

Decarbonizing India's Power Sector

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Giving Green

Table of Contents

Table of Contents **1**
Summary **2**
Background **4**
Pathways to Decarbonize India's Power Sector **6**
Clean Energy Supply Expansion 6
Grid Flexibility and Resilience 9
Clean Energy Demand Growth 12
Assessment of Philanthropic Sub-Strategies **15**
Theory of Change for Philanthropic Engagement **20**
Evaluating Key Assumptions 22
Cost-Effectiveness of Decarbonizing India's Power Sector **24**
Is There Room for More Funding? **26**
Are There Major Co-Benefits or Potential Risks? **28**
Co-Benefits 28
Potential Risks 29
Key Uncertainties and Open Questions **30**
Bottom Line and Next Steps **31**
Acknowledgments **32**

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Questions and comments are welcome at hello@givinggreen.earth.

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Summary

- **Why is India's power sector decarbonization important?**

  India contributes roughly 8.2% of global emissions as the world's third-largest emitter after China and the United States. India's emissions are projected to grow from 4.3 billion metric tons of CO_2-equivalent (tCO_2e) to 6.1 billion tCO_2e by 2050 under a business-as-usual scenario. Electricity generation alone is responsible for about half of India's emissions.

  Given India's development trajectory as a rapidly growing economy, accelerating its power sector decarbonization is essential to avoiding long-term lock-in to high-emission pathways and providing a leading example for other low- and middle-income countries (LMICs) seeking a similar development trajectory.

- **How could efforts to support India's power sector decarbonization reduce greenhouse gases?**

  Reducing power sector emissions in India will require the simultaneous scaling of clean energy capacity and the strengthening of grid infrastructure to ensure that generated power is effectively utilized. Electrification in the industrial sector is also critical to ensure that clean energy deployment delivers additional and durable emissions reductions.

- **What do our findings suggest are the most promising philanthropic pathways for reducing power sector emissions in India?**

  Based on our evaluation of scale, feasibility, and funding need, we think the most promising philanthropic sub-strategies center around:

  1. Advancing research and pilots to derisk underexplored deployment models, technologies, and geographies for scaling clean energy
  2. Providing technical assistance to state utilities with policy design and planning to strengthen, expand, and modernize the power grid
  3. Providing technical assistance and capacity building support to state governments and institutions for energy transition planning and implementation
  4. Supporting research and pilots to accelerate adoption of electrification measures in the industrial sector

- **Is there room for more funding?**

  We estimate that efforts to reduce India's power sector emissions receive an average of $45 million USD in foundation funding per year, equivalent to 8% of total global philanthropic funding by foundations for power sector decarbonization.

Total public and private climate finance for India's power sector stands at roughly $24 billion annually, only 9% of the estimated $274 billion required each year to decarbonize the sector and achieve India's goal of net-zero emissions by 2070.

Based on this funding data, we think efforts to reduce India's power sector emissions are severely underfunded.

- **Are there major co-benefits or potential risks?**

  Power sector decarbonization in India offers meaningful co-benefits around energy access and security, air quality, and job creation. At the same time, a poorly managed transition could not only hinder progress on livelihoods, health, and economic mobility for vulnerable communities but also reverse development gains by limiting access to affordable, reliable, and clean energy.

- **What are the key uncertainties and open questions?**

  The most significant risk to decarbonization in India is a political retreat from climate action if it is perceived to be in conflict with development and economic progress. We have medium certainty about the feasibility of targeted distribution company (DISCOM) reforms, as well as the pace of adoption and scalability of economic diversification strategies. We are also uncertain about the pace at which offshore wind, nuclear, and geothermal energy will become viable at scale in India.

- **What is the bottom line, and what are the next steps?**

  India's power sector decarbonization is among the highest-leverage opportunities in global climate philanthropy, yet it remains significantly underinvested.

  Given the growing relevance and the magnitude of impact of India's power sector on global emissions, and the extent to which it remains underfunded, we think it is important to direct more philanthropic funding toward supporting India's power sector decarbonization.

  We recommend that philanthropists consider funding organizations that are working to address the challenges outlined in this report and consider grants aligned with the strategies we have laid out.

  The findings in this report will inform the grantmaking strategy for the Giving Green Fund and our list of Top Climate Nonprofits. Therefore, donors interested in progressing this work can choose to donate directly to the Giving Green Fund.

