2. First National Geothermal Energy - Geography

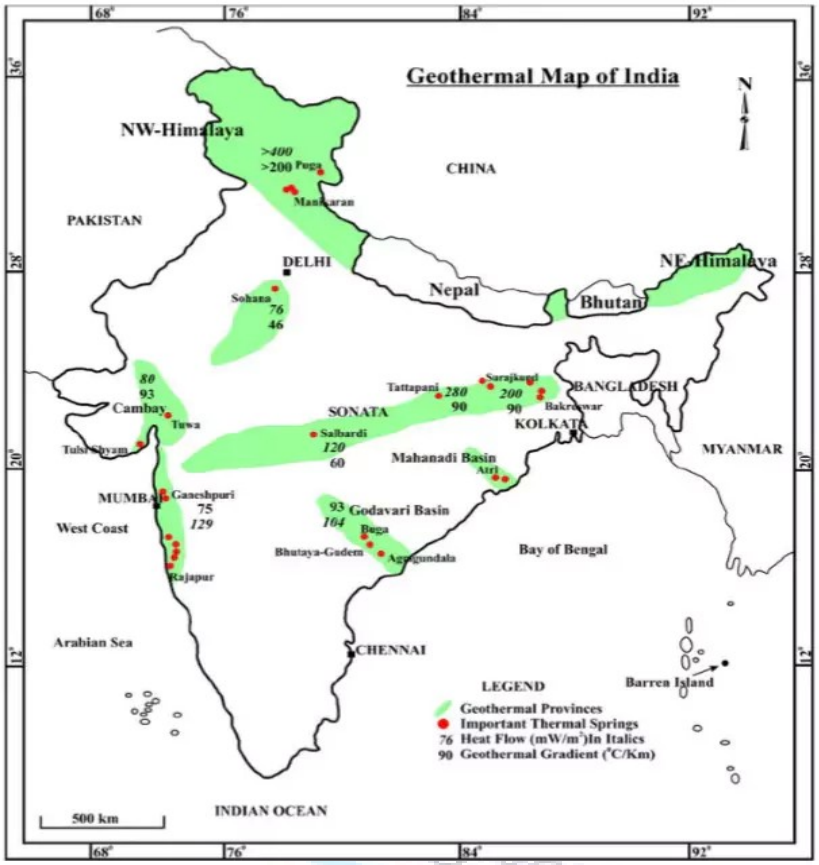
India has launched its first National Geothermal Energy Policy to unlock 10,600 MW of potential, aiming to make geothermal a key source of clean, 24/7 baseload power. The policy offers fiscal incentives, allows 100% FDI, and promotes both electricity generation in high-potential zones and direct-use applications nationwide.

Introduction - A New Frontier in India's Clean Energy Journey

In a landmark move to diversify its renewable energy portfolio, the Ministry of New and Renewable Energy (MNRE) has notified India's first National Geothermal Energy Policy (2025). This pioneering policy aims to unlock the nation's untapped geothermal potential, establishing it as a key pillar alongside solar and wind energy. It provides a strategic roadmap to harness geothermal resources for clean, reliable power, aligning with India's ambitious goal of achieving Net Zero emissions by 2070.

About the National Geothermal Energy Policy (2025)

The policy is designed to create a robust ecosystem for geothermal development, from exploration to end-use applications.



Vision & Goals

Mainstream Geothermal Energy - To integrate geothermal energy into India's mainstream renewable mix, recognizing its potential for providing stable, 24/7 baseload power.

Harness Untapped Potential - To unlock an estimated 10,600 megawatts (MW) of geothermal potential, thereby enhancing national energy security.

Drive Decarbonisation - To use geothermal energy for direct-use applications, such as Ground Source Heat Pumps (GSHPs), to decarbonise buildings, industries, agriculture, and urban infrastructure.

Build a Strong Ecosystem - To foster a vibrant public-private partnership model, promote capacity building, and adopt global best practices in geothermal exploration and development.

Identified Potential and Key Zones

The Geological Survey of India (GSI) has mapped 381 geothermal springs across 10 geothermal provinces.

High-Enthalpy (High Temperature) Zones - Sites like Puga–Chumathang in Ladakh are earmarked for large-scale electricity generation.

Medium/Low-Enthalpy Zones - Regions with moderate thermal gradients, such as the SONATA Basin (Sone-Narbada-Tapti Lineament Zone), are targeted for direct-use applications like greenhouse heating, aquaculture, and industrial processes.

