

GEOHERMAL ENERGY IN THE EURASIAN CORRIDOR

A Policy and Investment Review



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Geothermal Energy in the Eurasian Corridor

Trilemma Tensions, Investment Frontiers & the New Energy Architecture

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EXECUTIVE SUMMARY

The Eurasian Corridor, stretching from the Aegean coastline of Türkiye across the steppe basins of Central Asia to the tectonic frontier of Pakistan, sits at the intersection of three converging forces: chronic energy insecurity, a post-Ukraine geopolitical realignment, and a technology revolution in subsurface engineering. The World Energy Council's Energy Trilemma Index reveals that every country in this corridor struggles to balance energy security, equity, and environmental sustainability simultaneously, and geothermal energy offers a rare and compelling means to advance all three dimensions at once. This paper investigates the geothermal potential of the Eurasian Corridor, situates it within the evolving discourse at CERAWeek 2024-26, the world's foremost energy conference by S&P Global and maps the investment landscape with specific attention to opportunities, risks, and risk mitigation architecture. Drawing exclusively on peer-reviewed research, IEA reports, World Bank and IFC analyses, and verified conference proceedings, it argues that geothermal is not merely a transition-era footnote but a geopolitical asset whose time has arrived.

I. The Energy Trilemma as Strategic Compass

The World Energy Council (WEC), a UN-accredited body, has since 2010 published its *World Energy Trilemma Index*, a ranking of 127 countries across three interlocking dimensions: energy security, energy equity (accessibility and affordability), and environmental sustainability.¹

The trilemma is not merely an academic scoring exercise. Its 2024 edition — the 15th — describes how the war in Ukraine triggered what the WEC calls the world's first consumer-led, demand-driven energy shock, cascading into a crisis of all three trilemma dimensions at once: supply disruption threatened security, price spikes destroyed equity, and coal re-entry damaged sustainability.

As WEC Secretary General Dr. Angela Wilkinson observed:

"The world's first consumer-led energy shock, the materiality of the renewable energy revolution and the continued rise in structural inequalities are red flags to business-as-usual." — Dr. Angela Wilkinson, WEC Secretary General, Trilemma Report 2024

For the Eurasian Corridor, the trilemma's three vertices are in chronic tension. The post-Soviet states of Central Asia remain heavily dependent on fossil fuel revenues and imports, compromising security diversification and equity.

Pakistan faces catastrophic circular debt in its power sector, reaching Rs. 2.6 trillion (approximately USD 9.3 billion) by October 2023, with imported fossil fuels at the centre of the fiscal spiral.

Türkiye, the corridor's most advanced economy, spends more than 70% of its energy import bill on oil and gas, distorting its trade balance, which ran to USD 106.6 billion in 2023, while simultaneously becoming a global leader in geothermal deployment. Eastern European states, meanwhile, are pivoting hard away from Russian gas under the pressure of the post-2022 European security order.

Geothermal energy addresses all three vertices. As a domestic, dispatchable, and baseload resource with near-zero fuel costs, it simultaneously improves energy security, reduces the import burden on household energy costs (equity), and produces electricity and heat with minimal greenhouse gas emissions. The IEA's landmark December 2024 report, *The Future of Geothermal Energy*, is the most authoritative statement yet of the sector's global potential.

II. Global Geothermal Landscape: From Niche to Frontier

As of end-2024, global geothermal installed power generation capacity reached 16,873 MW, spread across 35 countries. The sector grew by only 389 MW in 2024, modest by renewable standards, but is entering a period of technological transformation that will reshape its trajectory entirely.

The IEA's Transformative Projection

The IEA's December 2024 special report sets out an arresting scenario: with continued technology improvements and reduction in project costs, geothermal could meet up to 15% of global electricity demand growth by 2050. This would mean the cost-effective deployment of as much as 800 GW of geothermal power capacity worldwide, producing almost 6,000 TWh annually, equivalent to the current electricity demand of the United States and India combined.⁸

The same report projects that global investment in geothermal could reach USD 1 trillion cumulatively by 2035 and USD 2.5 trillion by 2050. At its peak, investment could reach USD 140 billion per year, surpassing current global investment in onshore wind power.⁹

The technology unlock driving this projection is the transfer of oil and gas expertise, particularly horizontal drilling, hydraulic fracturing (as perfected in the shale revolution), and high-temperature downhole engineering, to enhanced geothermal systems (EGS). EGS removes the geological constraint that has historically restricted geothermal to volcanic or tectonically active zones. By engineering fractures in hot, dry, impermeable rock, EGS opens the thermal resource of nearly every country on earth.