Giving Green has conducted the following cost-effectiveness analysis related to this strategy: Cost-Effectiveness Analysis of Integrated Grid Modeling in India

Background

As the most populous country in the world, **India is the third-largest contributor to greenhouse gas emissions, accounting for roughly 8.2% of annual global emissions or approximately 4.3 billion tCO_2e.**[1] These emissions are expected to continue rising as the economy grows, with **electricity demand alone projected to quadruple by 2050**.[2] At the same time, India's per capita emissions remain among the lowest of any major economy at around 3 tCO_2e per person, less than half the global average of 6.6 tCO_2e.[3] This contrast highlights the central challenge of balancing development priorities with decarbonization.

The power sector accounts for roughly half of the country's CO_2 emissions as well as greenhouse gas emissions, making it the primary lever for reducing emissions.[4] In recent years, India has demonstrated strong progress on renewables, ranking third globally in installed renewable energy capacity, with commitments to achieve 500 GW of clean energy capacity by 2030 that are currently on track.[5] Decarbonizing the energy system is also central to India's economic development vision, Viksit Bharat.[6] Scenario modeling by NITI Aayog underscores that reliable, affordable, and progressively cleaner electricity is essential to improving living standards while enabling a transition to net-zero emissions by 2070.[7]

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[1] "With a share of approximately 8.2% in the total global emissions (53.2 $GtCO_2e$) in 2024, India is the third largest emitting economy after China and the United States." Crippa et al., 2025, p. 21

[2] Based on 1,541 TWh in 2024 to 6,544 TWh in 2050 in Table E.1: A snapshot of power sector by 2050 and 2070. NITI Aayog, 2026. "The study estimates that the grid electricity generation need is likely to increase fourfold [...] driven by continued economic growth, strong industrialization, urbanization, rising per capita income, and the emergence of new demand drivers." TERI, 2024

[3] "India's per-capita emissions (3.0 t CO2eq/cap in 2024) are six times lower than those of the United States and Russia, four times and three times lower than those of China and the EU27 and two times lower than those of Brazil" Global per capita emissions sources from Table 1: 2024 GHG emissions ($MtCO_2$ eq), shares in global emissions, changes relative to 2023, emissions per capita (tCO_2 eq/cap), and CAGR (1990-2024) (%) Crippa et al., 2025, p. 21

[4] "The transition of the power sector in India is of particular importance given that it contributes to approximately 50% of the country's CO_2 emissions." TERI, 2024; India's power sector emitted 2.2 billion tCO_2e based on 2024 data from EDGAR's consolidated spreadsheet with 'Annual GHG emissions by country and sector [1970-2024]'. Crippa et al., 2025

[5] "India ranks third globally in Renewable Energy Installed Capacity" Ministry of New & Renewable Energy, 2026; "Govt. of India has set a target for establishing 50% cumulative electric power installed capacity from non-fossil fuel-based energy resources by 2030." Ministry of Power, 2023

[6] Viksit Bharat 2047 is the Government of India's ambitious vision to transform the nation into a fully developed nation by 2047, marking the 100th year of independence.

[7] NITI Aayog serves as the apex public policy think tank of the Government of India, and the nodal agency tasked with catalyzing economic development and fostering cooperative federalism through engagements with state governments in the policymaking process. NITI Aayog conducted a scenario-based modeling exercise integrating India's economic growth, development priorities, and climate commitments to support long-term policy planning. Press Information Bureau, Government of India, 2026

Despite this progress, several structural barriers continue to constrain the pace and scale of the transition. On the supply side, renewable energy capacity is concentrated in a few resource-rich states requiring long-distance transmission to demand centers, straining the transmission infrastructure.[8] At the same time, expansion of utility-scale renewables is likely to become progressively more difficult as land and transmission constraints intensify.[9] On the integration side, grid infrastructure has emerged as a critical bottleneck. Transmission and distribution companies face persistent financial and operational constraints that limit storage deployment, restrict open access markets, and slow the integration of new renewable energy capacity.[10] On the demand side, electrification remains limited, particularly in the industrial sector.[11]

These challenges are amplified by uneven progress on power sector decarbonization across states, with strong variation in policy support, regulation, and resource allocation. While national policy direction is strong, subnational action remains concentrated in states with more developed markets and regulatory environments.[12] Despite their central role in tariff design, procurement, and power planning, state governments, regulators, and state-owned utilities often lack the capacity and support needed to accelerate progress.[13]

Addressing these constraints requires a coordinated approach that strengthens both systems and institutions. Key priorities include diversifying the energy mix, building the regulatory and institutional support for grid modernization, expanding transmission infrastructure, reforming distribution systems, reducing risks associated with industrial electrification, and strengthening the capacity of state governments, regulators, and implementing agencies.

