The Future of Geothermal in India

POWERING ECONOMIC GROWTH AND PROSPERITY WITH ABUNDANT DOMESTIC ENERGY

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Powering Economic Growth and Prosperity with Abundant Domestic Energy

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Executive Summary

The Geothermal Opportunity in India

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Geothermal energy can become a cornerstone of India's future energy supply for industrial heat, building cooling, and some electricity generation—enhancing energy security, reducing emissions, and supporting regional equity. And India can position itself at the forefront of the global geothermal boom, creating hundreds of thousands of jobs and ensuring a reliable, domestic, affordable, and clean energy future for generations to come.

From the Himalayas to the Deccan Traps, India's subsurface holds extensive geothermal resources—including some sites with temperatures hot enough to produce electricity and many locations where geothermal could supply cooling for buildings and heat for industrial processes. Perhaps most exciting is that by deploying these abundant direct-use geothermal resources, India could displace coal, oil, and diesel; improve urban air quality; and ease pressure on the grid.

As one of the world's fastest-growing major economies, India faces a dual challenge: sustaining rapid economic development while meeting its commitments to energy security and decarbonization. The government of India has set ambitious goals to achieve energy independence by 2047 and net-zero emissions by 2070 while also ensuring reliable and affordable energy for its population. To accomplish these goals, India needs to diversify its clean energy mix beyond solar, wind, and hydropower and accelerate the adoption of firm, clean energy sources that can provide round-the-clock reliability. The country's geothermal potential can play a key role.

According to the India Climate and Energy Dashboard, industry accounts for roughly 40% of the nation's energy use and households for about 24%.[1] Given the country's rapidly growing cooling demand—and the continued dominance of coal and oil in overall energy use—geothermal offers a major opportunity to meet a good portion of India's energy needs. Many areas facing

GEOTHERMAL APPLICATION POTENTIAL ACROSS INDIA, CLASSIFIED BY APPLICATION TYPE

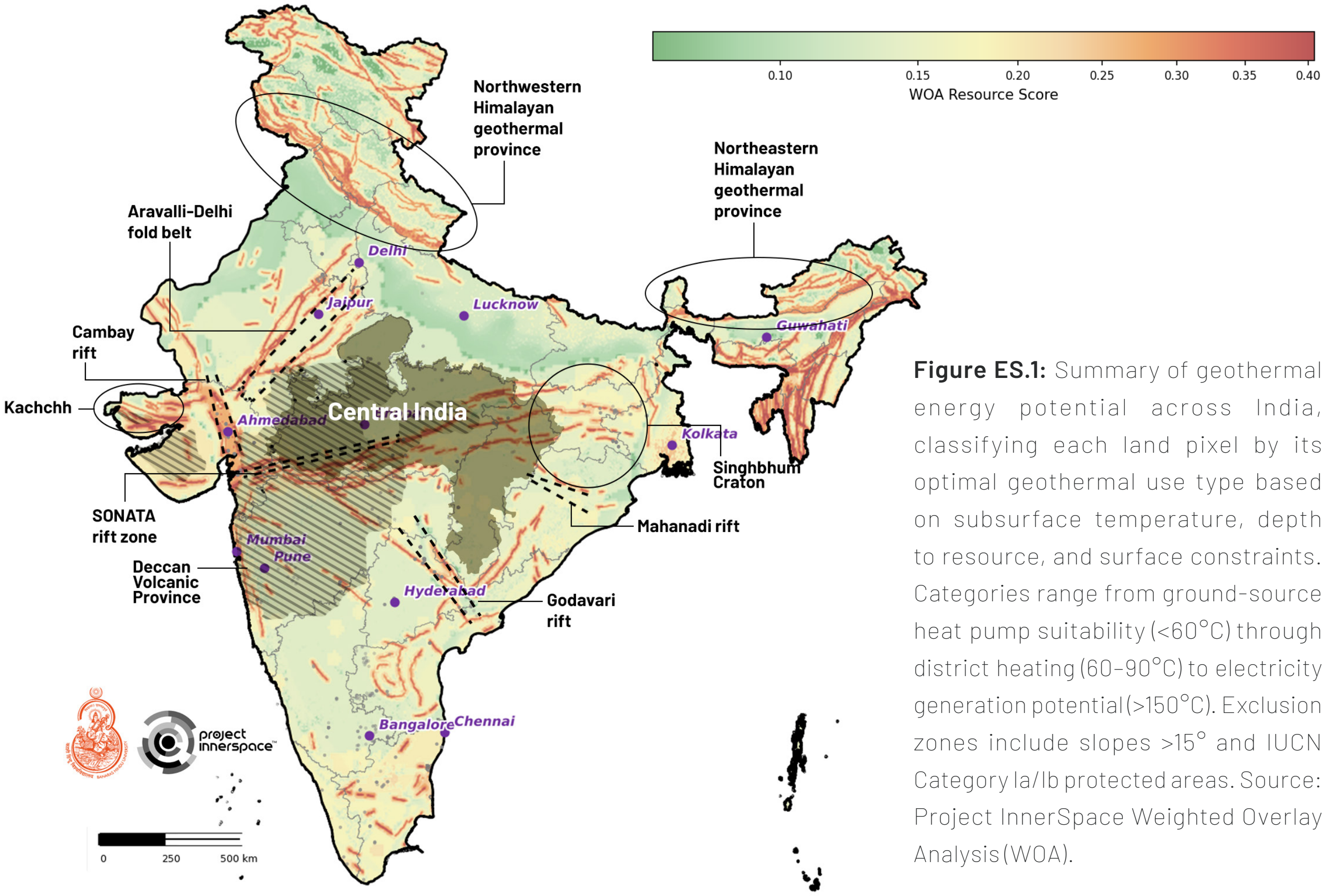


Figure ES.1: Summary of geothermal energy potential across India, classifying each land pixel by its optimal geothermal use type based on subsurface temperature, depth to resource, and surface constraints. Categories range from ground-source heat pump suitability (<60°C) through district heating (60–90°C) to electricity generation potential (>150°C). Exclusion zones include slopes >15° and IUCN Category Ia/Ib protected areas. Source: Project InnerSpace Weighted Overlay Analysis (WOA).

heat stress in India sit on top of geology that is well suited for geothermal cooling.

India's geothermal potential is vast and widely distributed. Project InnerSpace analysis estimates the country has more than 11,000 gigawatts of direct-use industrial heat potential (with a 100°C cut-off temperature down to 3,500 metres) and more than 1,500 gigawatts of geothermal cooling potential. Additionally, India has technical potential for roughly 450 gigawatts of electricity generation (down to 5 kilometres) today and more than 8,000 gigawatts of electricity (down to 7 kilometres) as technology improves. (For more on how these estimates were developed, see Chapters 2, 3, and 4.) This potential means every state could deploy this energy source through electricity, industrial heat, or cooling.