The IEA calculates that the total subsurface heat accessible via EGS at depths of up to 8 km amounts to approximately 300,000 EJ of technically extractable energy, equivalent to almost 600 TW of geothermal capacity operating for 20 years. This exceeds the technical potential of conventional geothermal by nearly 2,000 times.

From Cost Problem to Cost Opportunity

The IEA also identifies a compelling cost trajectory. EGS LCOE is currently over USD 230/MWh, high but declining. With strong innovation support, costs could fall by 80% by 2035, bringing geothermal to approximately USD 50/MWh. At USD 30/MWh by 2050, it would rank among the cheapest dispatchable low-emissions electricity sources in the world, competitive with existing hydropower and nuclear.¹²

This trajectory mirrors the cost collapse that solar PV underwent between 2010 and 2023. The analogy carries strategic weight: if geothermal follows the solar learning curve, early-mover countries, including those in the Eurasian Corridor, could lock in long-term cost advantages that compound over the lifetime of the resource.

The CERAWeek Inflection Point

For three consecutive years, geothermal has moved from the margins to the main stage of the world's most important energy gathering. CERAWeek by S&P Global, described in the energy press as the "*Super Bowl of Energy*" — convenes over 10,000 thought leaders, including more than 650 CEOs and 90 government ministers.¹³

At CERAWeek 2024, the U.S. Department of Energy's Loan Programs Office dedicated a Lyceum session specifically to next-generation geothermal, featuring ARPA-E Deputy Director Danny Cunningham and Geothermal Technologies Office Director Lauren Boyd. The DOE also positioned geothermal as one of three liftoff-pathway technologies alongside clean hydrogen and carbon management, a policy signal of the highest order.

At CERAWeek 2025 — themed "*Moving Ahead: Energy Strategies for a Complex World*" — the geothermal session on March 12 featured Ajit Menon, Vice President for Geothermal at Baker Hughes, alongside Tim Latimer, Co-Founder and CEO of Fervo Energy, who presented how geothermal energy is scaling as a reliable and sustainable power source.¹⁵

The session reflected a broader conference theme identified by energy analyst network CTVC in its post-CERAWeek 2025 dispatch: that technology majors such as Meta and Google are actively pursuing geothermal as a baseload power source for AI data centres, alongside nuclear. The Rhodium Group estimated that geothermal could supply up to 64% of data centre loads at scale.

Energy is not A sector of the economy; it is THE sector that enables every other sector.
— U.S. Energy Secretary Chris Wright, CERAWeek 2025 Opening Plenary

The energy trilemma theme was explicit in CERAWeek 2025's opening session: the age-old tension between energy security, affordability, and sustainability 'continued to rear its head' in panel after panel, as reported by World Oil. The conference signalled that geothermal — with its baseload, domestic, and clean-energy attributes — is uniquely positioned to resolve all three corners of the triangle.

III. Country Geothermal Profiles: The Eurasian Corridor

A. Türkiye — The Corridor's Geothermal Anchor

Türkiye is not merely a participant in the global geothermal story; it is one of its defining characters. With 1,734 MW of installed geothermal power capacity as of end-2024, Türkiye ranks fourth globally, behind the United States,

Indonesia, and the Philippines, and is first in Europe. Its geothermal sector has expanded roughly 100-fold over the past decade, driven by private sector investment and a sustained government support framework.

The geological foundation is exceptional. The Western Anatolian Graben systems, particularly the Büyük Menderes and Gediz Grabens, host some of the world's highest geothermal gradients. Türkiye has identified 239 geothermal fields with an estimated potential of 60,000 MWt of thermal energy, with approximately 40,000 MWt of fields hot enough to generate up to 4,000 MW of electricity.

The country is also the world's second-largest user of geothermal direct heat, after China, with almost 4 GWt of direct-use capacity including 1,120 MWt of district heating, 855 MWt of greenhouse heating, and over 520 spa and bathing installations. Direct heating serves over 125,000 households; the country hosts 5,400 decares of geothermally heated greenhouses.

Government targets set the ambition: installed geothermal power capacity is projected to reach 3,000 MW by 2030, and the National Energy and Mining Policy plan calls for total geothermal and biomass capacity of 5 GW by 2035. A study in 2024 notes that geothermal installed capacity already stands at 4.5 GWe in thermal equivalent, utilising 38.4% of identified potential.²²

The World Bank has underwritten Türkiye's ambitions with grants and loans worth USD 600 million for the sector, with developments expected to reduce the country's carbon emissions by 30 million tonnes over project lifetimes and create 380 MW of new capacity through World Bank-supported investments, also drawing in an estimated USD 550 million in additional private investment.