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[8] "India's RE generation is concentrated in a few states—Rajasthan, Gujarat, Tamil Nadu, Karnataka, Maharashtra, and Andhra Pradesh—which collectively account for the bulk of the country's solar and wind capacity. However, demand centers like Delhi-NCR, Uttar Pradesh, Punjab, Haryana, West Bengal, and Bihar are located far from key generation hubs." IFRI, 2025; "The growing concentration and scale of renewable energy capacity in a few regions are creating congestion in key transmission corridors." EMBER, 2026

[9] "Population density significantly limits the realization of India's RE potential, with only 29% of onshore wind potential and 27% of solar potential located in areas with a population density lower than 250 people/km²." CEEW, 2024

[10] Open access markets allow commercial and industrial consumers to directly procure electricity from independent power producers instead of DISCOMs exclusively. JMK & IEEFA, 2022

[11] "India's industrial sector accounts for nearly 49% of the nation's total final energy consumption, yet only 18.7% of this comes from electricity" GGGI, 2025

[12] "West and Central India dominate the renewable energy landscape(..)The region hosts major renewable energy parks and benefits from well-developed transmission infrastructure connecting generation sites to consumption centers. Favorable state policies and streamlined approval processes accelerate project implementation across these states." IMARC Group (accessed July 2026)

[13] "While the central government sets broad policy direction, the decisive levers—tariff setting, procurement approval, grid planning, and market access—reside with state-level regulators." ORF, 2026; In the context of India's power sector, a *tariff* is a regulatory and pricing framework governing the cost consumers incur for their electricity consumption.

Pathways to Decarbonize India's Power Sector

Summary of key pathways to reduce power sector emissions in India

- **Clean energy supply expansion:** India's clean energy deployment remains concentrated in a limited number of geographies and relies heavily on utility-scale solar and onshore wind. Scaling clean energy supply requires deploying renewables in underserved regions, enabling new electricity delivery models, and advancing emerging technologies.
- **Grid flexibility and resilience:** Rapid growth in renewable capacity and electricity demand is outpacing the expansion and modernization of India's transmission and distribution systems, limiting the integration and utilization of clean power. Strengthening grid planning, transmission infrastructure, storage integration, and DISCOM capacity will be critical to reliably absorb and deliver increasing volumes of clean electricity.
- **Clean energy demand growth:** Alongside an increase in clean energy supply, accelerating demand for clean electricity will be critical to enable decarbonization of end-use sectors. India's industrial sector remains heavily reliant on conventional energy, with relatively low levels of electrification. Hence, demand growth will require greater adoption of electrification measures, particularly in the industrial sector.

We prioritize all of the above pathways given their interdependent and synergistic nature, with a cross-cutting focus on strengthening subnational and state-level capacity to accelerate progress in India.

Clean Energy Supply Expansion

India will need to substantially scale clean electricity generation to meet its rising energy needs while staying on a net-zero trajectory. NITI Aayog estimates suggest that clean energy capacity, particularly renewable capacity, must increase from around 283 GW today to nearly 3,000 GW by 2050 to align with a net-zero trajectory, implying a tenfold expansion over the next two decades.[14] Current growth is driven largely by utility-scale

[14] Table E.1: A snapshot of the power sector by 2050 and 2070. NITI Aayog, 2026; "So far, a total of 283.46 GW of capacity from non-fossil fuel sources has been installed in the country as on 31.03.2026" Press Information Bureau, GoI, 2026

solar and onshore wind in a few resource-rich regions, supported by favorable economics and policy incentives. However, the next step change in scaling clean electricity capacity will require diversification across several dimensions where current progress remains limited.

Geographic distribution: Despite accounting for roughly 40% of national electricity demand and emissions, five states—Rajasthan, Gujarat, Maharashtra, Karnataka, and Tamil Nadu—account for over 66% of India's installed renewable capacity, while other regions with comparable resource potential remain underleveraged.[15] Although India operates a unified national grid, this geographic concentration strains the transmission infrastructure, slowing deployment and increasing vulnerability to localized disruptions.[16] Many lagging states lack a combination of enabling policies, viable market structures, or adequate transmission and grid infrastructure for clean energy deployment.[17] Unlocking clean energy in these regions will require policy support and context-specific approaches tailored to local constraints and resources, such as hydropower in the Himalayan belt and distributed energy systems in land-constrained states such as Uttar Pradesh and Bihar.[18]