The government has recently published the National Policy on Geothermal Energy, which sets a framework for geothermal exploration, permitting, and pilots. This policy is an important step, but more can be done to move from opportunity to projects. This report identifies areas where geothermal heat, cooling, and electricity can scale first; outlines policy pathways to tap this potential; and highlights environmental, workforce, and legal issues that need to be addressed for the country to ensure that successful and secure projects are built this decade.

Going big on all geothermal applications in India could improve air quality, reduce fuel imports, and—via upskilling and training—create hundreds of thousands of jobs that build on the country's strengths in drilling, geoscience, and engineering. It would also expand access to cooling—a public health and productivity priority—without proportionally increasing electricity demand. As a result, India would strengthen resilience and equity as dangerous heat events become more frequent.

IN SHORT: GEOTHERMAL'S ADVANTAGES AND BENEFITS FOR INDIA

- **Energy security:** As a domestic resource, geothermal reduces dependence on imported fuels, enhances energy independence, and supports critical applications such as data centers.
- **Resilience, reliability, and regional equity:** Geothermal provides continuous, round-the-clock energy and can withstand extreme weather, grid stress, and supply disruptions. Geothermal cooling systems also require less energy, can operate during grid challenges, and can be deployed across much of the country.
- **Local economic and workforce benefits:** Geothermal could create between 350,000 and 700,000 jobs while also increasing economic development in the agricultural industry.
- **Long-term competitiveness:** Direct-use applications reduce fuel consumption by as much as 80%. Technological innovations and competitive levelized costs make geothermal increasingly cost-attractive for industrial heat and baseload electricity.[2,3]
- **Small footprint:** Geothermal facilities require far less space and infrastructure than most other energy sources, including less transmission build-out.
- **Lower emissions and cleaner air:** Geothermal displaces coal, diesel, and furnace oil for power, heat, and cooling, slashing greenhouse gases while sharply reducing sulfur dioxide, nitrogen oxides, and fine particulate matter. As a result, the country could make meaningful progress toward climate targets and immediate air quality and public health gains in cities and industrial corridors.

TODAY'S INDIAN ENERGY LANDSCAPE

Over the past decade, India's electricity sector has changed dramatically. As of September 2025, about 51% of total capacity (more than 255 gigawatts)[4] comes from non-fossil sources—most of it solar and wind.[5] India is decarbonising its electricity system rapidly—yet most industrial heat and process-energy demand (needed to power cooling, industrial drying, and agricultural processing) remains fuel-based,[6] meaning thermal energy continues to be a critical missing piece of the country's clean energy transition. Coal alone contributes more than 91% of the total fossil fuel energy used in India.[7] Geothermal energy is a strong solution for India because it provides clean, reliable, always-available heat in the exact temperature range needed for many industrial, agricultural, and cooling applications. Unlike solar or wind, geothermal delivers steady, 24/7 thermal energy without storage, making it a practical and cost-effective alternative to coal.

At the same time, the demand for energy in India is rising quickly: Peak electricity demand in some regions is growing at between 8% and 10% each year as industrialisation, urbanisation, and cooling loads increase.[8] During severe heat waves in 2024, electricity demand rose by 10.4% compared with the previous year.[9]

SOURCES OF ELECTRICITY IN INDIA AS OF SEPT. 2025

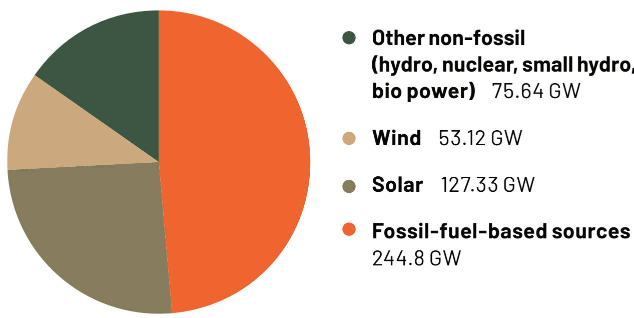
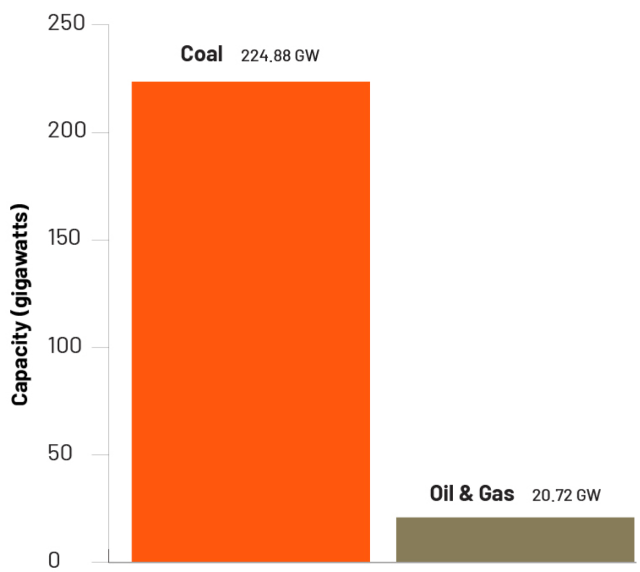


Figure ES.2: As of September 30, 2025, India's total installed power capacity had reached 500 gigawatts (GW), led by non-fossil sources, including just more than 127 gigawatts of solar and 53 gigawatts of wind power, making up 51% of the total, and almost 245 gigawatts of fossil fuel-based sources (about 49%). This marks a strong shift toward renewable energy and energy security. Source: Ministry of Power. (2025, October 29). *India achieved historic milestone in power sector: Surpasses 500 GW and renewable energy generation exceeds 50% of demand* [Press release]. Government of India.

Air-conditioning alone accounted for nearly one-third of that increase. This combination of higher demand and the continued reliance on thermal generation sources to

INSTALLED FOSSIL FUEL ENERGY CAPACITY IN INDIA AS OF OCT. 2025



ES.3: India's thermal energy needs—the heat needed to power cooling, industrial drying, and agricultural processing—remain heavily dependent on fossil fuel, largely coal. Source: INITI Aayog. (2025). *India climate and energy dashboard*.

cater to peak energy demand underscores the urgency for policy, regulatory, and financing innovation. Without taking action now, meeting this projected cooling demand would require an additional 180 gigawatts of conventional generation capacity by 2035, and by 2037, it would generate roughly 810 million tonnes of carbon dioxide equivalent (CO_2e) annually.[10,11]

INDIA'S GEOTHERMAL RESOURCES

India started looking into geothermal energy in the 1970s. When the Geological Survey of India began exploring thermal anomalies, it found 381 geothermal fields with an estimated potential of 10.6 gigawatts of energy, then developed the first *Geothermal Atlas of India*.[12] Despite this resource base, geothermal deployment in India has lagged far behind solar and wind power.[13,14]