From a Trilemma perspective, Türkiye's geothermal programme is a textbook case. It directly addresses energy security (reducing dependence on hydrocarbon imports that account for roughly half of its trade deficit most years), energy equity (geothermal heat dramatically lowers household energy bills, particularly in rural western Anatolia), and environmental sustainability (displacing coal and gas for heating).

A known challenge: CO₂ emissions from new Turkish geothermal plants — particularly in the metamorphic-rich Menderes Massif — can run from 900 to 1,300 g/kWh in early years as dissolved carbon in geothermal fluids is released. However, the World Bank's assessment is that lifetime emissions track the global geothermal average as the reservoir stabilises, and solutions such as CarbFix reinjection are under active study.

B. Kazakhstan — Sedimentary Basins, Untapped Wealth

Kazakhstan is the Eurasian Corridor's most consequential untapped geothermal prospect. Early studies by Kazakhstan's Institute of Hydrogeology and Hydroecology estimate that approximately 40% of the country's territory has resources of geothermal hot water. Published work on Mangyshlak Basin, which is a 75,000 km² sedimentary formation in western Kazakhstan — identified elevated temperatures in multiple sub-regions and confirmed good candidates for both SedHeat and Enhanced Geothermal Systems.²⁶

The country's renewable energy policy framework provides an enabling environment. Kazakhstan targets a 10% share of alternative energy by 2030 and 50% by 2050. A draft Law on the Development of Alternative Energy, initiated by the Ministry of Energy in 2024, explicitly includes geothermal energy among priority development areas.

The practical reality is instructive. As the World Bank's ESMAP programme documented in 2020–2021 (with Icelandic expert support), Kazakhstan already has geothermal systems identified in its western, southern, and central regions — primarily in sedimentary basins at low-to-medium temperatures. The geothermal resources of Kazakhstan are currently minimally utilised, mainly for spas, bathing, and greenhouses, but the systems are compatible with district heating, agro-industries, and eventually power generation.

From a Trilemma lens, Kazakhstan faces a paradox characteristic of fossil fuel-rich states: high energy security (as a major oil and gas exporter) but poor equity outcomes domestically. A 2020 study found that 28% of surveyed households spend more than 10% of their income on energy, with coal-dependent northern regions suffering from particularly severe energy poverty. Approximately 40% of households use coal as their primary heating source. Geothermal district heating could directly address this structural inequity.

A June 2025 roundtable organised jointly by Kazakhstan's Ministry of Energy and the EU-funded SECCA project brought together experts from Kyrgyzstan and Uzbekistan alongside Kazakh academia and private sector representatives. Informed by the IEA's 2024 report, participants discussed the distribution of low-temperature resources and the potential for geothermal heat pumps to decarbonise energy supply across multiple climatic regions.

C. Central Asia (Kyrgyzstan, Tajikistan, Uzbekistan) — The Regional Case

A 2021 peer-reviewed overview published in *Renewable Energy Journal* estimated the geothermal potential across the five Central Asian states at between 2 MW and 54,000 MW, depending on resource assumptions and technology, an enormous range reflecting the region's nascent assessment status. The survey covered Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan.³¹

The IFC Vice President for the Middle East, Central Asia, Türkiye, Afghanistan, and Pakistan, Hela Cheikhrouhou, has publicly championed the regional case. In an op-ed published following official visits to Kazakhstan, Kyrgyzstan, and Uzbekistan, she noted that the region's subsoil is well-suited for geothermal heating and cooling technologies, and that each megawatt of installed geothermal capacity creates approximately 34 jobs, significantly higher than the 19 jobs per MW for wind and 12 per MW for solar, a critical consideration for economies seeking employment-generating clean energy.

The region's air quality crisis amplifies the urgency. IQAir rankings identify the Kyrgyz Republic and Tajikistan among the world's top-20 most air-polluted countries. The primary driver is coal combustion for heating. Geothermal district heating systems, even at low-to-medium temperatures, can replace coal boilers entirely in urban settings, as European and Icelandic precedents demonstrate.

Uzbekistan, meanwhile, is a significant fossil fuel producer in its own right but is investing in renewable diversification. In a regional context, geothermal offers Uzbekistan a means to reduce domestic gas consumption

(freeing gas for export earnings), while Central Asian states more broadly could reduce their vulnerability to energy import dependencies that currently compromise their energy security trilemma score.