Deployment models: Utility-scale renewables dominate capacity additions, followed by rooftop solar. This dominance reflects strong underlying economics and policy support, which reduces risks for developers and investors. However, land acquisition challenges and transmission constraints are likely to limit further expansion in the short to medium term, particularly in densely populated and land-scarce states with limited industrialization.[19] At the same time, alternative models remain underdeveloped due to

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[15] Calculated based on "National and State level Electricity Demand" data. Vasudha Foundation, 2025; Calculated based on 'Top-10 emitting states' data. Usthadian, 2025

[16] "Rajasthan in the Northern Regional Grid and Gujarat in the Western Regional Grid house the bulk of the country's utility-scale solar and wind capacities. Such concentration of capacities, combined with delayed transmission and evacuation infrastructure, is producing long queues at key pooling stations. On average, projects awaiting commissioning in FY2026–27 face connectivity delays of four to five months [...] Greater emphasis should also be placed on developing renewable capacity closer to demand centres, including at the intra-state level, that reduces excessive concentration in a few corridors." EMBER, 2026; "Any major concentration of power generation resources in one area in comparison to the total installed capacity of the country needs to be assessed in terms of vulnerability of the future grid operation due to any unexpected major generation loss by reasons attributable to defence, climate changes and active/reactive power management during fault of transmission lines." EnergyWatch, 2026

[17] "Decarbonisation performance across states varies widely. Performance is characterised by a clear concentration effect, with only a few states emerging as strong performers across individual parameters. Importantly, no state demonstrates strong performance across all six parameters. This uneven pattern highlights substantial heterogeneity, where progress remains dispersed across parameters rather than comprehensive [...] Viewed through the market enablers lens, electricity transition readiness varies sharply across states." IEEFA and EMBER, 2026

[18] See Figure 1: Characteristics of regions in terms of generation and demand. IFRI, 2025

[19] "Land acquisition, however, remains a critical concern and barrier. India's dense population and competing demands for agriculture, housing, infrastructure, and industry make large-scale land acquisition for solar parks increasingly difficult. Without innovative solutions, land scarcity could significantly hinder the pace of solar deployment. New and Innovative Solar Applications (NISA) can address these land-related constraints [...] The key NISA technologies include Agri photovoltaics (AgriPV), Building integrated photovoltaics (BIPV), Floating solar photovoltaics

higher perceived risk and weaker policy and financing support. Scaling alternative models—such as community solar, agrivoltaics (agriPV), floating solar, and virtual power plants—will be critical to expand clean energy generation in geographies where utility-scale approaches are not viable.[20] Targeted policy support and pilot programs can build the evidence base needed to mobilize capital at scale and attract private sector investment.

Technological pathways: Utility-scale solar and onshore wind account for the majority of clean energy additions in India and will remain central to its transition. However, increasing reliance on such variable renewable energy creates grid management challenges as penetration rises, leading to dependence on conventional energy backup for reliability and stability. Alternative clean firm technologies—such as nuclear, geothermal, and geologic hydrogen—or less variable generation through offshore wind remain nascent in India, with high development risk and limited private investment.[21] Scaling these technologies is important for long-term system stability, as they provide dispatchable generation, reduce concentration risk, and enable higher overall clean energy penetration.

Interventions: Given the uncertainty around scaling clean energy supply through new deployment models and emerging technologies, evidence generation is critical to derisk deployment, inform policy and investment decisions, and enable replication of successful models at scale. We think a high-leverage opportunity is to support pilots of new deployment models (e.g., agriPV, floating solar, and community solar), particularly in underserved and land-constrained geographies. We think geographical diversification and adoption of new deployment models will play a meaningful role in scaling clean energy deployment in the near to medium term. For emerging technologies, knowledge creation is particularly important given their early stage of development. We think feasibility and techno-economic assessments of nuclear, geothermal, and geologic hydrogen can help inform technology development and policy design as the ecosystem matures. For more mature technologies such as offshore wind, addressing downstream barriers, including tariff design, supply chain development, and financing mechanisms,

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(FSPV) and Rail and Road photovoltaics (RIPV)." Down to Earth, 2025; "A macro-level reassessment estimates India's total solar potential at roughly 11,000 GW, of which around 45% is from ground-mounted utility-scale solar and 55% from NISA technologies." TERI, 2025