To date, India has only piloted direct-use projects and small-scale demonstration plants rather than commercial-scale geothermal electricity generation. As explained in detail in Chapter 2, "Where Is the Heat? Exploring India's

KEY GEOTHERMAL POTENTIAL OF INDIA BY DISTRICT

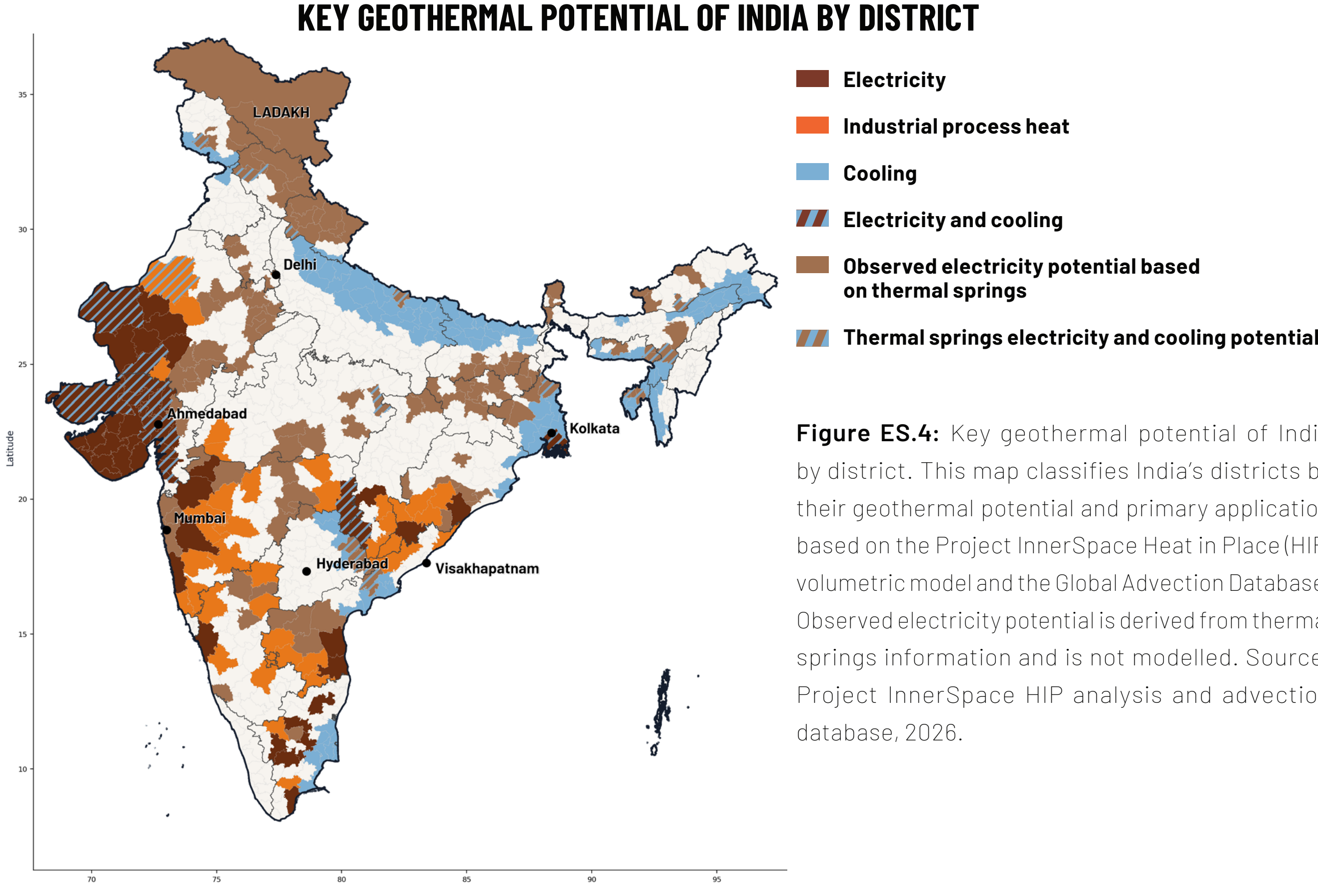


Figure ES.4: Key geothermal potential of India by district. This map classifies India's districts by their geothermal potential and primary application based on the Project InnerSpace Heat in Place (HIP) volumetric model and the Global Advection Database. Observed electricity potential is derived from thermal springs information and is not modelled. Source: Project InnerSpace HIP analysis and advection database, 2026.

Subsurface Geology," India's geothermal resources are predominantly low- to medium-heat, with a small proportion containing high-temperature geothermal resources suitable for electricity generation. With recent advances in technology, the potential areas where India can deploy its geothermal resources are expanding from a few hot spots to broad regions suitable for a range of geothermal applications, as illustrated in **Figure ES.4**.

GEOTHERMAL APPLICATIONS FOR INDIA

Cooling and Heating in Buildings

To tackle the rising demand for air-conditioning, developers should look to geothermal cooling systems. These heating and cooling systems are far more efficient than conventional systems—up to 70% more efficient than a standard heating, ventilation, and air-conditioning (HVAC) system. Ground source heat pump (GSHP) systems harness the Earth's relatively stable shallow subsurface temperature—generally between 20°C and 30°C at depths of between 8 metres and 20 metres across much of India—to serve as a heat sink for cooling via electrically driven heat pumps. And they can be deployed in most regions across India. Geothermal systems can also cut generation and transmission costs and ease peak surges. Paired with solar and batteries, geothermal heating and cooling systems can also operate off-grid during periods of grid stress. Studies in Indian metropolitan areas indicate that GSHPs can reduce electricity use for cooling by between 30% and 40% because they efficiently leverage stable subsurface temperatures.[15] This finding is critical for cities in hot climates such as Delhi, Ahmedabad, Hyderabad, and Chennai, where cooling drives peak electricity demand.

Additionally, geothermal district cooling—systems that function much like utilities that are built to distribute cooling across an area with multiple buildings (see Chapter 1,