D. Pakistan — Seismic Goldmine, Policy Desert

Pakistan's geothermal story is the most dramatic in the corridor: extraordinary potential, near-zero exploitation. The geological basis is unambiguous. Pakistan straddles the collision zone of the Indian and Eurasian tectonic plates — one of the planet's most tectonically active environments. Hot springs, mud volcanoes (including some of the world's tallest), fumaroles, and geysers are distributed across Gilgit-Baltistan, the northern Himalayas, Balochistan, Khyber Pakhtunkhwa, and Sindh.

A peer-reviewed survey published in *Renewable and Sustainable Energy Reviews* (2016) documented four major geothermal regions: northern Pakistan and Gilgit-Baltistan (plate margin zone, the highest-temperature resource), northwestern and southern Balochistan (including the Chagai volcanic arc with magmatic waters at 150°C), the Indus Basin and West Sindh (co-produced geothermal waters at 80–170°C from oil and gas wells), and southwestern and northern Punjab. Research by Pakistani geoscientist Javed Ahmad — acknowledged by US experts at the US-Pakistan Clean Energy Business Opportunities Conference in Washington DC in December 2015 — estimated a potential of up to 100,000 MW of geothermal energy across Pakistan's four provinces.³⁶

A more conservative but peer-reviewed estimate (*The Friday Times*, March 2024, citing academic consensus) puts Pakistan's technically exploitable geothermal generation capacity at approximately 15,000 MW — still more than half of Pakistan's peak electricity demand of 25,000 MW recorded in 2020.³⁷

A private 2025 study using the LEAP modelling platform projected that Pakistan's geothermal electricity production could reach 33.12 TWh by 2024 (baseline scenario), rising to 108.15 TWh by 2030 and 364.56 TWh by 2040 under a high-penetration scenario. Investment requirements were modelled at USD 1.07 billion by 2024, growing to USD 3.41 billion by 2030, USD 9.83 billion by 2040, and USD 55.34 billion by 2060.³⁸

The trilemma analysis is stark. Pakistan ranked poorly on all three dimensions of the WEC index in its most recent assessment. Energy security is compromised by dependence on imported fossil fuels that drive the circular debt crisis. Energy equity is devastated by power outages lasting 12–18 hours per day in many regions, combined with electricity tariffs that have doubled since 2020. Environmental sustainability suffers from heavy reliance on furnace oil and coal-based generation. Geothermal, as a domestic, baseload resource, is the single energy technology with the structural capacity to address all three deficits simultaneously.

The constraint is not geological but political and financial. Pakistan's energy governance is fragmented, its regulatory environment for renewables remains unpredictable, and its geothermal legal framework is underdeveloped. The country lacks a dedicated geothermal law, comprehensive subsurface data from exploration, or risk-sharing instruments for early-stage drilling. These are not insurmountable obstacles — they are the normal starting conditions of every geothermal frontier market, from Kenya in the 1970s to Indonesia in the 1990s.

E. Eastern Europe — The Expanding Frontier

In Europe, geothermal's centre of gravity is shifting eastward. As of 2024, Europe had 147 geothermal power plants in operation, producing approximately 20 TWh of electricity from just over 3.5 GW of installed capacity — roughly one-fifth of global geothermal capacity. While Türkiye, Italy, and Iceland dominate output, several Central and Eastern European (CEE) states are emerging as significant markets.⁴⁰

Hungary leads the CEE expansion. The city of Szeged hosts what is described as the EU's largest geothermal heating system — a project that cost approximately €70 million (with €23 million from EU Cohesion Policy) and provides clean energy to over 27,000 households and 400 public buildings. The target: to halve gas consumption, reducing CO₂ emissions by 30,000 tonnes annually. Hungary's national geothermal strategy, adopted in 2024, sets an ambitious 2030 target to double current geothermal capacity to 12–13 PJ, backed by a EUR 25 million risk-mitigation fund and EUR 50 million in interest-free soft loans.⁴¹

A techno-economic analysis by Ember (February 2026) estimated that geothermal power with costs below €100/MWh is technically viable across approximately 50 GW of continental European potential — with Hungary accounting for the largest share at around 28 GW, followed by Türkiye at almost 6 GW. Romania has set out a 5 GW geothermal development plan by 2040 and increased the geothermal share in its district heating mix from 8% to 11%, with a target of 25% within three years. Poland has roughly 200 MW of geothermal district heating capacity with dedicated state financial institution support.