[20] "The Variable Renewable Energy led transition extends beyond utility-scale projects to include decentralised solutions such as rooftop solar, building-integrated PV, agrivoltaics, and other behind-the meter resources. These options reduce land-use pressures, ease grid congestion, strengthen resilience, and support more inclusive energy participation, particularly in urban, agricultural, and industrial areas. By improving alignment between local generation and demand, distributed renewables complement utility-scale VRE while enhancing energy access and local economic benefit." NITI Aayog, 2026

[21] Offshore wind projects face high implementation risk reflected in higher generation costs. "Two landmark auctions found little interest [in offshore wind] from developers and were eventually called off in 2025 [...] India's tendering model even produced an uncovered gap: even after VGF subsidy, the levelised cost of generating electricity was about INR 5/kWh higher than the pre-determined tariff at INR 4.5/kWh." EMBER, 2025

will be critical to overcoming implementation bottlenecks.[22]

Grid Flexibility and Resilience

Accelerating supply of clean power is necessary but insufficient without parallel investment in transmission and distribution infrastructure. Despite contributing 50% of India's electricity generation capacity, clean energy sources accounted for only 25% of actual generation due to limited storage and insufficient grid flexibility to manage variability.[23] These constraints are already slowing new project development, with several renewable projects facing delays or remaining underutilized. Enabling grid flexibility and resilience requires a two-pronged approach focused on transmission expansion and modernization alongside distribution system reform.

Transmission expansion and modernization: India's transmission network is unable to keep pace with rapidly expanding renewable generation capacity, with new build-out and modernization severely lagging.[24] As a result, over 50 GW of commissioned renewable energy capacity was stranded as of mid-2025.[25] A resulting cascading effect is that state-owned DISCOMs are unwilling to sign new power purchase agreements, developers face steeper financing costs, and participation in competitive transmission bidding has weakened. At the same time, existing infrastructure is often underutilized, as interstate transmission corridors operate below capacity due to mismatches between variable generation and static transmission allocation.[26]

Transmission challenges stem from both planning and execution gaps. On the planning side, coordination failures between stakeholders in the power sector value chain (e.g.,

[22] "[...]offshore wind requires specialised port infrastructure, marine logistics, robust seabed leasing frameworks, clear risk allocation, and bankable commercial structures, making it one of the most complex segments of the global energy transition." Akashvani, 2026; "To truly kickstart offshore wind in India, the government's approach must evolve, building on early groundwork through a blend of domestic innovation and global best practices. The priorities are clear: craft targeted incentives for first-of-a-kind projects, catalyse domestic supply chains and translate them into bankable projects that can come to life." EMBER, 2026

[23] "Non-fossil sources contributed about 50% of this [total installed capacity], while coal accounted for 46%. Coal supplied 73% of the total power generation; non-fossil sources contributed roughly 25%." NITI Aayog, 2026

[24] "The current largest structural driver of renewable energy curtailment in India is the mismatch between the deployment of renewable energy generation and associated transmission infrastructure." EMBER, 2026

[25] "The implications are significant—over 50GW of renewable energy capacity is currently stranded nationwide, increasing per-unit transmission costs, weakening project viability, and deterring private investment." JMK Research and IEEFA, 2025

[26] "There is reluctance among DISCOMs to sign new PPAs, even for competitively priced projects, due to concerns over grid congestion and the risk of non-availability of contracted power during curtailment events [...] In FY2025, only 8,830ckm of new transmission lines were commissioned against a target of 15,253ckm, reflecting a 42% shortfall, with Inter-State Transmission System (ISTS) additions at their lowest in a decade. Alongside this capacity gap, system inefficiencies are emerging, with analysis by the NREL indicating that up to 71% of ISTS corridors operate below 30% utilisation, underscoring the mismatch between infrastructure availability and actual power flows." JMK Research and IEEFA, 2025

generation companies, demand-side actors, transmission companies, DISCOMs) lead to misalignment between infrastructure investment decisions and emerging demand needs.[27] As a result, transmission expansion remains reactive and struggles to keep pace with demand growth driven by electrification, industrial expansion, green hydrogen production, and data center load.[28] Long project timelines further compound this issue, as transmission infrastructure typically requires several years to plan and build. On the execution side, high reliance on imported materials and equipment, right-of-way disputes—land acquisition disagreements between developers and landowners for interstate transmission projects—and procedural complexity stemming from multi-agency approval requirements continue to delay project delivery.[29]

Addressing these constraints will require a combination of policy, infrastructure, and technology interventions. On the policy front, interventions include enabling unified generation–transmission planning, simplifying bureaucratic processes, incentivizing performance-based asset utilization, and supporting asset monetization models. On the infrastructure and technology front, interventions include upgrading congested renewable-rich transmission corridors as a lower-cost alternative to new builds, integrating storage in high-curtailment regions, mobilizing capital through public–private partnership models, building domestic material and equipment supply chains, and modernizing the grid with higher-capacity lines, advanced protection systems, and digital monitoring.