GEOTHERMAL COOLING AND HEATING NETWORK

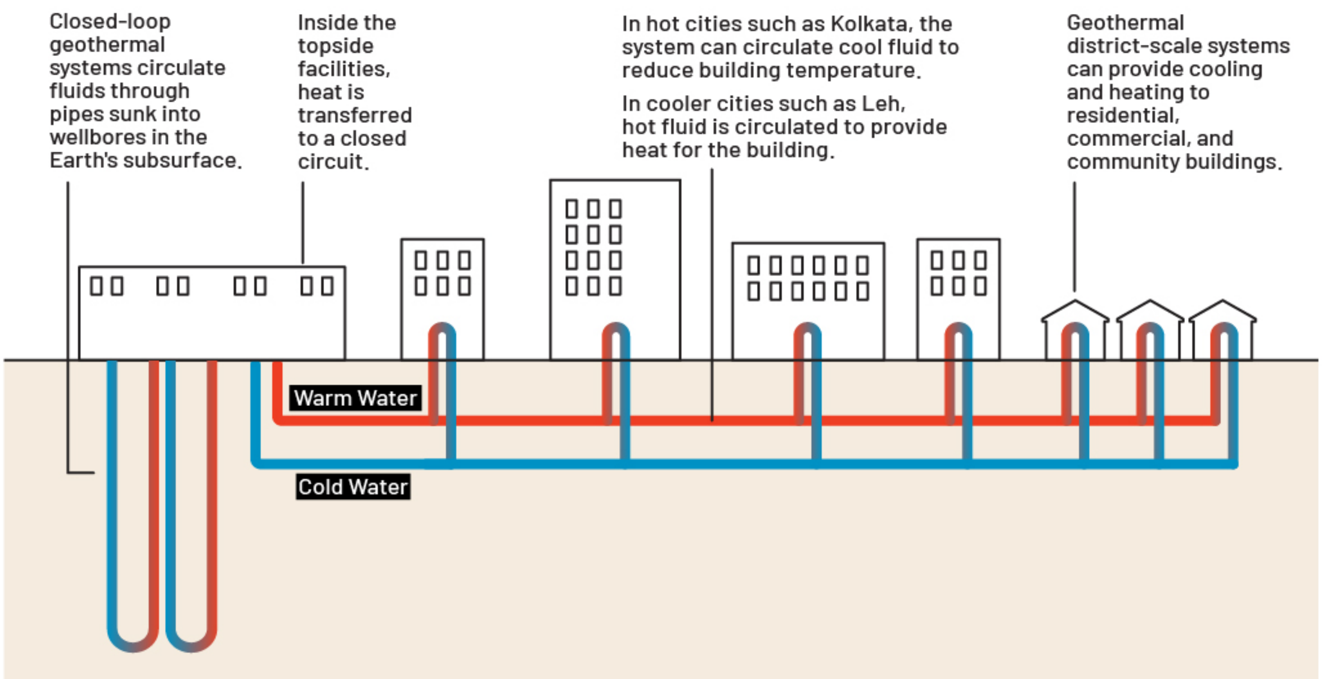


Figure ES.5: In a district cooling system, fluid is typically brought to the surface at a target temperature of around 21°C. That fluid is then passed through a heat pump to provide cold water in the summer for cooling and hot water in the winter for heating. This style of cooling and heating can be more than twice as efficient as traditional HVAC systems as the thermal load is shared between buildings. Source: Adapted from U.S. Department of Energy. *Geothermal district heating & cooling.*

DISTRICTS WITH ALIGNMENT OF AQUIFER COOLING POTENTIAL AND HIGH DEMAND DUE TO EXTREME HEAT

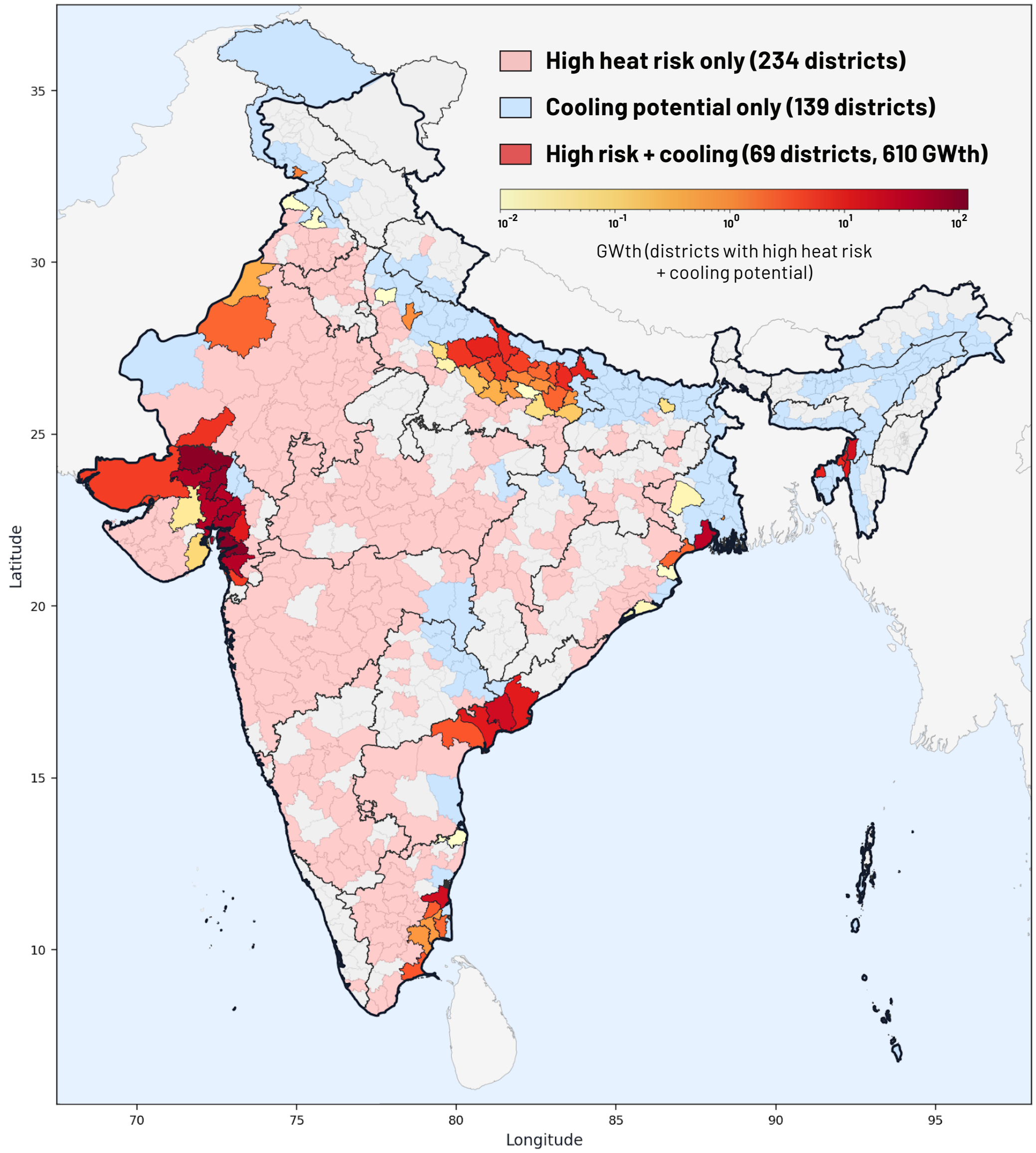


Figure ES.6: The highlighted districts represent areas identified as having both (a) significant geothermal energy potential (in gigawatts [GWth] per pixel ~ 10 square kilometers) in sedimentary aquifers and (b) high or very high heat risk according to the Council on Energy, Environment and Water Composite Heat Risk Index. These zones present optimal conditions for sustainable cooling interventions, offering a strategic opportunity for geothermal-based thermal resilience infrastructure. Source: Project InnerSpace analysis, 2025.