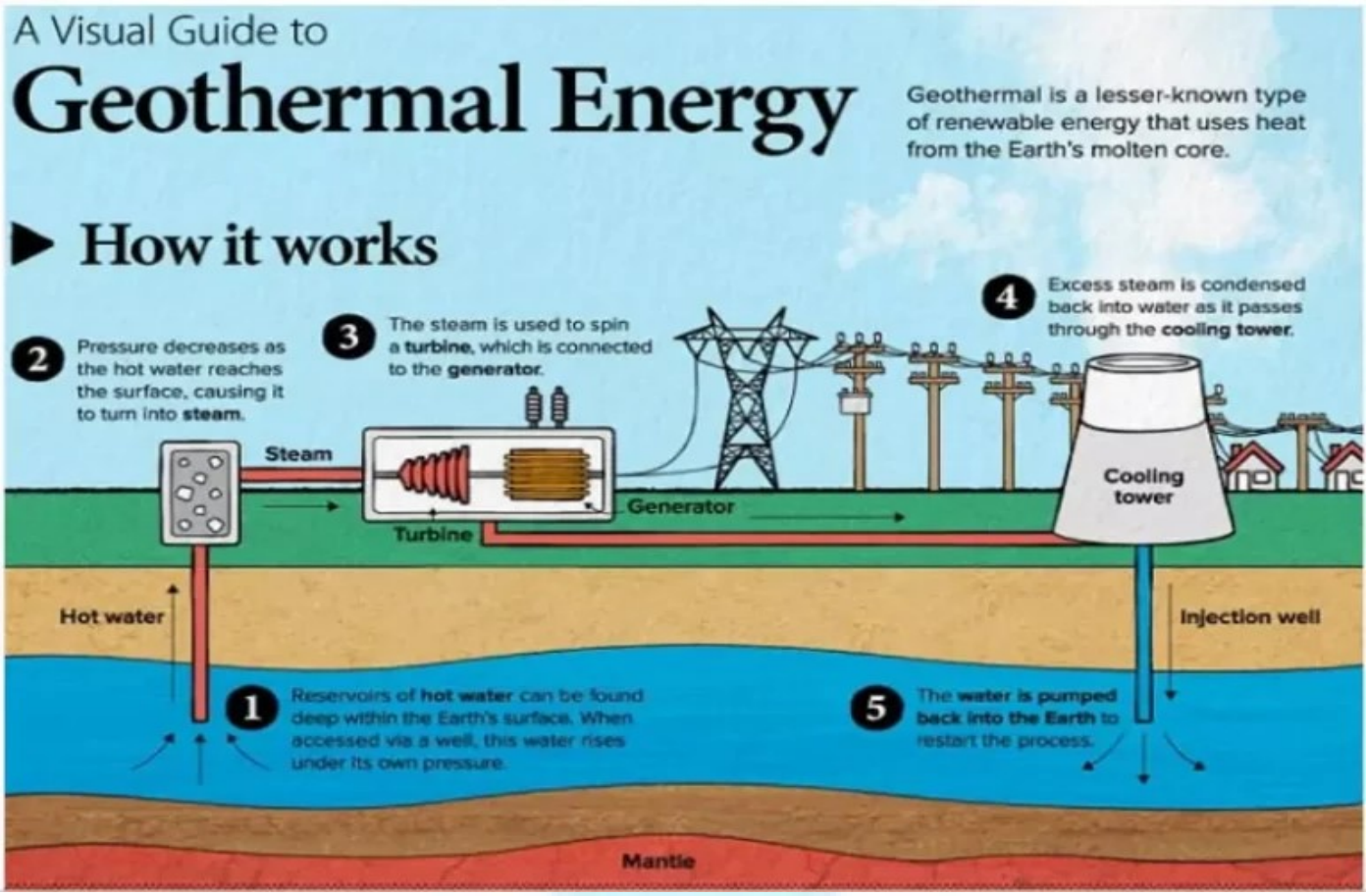
Key Features of the Policy

1. Systematic Exploration - Mandates comprehensive geological, geochemical, and geophysical surveys and the creation of a National Geothermal Resource Repository in collaboration with the Ministry of Mines, DGH, and CSIR-NGRI.
2. Repurposing Idle Wells - Promotes collaboration with ONGC and other petroleum companies to retrofit abandoned oil and gas wells for geothermal energy extraction.

3. Promotion of GSHPs - Encourages the widespread adoption of Ground Source Heat Pumps for efficient, round-the-clock heating and cooling by leveraging shallow ground temperatures.
4. Fiscal Incentives & FDI - Offers a suite of financial de-risking measures, including tax holidays, viability gap funding (VGF), green bonds, and import duty exemptions. It allows up to 100% Foreign Direct Investment (FDI) to attract global capital and expertise.
5. Project Security - Geothermal projects will be supported for a tenure of 30 years, with provisions for extension.
6. Diverse Applications - The policy supports a wide range of direct uses, including cold storage, horticulture, aquaculture, and geo-tourism, to create rural income streams.
7. Mineral Extraction - Allows for the extraction of valuable by-products like lithium, silica, and boron from geothermal fluids, governed by the Mines and Minerals (Development and Regulation) Act, 1957.
8. Environmental Safeguards - Ensures strict compliance with all major environmental laws, including the Environment Protection Act (1986) and the Wildlife Protection Act (1972).