Distribution system reform: DISCOMs are central to India's power sector decarbonization. They control procurement, tariff design, market access, and the integration of new demand, making their financial and operational capacity critical for the power sector.[30] Hence, constraints at the DISCOM level have significant downstream effects, including delays in renewable integration, limited storage deployment, and restricted market development.

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[27] "This lack of coordination not only weakens the credibility of the national electricity plan but also affects investment decisions by utilities and developers who rely on consistent long-term signals. Fragmented planning also hampers transmission development, storage deployment, and the design of market mechanisms that depend on a shared understanding of future system needs." Mishra and Sheoran, 2025

[28] "Setting up a transmission line requires coordination with multiple authorities across different government levels. Key approvals include techno-economic clearance from the CEA, grid connectivity from dispatch centres, and transmission licences from regulatory commissions. State and local agencies must obtain additional approvals, such as land acquisition and route alignments." JMK Research and IEEFA, 2025

[29] Right-of-way issues significantly delay transmission development due to the time required to secure land and permits along transmission routes. There is also a clear mismatch between transmission and renewable energy project timelines: renewable projects can be completed in 12-18 months, whereas transmission projects often take 3-4 years. Outlook Business, 2025; "Considering the majority of the equipment and material for high-voltage direct current(HVDC) systems is imported by India, supply chain constraints have and continue to cause delay in building these transmission lines." IECC, 2026

[30] "The decisive levers of the transition—land allocation, intra-state transmission, procurement strategies, tariff design, and DISCOM finances—sit with states, not the Centre." ORF, 2026

Despite repeated reform efforts, DISCOMs remain financially stressed, with accumulated losses estimated at around ₹7.08 lakh crore ($75 billion USD) as of March 2024.[31] They face persistent structural challenges, including high electricity procurement costs, politically constrained tariffs, delayed government subsidy reimbursements, and reliance on debt for working capital. At the same time, DISCOMs are losing their paying customers as commercial and industrial consumers are increasingly shifting to open access markets and exploring solar-plus-storage investments to meet their own demand at costs below DISCOM tariffs, while still depending on DISCOM procurement and distribution to fill any gaps in their own generation.[32] Although recent improvements in subsidy payments from state governments have reduced reported losses, other underlying structural issues remain unresolved.[33] As a result, DISCOMs face constraints on both revenue generation and cost recovery, limiting their ability to invest in grid modernization and expansion. We think that targeted reforms could materially improve DISCOM performance, including regular and predictable tariff adjustments, agricultural feeder solarization, least-cost procurement planning, and cost-reflective pricing for grid services.[34]

We are skeptical of privatization as a near- to medium-term solution. Evidence from Delhi and Odisha indicates that privatization can improve service quality and reduce losses, but these outcomes require substantial political and regulatory support. More significantly, a change of ownership (i.e., public to private) does not resolve the underlying structural drivers of financial stress, such as politically constrained tariffs and high procurement costs. Further, enabling conditions for successful privatization—such as high aggregate technical and commercial (AT&C) losses, poor service quality, and a significant paying consumer base—are not uniformly present across states.[35] Privatization is likely to exacerbate already unevenly distributed outcomes across states and may raise concerns around affordability and access for low-income and rural consumers.[36] We think