"Geothermal 101: Overview of Actions and Technologies")—is particularly well suited to India's sediment-rich basins, where high-permeability aquifers lie beneath densely populated urban areas experiencing acute heat stress. Chapter 4, "Geothermal Cooling Opportunities," identifies the key areas in India where geothermal aquifer cooling can provide critical relief in the face of extreme heat, with the states of Gujarat, Uttar Pradesh, Tamil Nadu, West Bengal, Tripura, and Meghalaya potentially benefiting the most from district-scale geothermal cooling infrastructure. (See **Figure ES.6**.)

Geothermal district cooling offers a powerful low-carbon alternative that can help India meet its growing and urgent cooling needs—with an estimated 610 gigawatts of total cooling potential in areas at high risk for heat events and a

AARTI INDUSTRIES FACILITY IN JHAGADIA

Figure ES.7: A feasibility study done for the Aarti Industries facility in Jhagadia, Gujarat, illustrates how geothermal could serve as a cost-effective alternative to coal. Source: Aarti Industries.

total capacity of about 1,500 gigawatts across the country. Geothermal cooling can also help increase regional equity by not only increasing access to cooling but also creating jobs in areas that deploy these technologies.

Industrial Process Heat

As mentioned, the industrial sector dominates energy demand in India. Many processes—such as drying, bleaching, pasteurisation, washing, and more—require temperatures between 60°C and 200°C. Geothermal fluids are perfect for processes in that temperature range.[16] Plenty of industrial corridors are located near provinces with strong geothermal resources, including the following:

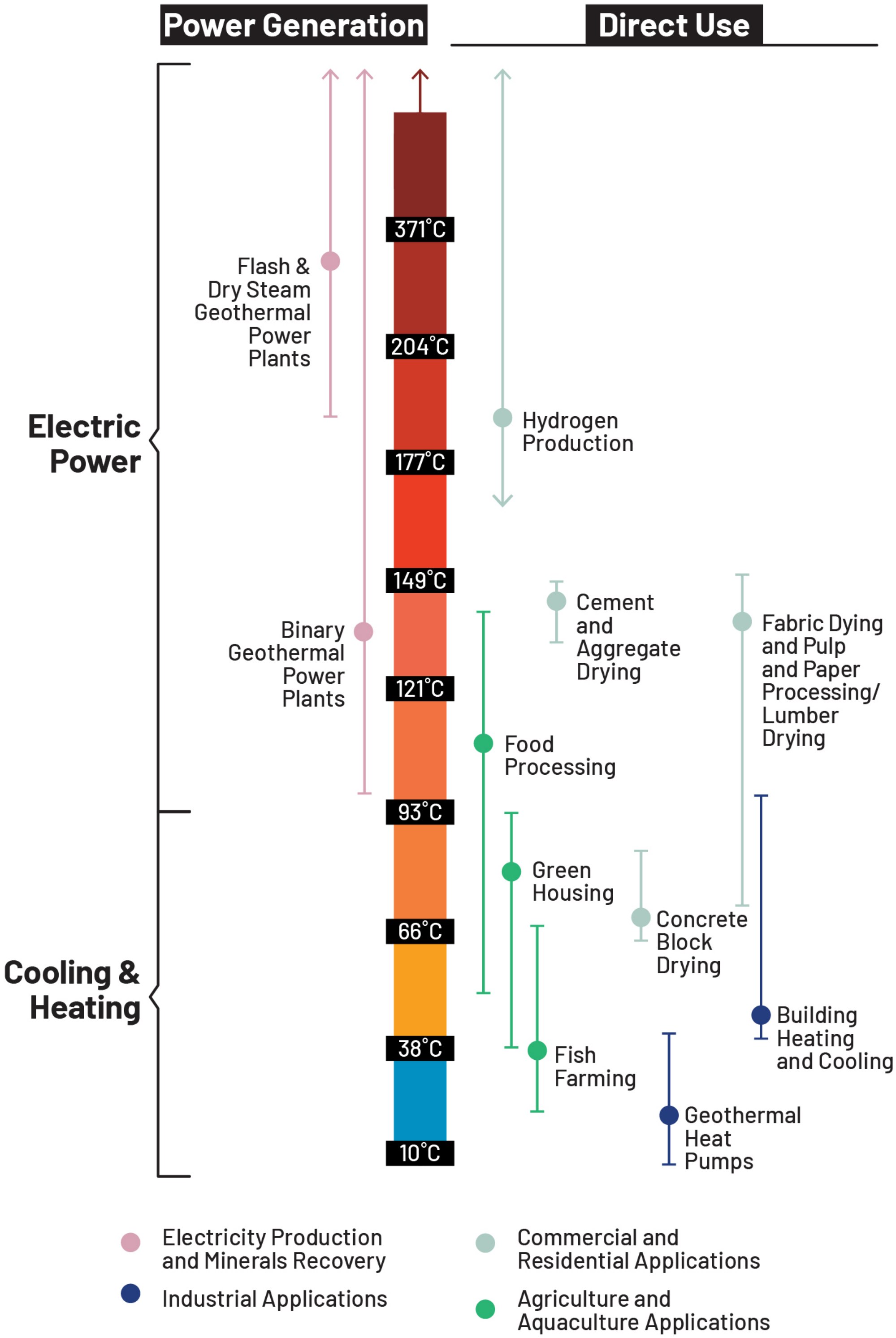
- Textile and chemical industries near Ahmedabad and Ankleshwar, on the Cambay graben in Gujarat.
- Agro-processing and paper mills near Chhattisgarh and Jharkhand, above the Son-Narmada-Tapti (SONATA) lineament zone.
- Food processing and pharmaceuticals in Maharashtra, West Coast Province.

Deploying geothermal heat in these clusters could replace the need for furnace oil, coal, and liquified petroleum gas, reducing both operational costs and carbon emissions. The use of geothermal would generate other significant benefits, such as reduced air pollution, a decrease in carbon dioxide emissions, and more local jobs. A recent feasibility study conducted by Project InnerSpace and Aarti Industries found that geothermal could fully replace high-grade process steam using only 0.8 hectares (approximately 2 acres) of land and a three-well system delivering approximately 200 kilograms per second of 250°C fluid. At between $30 and $35 per megawatt thermal, geothermal steam becomes cost-competitive with coal while offering long-term energy security and savings of millions of tonnes of carbon dioxide. (See Chapter 3, "Direct-Use Geothermal for Manufacturing and Industrial Processes.")