The EGEC (European Geothermal Energy Council) market report for 2024 recorded a record 17 geothermal surveys, compared to only 10 in 2023, with at least 500 district heating and cooling projects under development across Europe. Poland (72 projects) and Hungary (47 projects) are the most active EU member states in project development pipeline.

At the Central European Energy Conference (CEEC) in Bratislava in November 2025, the CEEGEO roundtable on geothermal in CEE identified financing as the decisive obstacle. Developers highlighted that even technically successful projects struggle without risk-sharing tools, long-term visibility, and supportive state-aid schemes. The model identified as exemplary: Poland's National Fund for Environmental Protection and Water Management, which has financed geothermal exploration for nearly three decades.

IV. Investment Landscape: Opportunities and Threats

Trilemma Positioning of Key Corridor States

The following table synthesises available World Energy Council Trilemma Index data and qualitative assessments for the primary countries under study, cross-referenced with geothermal endowment. Note that WEC Index scores involve a time lag in national data collection; the scores reflect WEC 2024 report assessments and associated country data.

Table 1: Energy Trilemma Status and Geothermal Potential — Eurasian Corridor States

Country	Security Rating	Equity Rating	Sustainability Rating	Est. Geothermal Potential	Development Stage
Türkiye	Moderate	Moderate	Improving	33,000 MWt identified; 5 GW power	Advanced / Commercial
Kazakhstan	High (fossil)	Low-Moderate	Poor	~40% territory viable; low-medium temp	Early Exploration
Uzbekistan	Moderate	Low-Moderate	Poor	Moderate; heating focus	Pre-Development
Kyrgyzstan	Low	Low	Mixed (hydro)	Low-medium temp; heating viable	Pre-Development
Tajikistan	Low	Low	Mixed (hydro)	Low-medium temp; heating viable	Pre-Development
Pakistan	Very Low	Very Low	Poor	15,000–100,000 MW (contested)	Nascent / Policy Vacuum
Hungary	Low-Moderate	Moderate	Improving	28 GW techno-economic potential	Scaling / Active
Romania	Moderate	Moderate	Moderate	5 GW plan by 2040	Emerging
Poland	Low-Moderate	Moderate	Improving	200 MW district heating installed	Active / Growing

Note: Security, Equity, and Sustainability ratings are qualitative syntheses based on WEC Trilemma 2024 regional analysis. Geothermal potential figures are from IEA (2024), ESMAP, IFC, peer-reviewed publications, and national reports as cited in this paper.

Investment Opportunity Matrix

Investment opportunities in the Eurasian Corridor's geothermal sector fall into four categories, each with a distinct risk-return profile and timeline.

Table 2: Geothermal Investment Opportunity Matrix — Eurasian Corridor

Category	Geography	Investment Type	Time Horizon	Est. Ticket Size	Risk Level
Power Generation (EGS)	Türkiye, Pakistan (Balochistan), Hungary	Private equity, DFI debt, PPAs	5–10 years to full return	USD 50–500 M+	High→Med
District Heating	Kazakhstan, Kyrgyzstan, Poland, Romania	Municipal bonds, multilateral loans, ODA	3–7 years	USD 20–100 M	Medium
Exploration & Data	Pakistan, Uzbekistan, Tajikistan	Government grants, risk capital, DFI	2–5 years	USD 5–50 M	Very High
Technology Supply Chain	Regional (all countries)	Corporate venture, strategic JVs	2–8 years	USD 10–200 M	Medium

Sources: IEA (2024), IFC, World Bank ESMAP, EGEC, author's analysis.

The Technology Supply Chain Story

One of the most significant corporate developments in the global geothermal industry reflects directly on investment dynamics in the corridor. In September 2025, Baker Hughes announced an award from Fervo Energy to design and deliver equipment for five Organic Rankine Cycle (ORC) power plants at the Cape Station project in Utah — representing approximately 300 MW of clean power. The deal, following earlier awards for subsurface drilling and production technologies, represented a full-supply-chain integration between one of the world's largest oilfield services companies and the leading next-generation geothermal developer.⁴⁸

Baker Hughes CEO Lorenzo Simonelli stated: *"Geothermal power is one of several renewable energy sources expanding globally and proving to be a vital contributor to advancing sustainable energy development."* Baker Hughes VP for Geothermal Ajit Menon — who presented at CERAWEEK 2025 — has described the commercial logic: Baker Hughes has the world's largest installed base of geothermal Electric Submersible Pumps (ESPs), and the entire drilling, fracturing, and downhole technology portfolio of the oil and gas sector translates directly to EGS application.⁴⁹

This matters for the Eurasian Corridor because Baker Hughes and comparable companies (SLB, Halliburton) already have operational infrastructure, workforce, and relationships in the region — particularly in Kazakhstan, Türkiye, and Pakistan — through their oil and gas activities. The pivot to geothermal can proceed through existing corporate networks, dramatically reducing market-entry barriers.

