra. Photos by Trend Asia

⁸ Utomo, W. T., Rizqiana, A., Refani, F., Adhinegara, B. Y., Huda, N., Cristanto, F. T. J., Rakhman, O., & Reffelsen, T. (2024). *Geothermal di Indonesia: Dilema potensi dan eksploitasi atas nama transisi energi*. CELIOS Publishing House. <https://celios.co.id/publishing/geothermal-di-indonesia-dilema-potensi-dan-eksploitasi-atas-nama-transisi-energi/>

⁹ Utomo, W. T., Rizqiana, A., Huda, N., Cristanto, F. T. J., Rakhman, O., Reffani, T., Adhinegara, B. Y., & Reffelsen, T. (2025). Mining false solutions: The controversy of JETP in the Ijen geothermal project. CELIOS. <https://celios.co.id/mining-false-solutions-the-controversy-of-jetp-in-the-ijen-geothermal-project>

¹⁰ Utomo, W. T., Rizqiana, A., Refani, F., Adhinegara, B. Y., Huda, N., Cristanto, F. T. J., Rakhman, O., & Reffelsen, T. (2024). *Geothermal di Indonesia: Dilema potensi dan eksploitasi atas nama transisi energi*. CELIOS Publishing House. <https://celios.co.id/publishing/geothermal-di-indonesia-dilema-potensi-dan-eksploitasi-atas-nama-transisi-energi/>

¹¹ Tim Floresa. (2023, December 15). Warga Mataloko Flores terus "tersengat" panas bumi: Proyek dilanjutkan usai gagal berulang dan timbulkan bencana lingkungan. Floresa. <https://floresa.co/reportase/liputan-khusus-id/58590/2023/12/15/warga-mataloko-flores-terus-tersengat-panas-bumi-proyek-dilanjutkan-usai-gagal-berulang-dan-timbulkan-bencana-lingkungan>

The ecological toll extends beyond water depletion to the severe contamination of vital water bodies. In Panembangan village, located at the foot of Mount Slamet, geothermal exploration polluted the Prukut River, turning the community's primary clean water resource turbid and muddy for months.¹² Furthermore, at the ADB-financed Lahendong geothermal power plant in North Sulawesi, operations have severely damaged Lake Linow.¹³ The contamination of the water body was evidenced by the disappearance of lake-specific insects, known locally as sayok and komo, which are highly sensitive bio-indicators of water quality and a source of nutrients for the local villagers.¹⁴

Human costs and oppressing dissent

Environmental degradation is only part of the challenge. The JATAM 2022 report describes a series of remarkable incidents in Mandailing Natal, North Sumatra.¹⁵ The geothermal project at Sorik Marapi has experienced a series of H₂S gas leaks since 2021. In January of that year, five women died while working in nearby fields. Subsequent poisoning incidents occurred in February, March, April, and twice in September 2022, affecting more than 150 residents. Additional incidents in 2024 and 2025 caused further harm and affected hundreds more people.¹⁶

In other regions, such as Wae Sano, Sakoria, and Ulumbu in East Nusa Tenggara, geothermal development is projected to cut the farmer's income by up to IDR 470bn (or about \$27.56m). For every 1MWe of geothermal electricity produced, the water required is equal to that needed for 59 corn growing seasons. As land, labour, and water are shifted from agriculture to construction and related sectors, farm productivity falls and the added value of food crop agriculture declines. Broader economic losses are estimated to reach IDR 1.1tn, or about \$64.5m, in the first two years of operation, mainly due to a sharp decline in economic output from agriculture, forestry, and fisheries. When these sectors collapse, the livelihoods of entire communities are also put at risk.¹⁷

The human cost of geothermal development is distinctly gendered, exacerbating existing inequalities and the feminisation of poverty. When agrarian resources and clean water are depleted, women, who are culturally tied to domestic and reproductive roles, bear the brunt of the burden, forced to travel greater distances to secure water and food. The destruction of local livelihoods frequently pushes women into seeking employment abroad as migrant workers, exposing them to further exploitation. Despite this, environmental and social impact assessments conducted by project developers remain too narrow, focusing on formal employment metrics rather than the profound socio-economic impacts on women.¹⁸

Beyond the economic and physical harm, aggressive geothermal expansion is posing an existential threat to Indigenous identities and cultural heritage. In Atadei, East Nusa Tenggara, the foul-smelling odours emanating from nearby geothermal wells have deterred the community from performing the Tun Kwar (grilled corn) ritual, a vital cultural expression of gratitude for harvests that are now in danger of extinction. Similarly, World Bank-backed exploration on Mount Rajabasa in Lampung threatens a protected forest that serves not only as a crucial water reservoir but as an ancestral shelter and a sacred pillar of the Saibatin Paksipak Sekala Brak Customary Kingdom. In Poco Leok, Flores, community members vehemently oppose the expansion of the ADB-financed Ulumbu plant because the proposed drilling sites risk desecrating their ancestors' graves and sacred springs.¹⁹