Heat for Agriculture Processes and Cold Chains

Geothermal energy can strengthen India's agricultural industry via greenhouse heating, aquaculture, and crop drying. For example, the geothermal heat below the low-

GEOTHERMAL APPLICATIONS AND TEMPERATURE REQUIREMENTS



ES.8: Geothermal energy can be used for generating electricity, heating and cooling homes and offices, and manufacturing. There are also new and emerging applications such as geothermal energy storage, where the subsurface serves as an earthen battery, and geothermal critical minerals extraction, for rare elements such as lithium. Adapted from Porse, S. (2021). *Geothermal energy overview and opportunities for collaboration*. Energy Exchange.

TAPRI GEOTHERMAL COLD STORAGE PROJECT

Figure ES.9: The Tapri Geothermal Cold Storage Project, an InnerSpace GeoFund portfolio project. Source: Geotropy.

enthalpy fields in Himachal Pradesh, Bihar, and Jharkhand could extend growing seasons, support horticulture, and power cold-storage facilities.[17] Deployment would support India's growing focus on reducing food loss and modernising cold chains. (In Chapter 3, "Direct-Use Geothermal for Manufacturing and Industrial Processes," the author explains how geothermal direct use at the Tapri Geothermal Cold Storage Project facility in Himachal Pradesh can relieve farmers from the challenges of seasonal variability and improve resilience for farming communities. See **Figure ES.9**.)

Electricity Generation

While most of India has low- to medium-temperature resources, a few areas with high temperatures hold promise for electricity generation. (See Chapter 2, "Where Is the Heat? Exploring India's Subsurface Geology.") The Puga Valley in Ladakh has reservoir temperatures of between 220°C and 270°C,[18] which means it could support binary and flash power plants as well as next-generation technologies. Chhattisgarh, Himachal Pradesh, Uttarakhand, Rajasthan, Gujarat, Maharashtra, Madhya Pradesh, Sikkim, Arunachal Pradesh, and Meghalaya also have high-temperature geothermal fields that could support power generation.

Direct Use First: Priorities to Maximise India's Geothermal Resources

The best near-term roles for geothermal in India lie in *thermal applications*—industrial and residential heat, industrial and residential cooling, district energy, and agriculture— with benefits such as the following:

- **Load management for cooling:** GSHPs and district cooling systems can lower peak electricity demand in densely populated cities, easing grid integration challenges. This approach offers a cost-effective alternative to expanding transmission, distribution, and infrastructure in rapidly growing urban areas.
- **Industrial decarbonisation:** Direct geothermal heat can replace fossil fuels for businesses, helping India achieve its net-zero goals. Focusing on micro, small, and medium enterprise clusters located where there are strong geothermal resources would be an effective first step.
- **Improved agriculture resilience**: Geothermal can be used for many agricultural purposes, including extending growing seasons, reducing food loss, and creating economic opportunities in rural areas.

LOWERING GEOTHERMAL COSTS IN INDIA: POLICY AND EMERGING TECHNOLOGY PATHWAYS

Unlocking India's geothermal potential for industrial heat, cooling, and electricity generation will require new policies. Recognizing this need, India recently adopted a National Policy on Geothermal Energy; Chapter 8, "Policy and Regulatory Pathways to Catalyse Geothermal in India," outlines a set of five policy recommendations aimed at accelerating geothermal deployment through rapid implementation of the National Policy on Geothermal Energy and proposes additional ideas for pilot projects, clear government signals, and targeted financial incentives.

Near-term policy priorities could include the following:

1. Establishing national goals and launch a national geothermal cooling mission inside India's Cooling Action Plan—targeting 10 gigawatts of cooling, 50 gigawatts of industrial direct use, and 10 gigawatts of electricity by 2050.
2. Implementing the 2025 National Policy on Geothermal Energy through clear rules, timelines, and transparent permitting.
3. De-risking investment via financial incentives, such as covering about 50% of exploration costs and around 30% of development costs.

POLICY RECOMMENDATIONS TO CATALYSE GEOTHERMAL DEVELOPMENT IN INDIA

Near Term (1-3 Years)

1 — Establish national goals and a national geothermal cooling mission.

India could set national geothermal targets for electricity, industrial heat, and cooling:

- **Electricity:** 200-400 MW of geothermal electricity by 2035, 1 GW by 2040, and 10 GW by 2050.
- **Industrial:** 10 GW of geothermal process heat by 2035, 20 GW by 2040, and 50 GW by 2050.
- **Cooling:** 800-1,000 MW of geothermal cooling by 2035, 3-4 GW by 2040, and 10 GW by 2050, supported by a national geothermal cooling mission under the India Cooling Action Plan.

2 — Implement the 2025 National Policy on Geothermal Energy.

The Ministry of New and Renewable Energy could rapidly operationalise the new policy by:

- directing states to form geothermal nodal agencies;
- launching a single-window clearance system; and
- piloting projects in high-potential regions such as the Himalayas, Cambay Graben, and the Godavari Rift Valley.

3 — De-risk investment through financial incentives.

Introduce exploration and development subsidies (50% and 30%, respectively), tender-based procurement for power and heat, and Production Linked Incentive-style manufacturing incentives for geothermal equipment. Budgetary support of between ₹500 and ₹1,000 could fund R&D and early demonstration projects.

Medium Term (3-5 Years)

4 — Enact a geothermal energy act within the National Renewable Energy Act.

A geothermal energy act would define resource ownership, clarify permitting processes, and establish environmental and safety standards. It would also provide legal certainty for investors and streamline coordination between central and state agencies. While not a prerequisite for progress, such legislation would accelerate deployment and reduce friction across jurisdictions.

5 — Create market demand and awareness.

Governments could introduce thermal consumption obligations that require industries to adopt renewable heat; integrate geothermal into public procurement; and expand capacity-building programs for micro, small, and medium enterprise clusters and state energy departments.

Figure ES.10: Policy recommendations to catalyse geothermal development in India. Source: the authors.

Longer-term measures could include the following:

4. Enact a geothermal energy act within the National Renewable Energy Act.
5. Create market demand and awareness.

Geothermal development is capital-intensive. Exploration and drilling often account for between 40% and 60% of a project's costs—and returns are uncertain until wells are proven. This issue is one of the main reasons why India's geothermal installations are still in the pilot phase, despite all of the nation's subsurface resources. The policy recommendations in this report are intended to move pilots to projects.

Alongside policy reforms, technological progress and an increase in domestic project data will be critical to lowering costs. India's few geothermal deployments are currently concentrated in remote sites that are geologically difficult when it comes to electricity generation. As a result, historical costs are not representative and should not be used as proxies for large-scale planning across all geothermal applications.

However, insights from more advanced geothermal markets show what is achievable. Emerging technologies—largely from the oil and gas sector—such as improved reservoir stimulation, modern well completion methods, and advanced thermal resource management are already reducing costs around the world.[19,20,21, 22] Recent results from Fervo Energy in the United States demonstrate significant cost improvements. Between 2022 and 2024, the costs for a well dropped by nearly half, and the time it took to drill a well fell by almost 70%.[23,24]

Advances in directional drilling, artificial intelligence (AI)–assisted site characterisation, and improved drilling fluids are similarly shortening timelines and reducing risk in the United States and Europe. These results provide a strong indication of how India can bridge its technology gaps and improve performance, especially for medium-temperature resources. More domestic deployment builds expertise and reduces costs.