Similarly, Zorlu Energy — Türkiye's largest private geothermal developer, operating the Kizildere complex — has been expanding its knowledge-sharing and technology partnerships. At Geothermal Power 2024 in Brussels, Zorlu's R&D Manager noted that Türkiye holds 11% of global geothermal installed capacity and has the potential to heat up to 5 million households — a vision requiring further private and international capital.

V. Risk Mitigation Architecture

Risk Typology

Table 3: Table 3: Risk Assessment — Eurasian Corridor Geothermal Investment

Risk Category	Primary Geography	Severity	Mitigation Pathway
Subsurface/Reservoir Risk	Pakistan, Uzbekistan, Tajikistan	Very High	Resource risk insurance (e.g., GeoRisk programme); phased drilling with data-gating
Regulatory & Policy Risk	Pakistan, Central Asia	High	IFC/World Bank policy-linked lending; dedicated geothermal legislation; tariff clarity
Currency & Sovereign Risk	Pakistan, Kyrgyzstan, Tajikistan	High	MIGA political risk insurance; USD-denominated PPAs; escrow arrangements
Geopolitical/Supply Chain Risk	Pakistan (China exposure), CEE (Russia)	High	Technology diversification; IEA supply chain cooperation; allied-country DFI
Financing Risk (Drilling Cost)	All corridor states	Medium-High	Public first-loss mechanisms; concessional DFI; grant-funded exploration phases
Environmental (CO2 emissions)	Türkiye (Menderes)	Medium	CarbFix reinjection; resource monitoring; World Bank lifetime emission assessment
Grid Integration Risk	Pakistan, Central Asia	Medium	Baseload geothermal has high capacity factor (>75%) — inherently grid-stabilising
Seismic Induced Risk (EGS)	EGS sites regionally	Low-Medium	Adaptive Traffic Light Protocols (ATLP); regulatory seismic monitoring frameworks

Sources: IEA (2024), EGEC, CATF, World Bank, author's analysis.

The Financing Architecture: Lessons from the Corridor

The most transferable lesson from the corridor's most mature geothermal market — Türkiye — is the effectiveness of long-term, price-certainty support mechanisms. The Turkish government's 2024 update to the geothermal support framework established a fixed-price purchase period of 15 years for geothermal power plants, alongside a domestic contribution margin and additional price for a further 5 years. This provides the long-term cash flow visibility that makes large-scale, capital-intensive geothermal projects bankable.

Hungary's 2024 geothermal strategy demonstrates the risk-mitigation model appropriate for emerging corridor markets: a EUR 25 million risk-mitigation fund covering 50% of drilling costs for unsuccessful wells (and 10% for successful ones), combined with EUR 50 million in interest-free, 20-year soft loans for project development. This model directly addresses the 'valley of death' between exploration and commercialization that kills most emerging market geothermal projects.

For Pakistan and the Central Asian frontier states, the multilateral development bank architecture is the essential first mover. The World Bank Group's ESMAP programme has already provided technical assistance to both Kazakhstan and Türkiye. The IFC's explicit endorsement — through IFC VP Cheikhrouhou's public advocacy — signals that the financial structuring for Central Asian geothermal investment is entering the pipeline. The African Development Bank's GeoRisk programme, which provided first-loss risk cover for Kenyan geothermal development in the 1980s and 1990s and helped build one of the world's most successful geothermal industries, is the institutional blueprint.

VI. The Geothermal Supply Chain: Current State and Future Architecture

Current Supply Chain Configuration

The geothermal supply chain in the Eurasian Corridor is today fragmented, immature, and heavily weighted toward the Türkiye pole. In Türkiye, a domestic supply chain has developed organically alongside the sector's rapid growth. Turkish companies (including Zorlu Energy, Akfen Holding, and Güris) have built integrated competencies from well drilling through to power plant operation. Equipment, however — particularly ORC turbines and downhole ESP systems — is still largely imported from European manufacturers (Turboden, ORMAT) or from Baker Hughes and its affiliates.

In Central Asia and Pakistan, the supply chain picture is essentially a blank canvas. Geothermal-specific equipment is absent. Subsurface data is sparse, and exploration-grade drilling rigs (which must operate at temperatures above 200°C) are not locally available. The available workforce in the region's oil and gas sector — particularly in Kazakhstan, where major international operators have been active for three decades — provides the closest available skill base.