Understanding Geothermal Energy

Geothermal energy is the thermal energy stored within the Earth's crust. Unlike intermittent renewables like solar and wind, it provides a continuous and reliable source of clean power.



Power Generation Technologies

Technology	How It Works	Best Suited For
Dry Steam Plants	Directly uses natural high-pressure steam from underground reservoirs to spin turbines.	High-temperature geothermal fields with existing natural steam. The Geysers in California is a prime example.
Flash Steam Plants	Pumps high-pressure hot water into a low-pressure tank, causing it to rapidly vaporize ("flash") into steam, which then drives turbines.	High-temperature water reservoirs (above 182°C). This is the most common type of geothermal power plant today.

Technology	How It Works	Best Suited For
Binary Cycle Plants	Uses moderately hot geothermal water to heat a secondary fluid (like isobutane) with a lower boiling point. This secondary fluid vaporizes to turn the turbines.	Lower-temperature geothermal reservoirs (below 200°C). This technology allows for power generation from a wider range of geothermal resources.

Global Context - International Precedence & Initiatives

India's policy aligns with a growing global recognition of geothermal energy's role in the clean energy transition.

Global Geothermal Leaders

Country	Key Achievement / Capacity
United States	World leader with the largest geothermal field, The Geysers Complex (California), producing ~1,500 MW. Big Tech is exploring it for powering AI data centers.
Indonesia	Second-largest global producer, leveraging its position on the "Ring of Fire".
Philippines	A top-three global producer, relying on geothermal for a significant portion of its electricity.
Turkey	Top five producer with 2 GW capacity, extensively uses geothermal for district heating and greenhouses.
Kenya	The Olkaria Geothermal Complex (~989 MW) supplies about 40% of the nation's electricity, making Kenya an African leader.
Iceland	Heats nearly 100% of its households with geothermal energy and operates major power plants like Reykjanes (130 MW).
Germany	Fast-tracking geothermal projects to provide reliable baseload power to complement its massive solar and wind capacity.

Global initiatives by IRENA, the World Bank, and the EU Green Deal are further providing financing, technical expertise, and policy guidance to expand geothermal energy worldwide.

Challenges in Harnessing Geothermal Energy in India

Despite its immense potential, India faces several significant hurdles in developing its geothermal resources.

1. **High Upfront Costs & Exploration Risks -** Drilling can be extremely expensive, and there is no guarantee that a well will be commercially viable, leading to high financial risks.
    1. *Example* - The Puga, Ladakh project was halted in 2023 after a wellhead blowout caused by unexpectedly high fluid pressures, highlighting the geological uncertainties.
2. **Remote Locations & Infrastructure Gaps -** Many high-potential sites, like Puga, are in difficult, high-altitude terrain, making infrastructure development and power evacuation costly and challenging.
3. **Regulatory Bottlenecks -** Project timelines are often hampered by delays in land acquisition, environmental clearances, and complex inter-agency coordination.
    1. *Example* - The Cambay JV project in Gujarat stalled in 2012 due to unresolved land-use rights and delays in statutory approvals.
4. **Limited Domestic Expertise -** India currently has a small pool of trained geothermal professionals and researchers compared to its vast solar and wind energy workforce.
5. **Financing Gaps -** Geothermal projects are not yet covered under mainstream green finance mechanisms like Renewable Energy Certificates (RECs), which limits the appetite of private investors.

Way Forward - A Roadmap for Success

To overcome these challenges and successfully implement the new policy, a strategic and focused approach is required.

1. **Establish a Nodal Authority -** Create a National Geothermal Development Board (NGDB) to act as a single-window clearance system.
2. **Enhance Financial Incentives -** Include geothermal energy in the REC mechanism, provide targeted viability gap funding, and offer exploration grants to mitigate upfront risks.
3. **Build Human Capacity** - Develop specialized geothermal engineering courses in premier institutions like the IITs and facilitate on-field training with GSI and ONGC.
4. **Foster Global Partnerships -** Actively collaborate with global leaders like Iceland, Kenya, and Germany for technology transfer and best-practice adoption.
5. **Promote Community Engagement -** Implement benefit-sharing frameworks to ensure local communities are partners in development, minimizing social friction.

Source - https - //www.thehindubusinessline.com/economy/geothermal-push-india-opens-sector-to-100-fdi-incentives-and-jv-partnerships/article70055463.ece