The policies outlined in this report are designed to help reinforce one another and to catalyse projects, thereby reducing costs quickly. Taken together, the five recommendations in the report can support India's pursuit of energy independence, economic competitiveness, and climate resilience, helping the country meet its growing energy needs while contributing to its commitment to achieve net-zero status by 2070.

OTHER CONSIDERATIONS FOR GEOTHERMAL DEPLOYMENT IN INDIA

Building a Skilled Workforce

With each megawatt of installed capacity in geothermal, between 5 and 10 employees are needed along the value chain.[25] Thus, reaching the geothermal goals laid out in Chapter 8, "Policy and Regulatory Pathways to Catalyse Geothermal in India," could create between 350,000 and 700,000 jobs. India already has a strong oil and gas industry; fortuitously, many of the skills those workers possess are applicable to geothermal. But while many existing engineering skills can be transferred to geothermal projects, to meet the goals outlined in this report, Indian workers will still need to develop some specialised knowledge in areas of geothermal exploration, drilling, and resource management. Not having enough engineering expertise may be the biggest bottleneck that could prevent India from achieving its geothermal potential. Vocational institutes and academic programmes can bridge these gaps by updating curricula, developing new training programs, collaborating with other academic institutions, and supporting industry-led initiatives, as noted in Chapter 5, "Leveraging Oil, Gas, and Mining Technologies and Workforce to Advance Geothermal in India." Seventy-five percent of oil and gas industry respondents surveyed for Chapter 5 said they expect geothermal development to increase employment in technical fields such as drilling, maintenance, plant operations, exploration, reservoir engineering, construction, equipment manufacturing, environmental monitoring, power plant operation, maintenance, and more.

TRANSFERABLE SKILL SETS FROM THE OIL AND GAS INDUSTRY

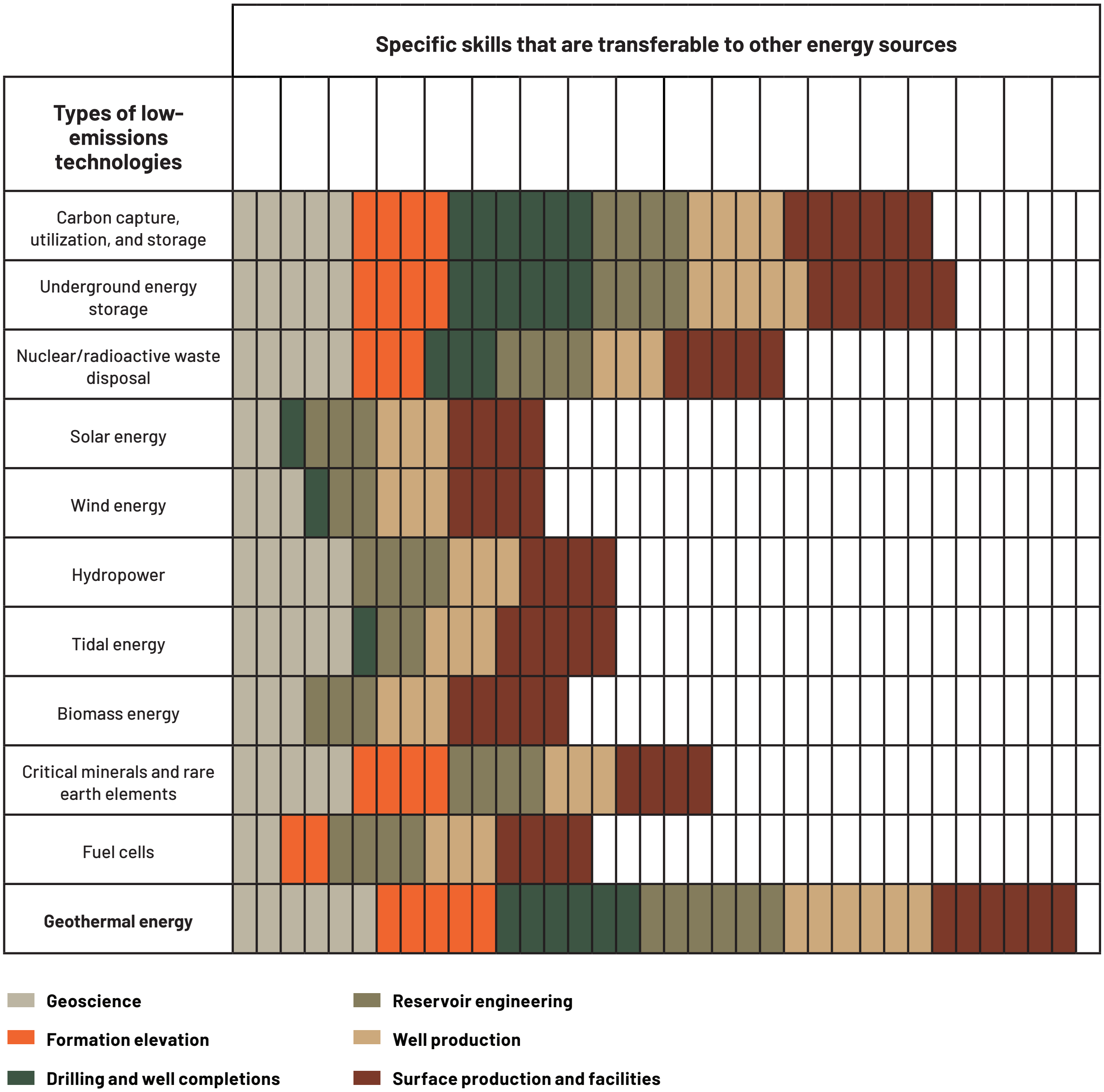


Figure ES.11: As shown, geothermal ranks highest when considering the potential impact of transferring oil and gas skills into other energy transition and low-carbon technologies. Source: Tayyib, D., Ekeoma, P. I., Offor, C. P., Adetula, O., Okoroafor, J., Egbe, T. I., & Okoroafor, E. R. (2023). *Oil and gas skills for low-carbon energy technologies*. Society of Petroleum Engineers Annual Technical Conference and Exhibition. San Antonio, TX, United States.