In Eastern Europe, the supply chain is more developed but remains thin outside Germany and Iceland. Poland's growing market is stimulating domestic demand for drilling services and heat exchanger technology. Hungary's new hybrid EGS project — announced in 2025 by state-owned MVM Green Generation — plans to drill to 2,500 metres depth at temperatures of 140–150°C, using novel closed-loop technology.

The Oil and Gas Skill Transfer Opportunity

The single most significant supply chain development globally is the systematic migration of oil and gas expertise into geothermal. At CERAWeek 2025, this theme was central. As Baker Hughes VP Ajit Menon noted (in his public interview with ThinkGeoEnergy), the shale revolution has produced a generation of engineers and service companies expert in horizontal drilling, hydraulic stimulation, and high-temperature downhole systems — all of which apply directly to EGS. The IEA calculates that applying oil and gas best practices to geothermal surface facilities alone

could reduce costs by approximately 15%, with wider adoption of drilling efficiencies through modular, repeatable design providing a further 35% reduction.

For Kazakhstan, Uzbekistan, and Pakistan — all of which have significant oil and gas sectors — this represents a unique supply chain advantage. The same companies (Baker Hughes, SLB, Halliburton) that operate the oil fields can pivot their equipment, personnel, and data infrastructure to geothermal exploration and development. This is not a theoretical proposition: SLB VP Vijay Betanabhatla, who presented at CERAWEEK 2025, has led the company's systematic portfolio expansion from oil services into energy storage and geothermal.

Predicted Supply Chain Evolution (2025–2040)

Table 4: Geothermal Supply Chain Evolution in the Eurasian Corridor — Forecast

Phase	2025–2028	2029–2033	2034–2040
Türkiye	3 GW target; World Bank projects online; EGS pilots in new regions	5 GW installed; export of expertise to Central Asia	Regional technology hub; lithium co-extraction from geofluids
Kazakhstan	New geothermal law enacted; IFC-backed feasibility studies; 2–3 pilot plants	First commercial district heating systems online; 50–100 MW total	Mangyshlak Basin EGS pilots; 200–500 MW potential; O&G supply chain pivoting
Pakistan	Policy framework enacted; World Bank/ADB exploration grants; seismic surveys	First commercial wells in Balochistan/GB; 50–200 MW pilot plants	1,000–5,000 MW buildout; circular debt relief through domestic baseload
Central Asia (ex-KZ)	SECCA/IFC technical assistance; low-temp heating pilots in cities	District heating systems in Bishkek, Dushanbe, Tashkent	Regional grid integration; 200–400 MW total installed
Eastern Europe (CEE)	EU Geothermal Action Plan; Hungary 12–13 PJ target; Romania 5 GW plan	EGS commercial demonstration; Hungary, Poland, Romania scaling	50 GW techno-economic potential partially realised; Russia-gas replacement

Note: Projections are author's synthesis based on IEA (2024), EGEC, ESMAP, IFC, national policy documents, and peer-reviewed literature. They reflect achievable trajectories under supportive policy and financing conditions.

VII. Geopolitical Dimensions: Energy, Power, and the Corridor

The Eurasian Corridor is not merely an economic geography — it is a contested geopolitical space where energy resources, transit routes, and great-power competition intersect. Geothermal energy, as a domestic and non-tradeable resource, inserts a fundamentally different geopolitical logic into this space.

The Post-Ukraine Restructuring

The WEC's 2024 Trilemma Report is unambiguous: the war in Ukraine triggered the world's first consumer-led demand-driven energy shock, and its effects extend well beyond Europe. The European energy security shock has driven rapid expansion of alternative supply routes through the Eurasian Corridor — including the Trans-Caspian pipeline discussions, increased LNG imports, and heightened interest in Azerbaijani and Central Asian gas.⁶⁰

The geopolitical implication for geothermal is counterintuitive but powerful: the more Russia's gas becomes a security liability for its customers, the more domestic energy resources — of which geothermal is a prime example — become strategic assets. This is already playing out in Türkiye, whose government frames its geothermal programme explicitly in energy security terms. It is increasingly salient in Eastern Europe, where any non-Russian heat source reduces structural political vulnerability.