In addition to economic and health impacts, resistance to geothermal development is increasingly met with legal threats. Indonesian Law No. 21 of 2014 allows for criminal charges of up to seven years in prison and fines of up to IDR 70bn for individuals deemed to obstruct exploration activities. The case of geothermal development in Mount Gede illustrates this irony. According to LBH Bandung's 2024 release, community members from 15 villages who rely

¹² NGO Forum on ADB. (2025). Geothermal power development in Indonesia: Debacle in Dieng and Flores. https://www.forum-adb.org/files/ugd/898604_5e67259d5b2f4bce9ef62adaf46ae56f.pdf

¹³ *ibid*

¹⁴ *ibid*

¹⁵ JATAM (Jaringan Advokasi Tambang). (2022, November). Geothermal industry expansion: The long way to seeding organized disasters—A report to the public and a warning to the businesses and authorities of Indonesian mineral and energy mining. JATAM. <https://jatam.org/wp-content/uploads/2022/12/Geothermal-Report-English-2022.pdf>

¹⁶ JATAM (Jaringan Advokasi Tambang). (2025, April 26). Semburan lumpur panas di geothermal Sorik Marapi: Janji palsu energi hijau. JATAM. <https://jatam.org/id/lengkap/Lumpur-Panas-di-Geothermal-Sorik-Marapi>

¹⁷ Walhi and Celios. (2024). Indonesia's Geothermal Challenges: Amidst Potential and Exploitation in the Name of Energy Transition. CELIOS Publishing. <https://celios.co.id/celios-x-walhi-geothermal-energy-economic-and-environmental-impacts/>

¹⁸ Aziziah, S. P. N., Kurniawaty, A., & Pascual, M. M. (2023, October). Exploring geothermal energy development in Indonesia: Policy failures and impacts on women's rights. Recourse & Solidaritas Perempuan. <https://re-course.org/wp-content/uploads/2023/09/Exploring-Geothermal-Energy-Development-in-Indonesia.pdf>

¹⁹ *ibid*

on 94 local natural springs are facing legal charges for opposing a project that could jeopardise the water supply of more than 30 million people.²⁰ The area is vital to four major watersheds; Citarum, Cimandiri, Cisadane, and Ciliwung.

These projects frequently advance through systemic violations of Free, Prior, and Informed Consent (FPIC). Information regarding the scope and potential impacts of projects is rarely made accessible to communities, and vital documents like Environmental Impact Assessments are often only provided in English, preventing communities from making informed decisions. When Indigenous and rural communities inevitably resist the expropriation of their lands, they are met with state-sponsored intimidation and violence. For example, during the expansion efforts of the Ulumbu geothermal project into Poco Leok, the arrival of the state electricity team (PLN) was escorted by fully armed police and soldiers, resulting in brutal clashes and the arbitrary arrest of resisting villagers.^{21 22}



Dieng Geothermal Power Plant in Central Java, Indonesia. Photo by CELIOS

The urgency of equitable green finance

The documented harms of geothermal projects together with recent surge in financing such projects in Indonesia are the predictable outcomes of a financing model that treats social and environmental risks as secondary to financial and geological ones. The commitments from the World Bank and the ADB effectively subsidise a system where corporations profit while communities pay the price in water, health and livelihoods.

Transitioning to renewable energy should not merely change the energy source but must transform the development model itself. Achieving true climate justice requires international financial institutions and the Indonesian government to adopt a 'Feminist Just Transition' framework. This approach demands a systemic shift away from extractive, profit-driven models and calls for addressing economic inequality, the redistribution of care work, and the meaningful participation of women and Indigenous communities in decision making. The exploration and implementation of geothermal power plants must be strictly driven by the explicit consent and needs of local communities.

People and nature are not peripheral to the energy transition, instead they are its foundation. Without a commitment to equity and justice, efforts to solve the climate crisis risk creating new social and environmental crises that are even more difficult to resolve.

²⁰ Lembaga Bantuan Hukum Bandung. (2024, September 15). Tolak geothermal: Warga Gunung Gede dikriminalisasi. LBH Bandung. <https://www.lbhbandung.or.id/tag/geothermal/>

²¹ NGO Forum on ADB. (2025). Geothermal power development in Indonesia: Debacle in Dieng and Flores. https://www.forum-adb.org/files/ugd/898604_5e67259d5b2f4bce9ef62adaf46ae56f.pdf

²² Aziziah, S. P. N., Kurniawaty, A., & Pascual, M. M. (2023, October). Exploring geothermal energy development in Indonesia: Policy failures and impacts on women's rights. Recourse & Solidaritas Perempuan. <https://re-course.org/wp-content/uploads/2023/09/Exploring-Geothermal-Energy-Development-in-Indonesia.pdf>