COMPANIES OPERATING IN INDIA'S OIL, GAS, AND MINING SECTORS

Operator Companies	Service Companies
Oil and Natural Gas Corporation Limited (ONGC)	Schlumberger (SLB)
Oil India Limited (OIL)	Baker Hughes
Coal India Limited (CIL)	Halliburton
GAIL (India) Limited	Seros
Bharat Coking Coal Limited (BCCL)	Revata Engineering
Indian Oil Corporation Limited (IOCL)	Global Drilling Fluids and Chemicals Limited
Bharat Petroleum Corporation Limited (BPCL)	Catalyst Drilling Fluids
Hindustan Petroleum Corporation Limited (HPCL)	Lotus Tricone Drill Bits
Cairn Oil & Gas (Vedanta Limited)	Gpak Offshore Services Private Limited
Reliance Industries Limited	Bergzest Energy Private Limited
Essar Oil and Gas Exploration and Production Limited	Interface Gas Consultants Private Limited
Shell	Stratom Energy Solutions
ExxonMobil	Encode Net Ventures Private Limited
Chevron	Petrosh Energia
BP	SAZ Oil

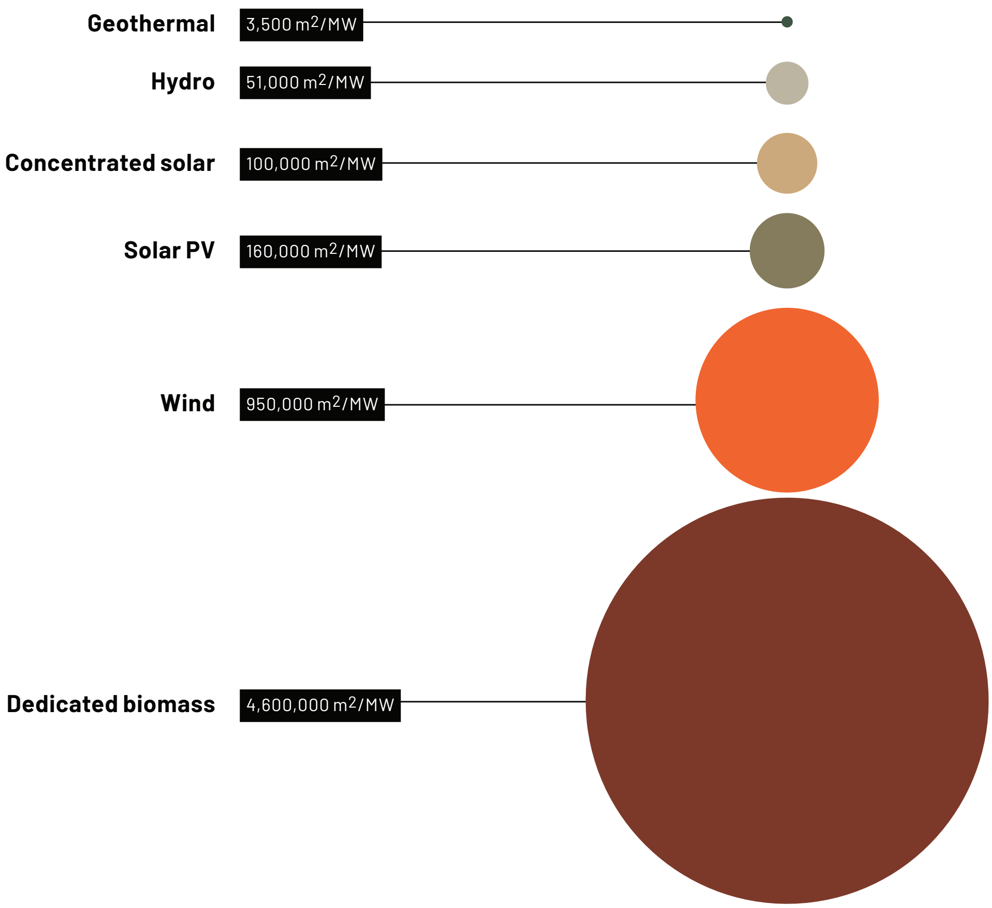
Figure ES.12: Operator and oil field service companies in India's oil, gas, and mining sectors. Source: Raj Kirana, Subsurface Energy and Storage Systems Lab, Department of Petroleum Engineering, Indian Institute of Technology (Indian School of Mines), Dhanbad.

Environmental Benefits and Management

Geothermal energy offers substantial environmental benefits. It produces little to no carbon dioxide, methane, or other pollutants. It is a powerful tool for reducing India's harmful emissions and air pollution. Compared with coal-fired power plants of similar size, geothermal plants can cut sulfur emissions by up to 97% and carbon dioxide emissions by up to 99%.[26] Geothermal facilities also have a smaller land footprint than any other renewable energy source, which helps protect natural landscapes and wildlife habitats. These facilities also use significantly less water than oil, gas, or coal—an important advantage in water-stressed regions of India.

At the same time, geothermal development requires careful environmental management. Risks include the potential for induced seismicity (earthquakes) from deep drilling and the improper discharge of drilling-related contaminants into water sources. These concerns are especially important in ecologically sensitive areas such as the Himalayas. Chapter 9, "Environmental Benefits and Considerations in India: Balancing Renewable Expansion and Ecological Stewardship in the Geothermal Sector," outlines recommendations for responsible and ethical geothermal development tailored to India's unique environments. Overall, with appropriate safeguards, expanding geothermal energy in India represents a major net environmental benefit.

COMPARING SURFACE FOOTPRINT



Geothermal has the smallest footprint of any renewable energy source

Figure ES.13: The project surface footprint, acre for acre for 1 gigawatt of generating capacity, is smallest for geothermal compared with other renewables and coal. PV = photovoltaic. Source: Lovering, J., Swain, M., Blomqvist, L., & Hernandez, R. R. (2022). Land-use intensity of electricity production and tomorrow's energy landscape. *PLOS ONE*, *17*(7), e0270155; National Renewable Energy Laboratory (NREL). (2022). *Land use by system technology*.

CONCLUSION: SEIZING INDIA'S GEOTHERMAL OPPORTUNITY

As this report highlights, India sits on a vast and diverse geothermal resource base—from the high-temperature fields of the Himalayas to low- and medium-temperature systems across central and western India. These resources can support a wide range of valuable geothermal applications, from industrial heat, district heating and cooling, and agricultural processing to electricity generation in select high-temperature zones. By leveraging this potential, India can address both non-electric energy needs and firm renewable power requirements, complementing its solar- and wind-heavy energy system.

India's renewable energy targets include achieving 500 gigawatts of non-fossil fuel capacity by 2030—and energy independence by 2047.[27] To meet these goals, India can and should bring additional resources to the energy mix. Adding geothermal—with its continuous, low-carbon baseload power source—can make all the difference.

India can turn its geothermal potential into real projects. Policymakers, researchers, industry, and communities can align to advance exploration, modern drilling, a trained workforce, and clear and efficient rules. With that coordination, costs will fall, risks will shrink, and deployment can accelerate at the scale India needs.

By embracing this opportunity, India can make geothermal energy a cornerstone of its clean energy transition—enhancing energy security, reducing industrial emissions, and supporting regional equity. And the country can position itself at the forefront of the global geothermal transition, ensuring a reliable, domestic, affordable, and low-carbon energy future for generations to come.

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