For Pakistan, energy security is inseparable from its broader strategic competition with India and its complex relationship with China. The China-Pakistan Economic Corridor (CPEC) has channelled Chinese investment into Pakistan's power sector, primarily coal-based generation at Thar — reinforcing fossil fuel dependency and adding to the circular debt crisis through high-cost imported fuel. A domestically-sourced geothermal base would fundamentally alter Pakistan's energy security calculus, reducing dependence on both imported hydrocarbons and foreign-financed generation.

The Critical Minerals Co-Benefit

A dimension receiving increasing attention in 2024–2025 discussions — including at Geothermal Power 2024 in Brussels — is the co-extraction of critical minerals from geothermal brines. Lithium, in particular, is concentrated in many high-temperature geothermal fluids. Vulcan Energy's operations in Germany's Rhine Valley are the most advanced example; the EGEC conference featured dedicated discussion of 'geothermal lithium' as a European strategic materials priority under the Critical Raw Materials Act (CRMA).

For the Eurasian Corridor, this co-benefit dimension could be transformative. Türkiye's geothermal brines contain lithium concentrations that, if commercially extracted, would contribute to Europe's critical minerals supply chain. Pakistan's tectonic settings — particularly the Chagai volcanic arc in Balochistan — host hydrothermal systems characteristic of porphyry copper-gold systems that may have lithium-bearing geothermal fluids. Kazakhstan, with its existing mining infrastructure and policy framework for critical minerals, could position geothermal lithium extraction as a revenue-diversification strategy alongside its oil and gas sector.

AI, Data Centres, and the New Demand Driver

One of the most discussed themes at CERAWEEK 2025 was the explosive growth in power demand from artificial intelligence infrastructure. The Rhodium Group estimated that geothermal could supply up to 64% of data centre loads at scale — owing to its ideal combination of 24/7 availability, locational flexibility (once EGS matures), and near-zero marginal fuel cost. At CERAWEEK 2025, as noted by CTVC's post-conference dispatch, technology majors including Meta and Google were actively pursuing geothermal alongside nuclear for data centre supply.⁶²

For the Eurasian Corridor, this represents a new and durable demand driver. Data centre construction is accelerating across Central Asia (particularly Kazakhstan, which is positioning itself as a digital hub), Türkiye (Istanbul is a major regional data centre market), and Eastern Europe (Poland and Hungary are rapidly growing data centre markets). Geothermal, with its baseload and clean-energy attributes, is structurally aligned with the data centre industry's power-purchase agreement requirements: firm, long-term, round-the-clock supply.

VIII. Conclusion: The Corridor at the Crossroads

The Eurasian Corridor is at an energy inflection point. The post-Ukraine security realignment, the technology revolution in subsurface engineering, the IEA's landmark December 2024 geothermal report, and the consensus emerging from CERAWeek 2024 and 2025 all point toward the same conclusion: geothermal energy is no longer a niche technology confined to volcanic zones, but a globally scalable, trilemma-resolving resource whose primary limitations are policy, finance, and data — not geology.

Within this corridor, Türkiye has already demonstrated what is possible: 1,734 MW of installed geothermal power capacity, fourth in the world and first in Europe, built through a combination of private sector dynamism and long-term policy support. Kazakhstan is entering its exploration phase with IFC and World Bank backing. Pakistan sits atop a geological resource of staggering scale — conservatively 15,000 MW of exploitable potential — with a regulatory and financing vacuum that development partners and patient capital can fill. Eastern Europe is scaling rapidly, driven by the imperative to replace Russian gas and enabled by EU financing and regulatory frameworks.

From a Trilemma perspective, the argument is clear. Geothermal advances all three vertices simultaneously in ways that no other energy source can replicate at this geography. It improves energy security through domestic, non-importable supply. It improves energy equity by reducing household heating costs and creating high-quality local employment (34 jobs per MW, by IFC's estimate). And it improves environmental sustainability as a firm, low-carbon, baseload technology that complements intermittent wind and solar.

At CERAWeek 2025, U.S. Energy Secretary Chris Wright crystallized the moment: energy is not a sector of the economy — it is the sector. For the Eurasian Corridor, that truth carries its sharpest weight in a region where energy poverty, geopolitical vulnerability, and climate exposure converge. Geothermal energy offers a path through all three. The investments required are large but finite. The risks are real but manageable. The window of opportunity — as the IEA's trillion-dollar investment projection makes clear — is opening now.

The question is not whether the Eurasian Corridor will develop its geothermal potential. The question is whether it will do so under the governance of its own states and in partnership with aligned development finance — or whether it will once again cede strategic assets to the highest and fastest bidder. That is, in the end, the geopolitical choice at the heart of every energy trilemma.

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