[31] DISCOMs reported ₹7.08 lakh crore in losses as of Mar 2024. Prayas (Energy Group), 2025
[32] Based on synthesis of section on "Major contributors to increasing losses and liabilities of DISCOMs" Prayas (Energy Group), 2025
[33] "DISCOM profit is significant, and reflects many much-needed wins in Indian electricity. But these wins were built primarily on a debt swap, subsidy arrears being cleared, and accounting improvements [...] but deeper structural problems like rigid procurement contracts and increasing tariffs remain untouched. Until those are addressed, this profit is best understood as the first milestone on a much longer, steeper road." Daily Brief by Zerodha, 2026
[34] Several experts highlighted these approaches, which are aligned with the financial performance analysis for the Sixteenth Finance Commission of India. Prayas (Energy Group), 2025; A feeder transmits electricity from a substation to distribution points. Under agricultural feeder solarization, a dedicated solar power plant supplies a feeder connected to multiple agricultural pumps, rather than connecting solar panels to each pump individually. OrnateSolar, 2025
[35] AT&C losses include technical losses from energy lost during transmission and distribution and commercial losses arising from theft, faulty billing, and poor revenue collection.
[36] Privatization is not inherently ineffective. Rather, its effectiveness varies considerably across regions and states, as it may not address the underlying drivers of specific DISCOM challenges. Our perspective is informed by expert interviews, alongside a synthesis of the section on "Experience with Privatisation" by Prayas (Energy Group), 2025 and key arguments from the 2025 reflection paper critiquing DISCOM privatization by CEEP, 2025; "Privatisation, if poorly designed, risks deepening inequalities. Many states may hand over profitable urban circles to private firms while retaining loss-making rural networks. This selective reform could widen the gap in both access and quality of power supply." PolicyCircle, 2025

strengthening regulatory, financial, and operational capacity within the existing DISCOM framework is likely to be the most feasible and scalable pathway for reform.[37]

Interventions: Philanthropy can play an important role in addressing the institutional capacity constraints of state utilities (i.e., transmission and distribution companies) and enabling storage integration, planning and forecasting, and policy and regulatory design for procurement and transmission. Specifically, we think the high-leverage opportunities include a) supporting policy design and modeling for DISCOMs on optimal tariff and market design, storage enablement, and planning and forecasting, b) supporting policy design and modeling for transmission companies on unified generation-transmission planning, streamlined approval processes, performance-based asset utilization, and asset monetization models, and c) supporting evidence-generation pilots and demonstrations (e.g., battery energy storage system (BESS) integration and round-the-clock renewable energy (RTC-RE) procurement models) that bundle regulatory design, financing, and implementation into a single intervention.[38]

More broadly, subnational institutions, especially state governments, also have limited capacity and technical expertise to navigate and implement energy transition strategies. Hence, sustained technical assistance and institutional capacity-building at the subnational level is critical to enable evidence-driven decision-making, policy design, and implementation. Specifically, we think high-leverage opportunities include providing technical assistance to state governments on a) designing state clean energy policies, regulatory reforms, and market mechanisms, b) conducting energy transition planning and investment prioritization, and c) implementing state energy transition priorities and project-level support (identification, design, development, and execution). While multi-year funding support should be prioritized for technical assistance, these efforts should also be structured to build lasting institutional capacity. Knowledge products such as digital dashboards, data tools, and playbooks can help institutionalize knowledge, while addressing gaps in skills and technical expertise can strengthen the ability of state institutions to sustain systems and processes independently beyond the engagement.

Clean Energy Demand Growth

India's net-zero trajectory is constrained not only by the pace of clean energy deployment but also by persistent dependence on conventional energy sources. A key structural

[37] Experts also suggest that state institutions may need to evolve in the long term for improved management of the renewable energy in the grid. Particularly, state load dispatch centers (SLDCs) which are responsible for coordinating generation and system operations within states, will play an increasingly important role in managing these challenges. While India currently does not have entities like distribution system operators (DSOs) who dedicatedly manage distribution operations, creation of DSOs may alleviate pressures on DISCOMs to manage the increasing complexity of distributed energy resources and grid operations. We are uncertain about the near-term feasibility of creating DSOs but remain open to supporting the development of such entities if our assessment is updated.

[38] While our focus is on state utilities, we will also consider opportunities to support SLDCs where their role in state-level system operations is important for strengthening grid operations and enabling decarbonization.

challenge underpinning this dependence is low levels of end-use electrification, particularly in the industrial sector, which limit the emissions reduction potential of a decarbonizing grid.[39]

End-use electrification: India's industrial sector accounts for about 50% of the nation's final energy consumption and a comparable share of energy-related greenhouse gas emissions, yet only around 19% of energy is used in the form of electricity, well below the global average of roughly 29%.[40] The sector remains heavily reliant on conventional energy sources for captive power generation, process heat, and, in some cases, feedstock.[41] Captive, conventional energy-based self-generation is widespread across energy-intensive industries and a major constraint to India's industrial decarbonization.[42]

The barriers to electrification are interdependent and complex to address:

- **Economic incentives are misaligned:** Cross-subsidization—a DISCOM pricing mechanism where commercial and industrial (C&I) customers pay more to offset losses from lower-paying residential and agricultural consumers—weakens the financial case for grid-connected electrification in the commercial and industrial sectors.[43] Hence, electrification is economically unattractive in the absence of targeted policies.[44] High upfront capital requirements further reinforce this constraint, particularly for micro, small, and medium enterprises (MSMEs) with limited access to affordable finance.[45]
- **Regulatory support remains limited:** The absence of a unified national industrial decarbonization strategy, inconsistent enforcement of Renewable Purchase

[39]We currently prioritize exploration of industrial electrification over broader demand-side measures because of its more direct potential to substitute carbon-intensive conventional energy sources. However, we remain open to exploring targeted demand-side interventions in the future, particularly in rapidly growing applications such as cooling, where there may be opportunities for significant emissions reductions.

[40] "India's industrial sector accounts for nearly 49% of the nation's total final energy consumption, yet only 18.7% of this comes from electricity [...] The industrial sector electrification level in India is much lower than the world and Asian average of 29% and 30%, respectively" GGGI, 2025

[41] Coal is used as feedstock in manufacturing of steel, cement, and syngas. World Coal, 2014; Syngas is a key building block for producing chemicals like methanol, ammonia, urea, and olefins. Wood Mackenzie, 2017

[42] Captive power plants are typically set up by industrial or commercial energy users to self-generate electricity primarily for self-consumption, often for reliability and cost advantages. "A significant portion of industrial consumption, around 30%, is met through captive generation rather than supply from DISCOMs." NITI Aayog, 2026

[43] "Under this mechanism, C&I consumers have historically paid tariffs above the average cost of supply to offset the below-cost tariffs charged to residential and agricultural consumers." Prayas (Energy Group), 2025

[44] We expect the Renewable Consumption Obligation (RCO), introduced by the Ministry of Power in 2025, to incentivize electrification. The policy requires designated consumers—including DISCOMs, open access consumers, and captive power producers—to increase the share of renewable electricity in total consumption from 29.9% in FY2024–25 to 43.3% by FY2029–30. Bureau of Energy Efficiency, 2026

[45] "India's domestic and agricultural electricity tariffs are more subsidised than industrial and commercial tariffs. This price distortion led to low electrification rates in Indian industries. High demand charges and banking limits also make electrification challenging." NITI Aayog, 2026

Obligations across states, and the lack of systematic policy prioritization for end-use electrification collectively suppress the investment signals needed to mobilize private capital.[46]

- **Commercially viable technologies remain either nascent or underutilized:** Electrified alternatives for process-related uses in sectors such as iron and steel, cement, and chemicals are at an early stage of deployment or not yet commercially viable in India. At the same time, technologies such as heat pumps, electric boilers, and battery storage for diesel replacement are commercially available and applicable across subsectors, but remain underutilized due to high capital costs and limited financial incentives for switching.[47]
- **Grid reliability remains a constraint:** Grid reliability issues further push industrial customers toward captive generation, reinforcing dependence on conventional energy sources.[48]

We think industrial electrification requires coordinated action across finance, policy, and technology.[49] Concessional capital, credit guarantees, and blended finance can reduce the cost of capital and improve bankability for early adopters. Policy measures such as performance standards, procurement mandates, and state-level transition roadmaps can strengthen demand signals. New delivery models, including energy as a service, can further reduce upfront investment barriers for industrial consumers.

Given the scale and complexity of the challenge, we prioritize industrial electrification within our power sector decarbonization strategy and explore additional sub-strategies for industrial decarbonization in India as part of our sector report on Industry.

Interventions: Evidence generation pilots providing clarity on economic viability, technical feasibility, and policy design are critical to unlocking policy reform, derisking financing, and mobilizing larger pools of capital. Hence, we think supporting pilots and demonstrations of industrial electrification measures and technologies is a high-leverage opportunity for philanthropy to generate this evidence and inform regulatory and financing mechanisms needed to accelerate adoption.

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[46] "Notably, there is no unified national strategy specifically focused on industrial electrification. Furthermore, current policies are often skewed toward electricity generation, with insufficient attention to end-use electrification." GGGI and CII, 2025

[47] "While electrification is mature for low-temperature heat (<150°C), technologies for high-temperature process heat (e.g., cement kilns, ethylene crackers) are either nascent or commercially expensive. Transitioning from fossil-fuel boilers to efficient electric alternatives like Industrial Heat Pumps or Electric Boilers requires significant capital investment." NITI Aayog, 2026

[48] Captive self-generation is preferred due to cost and reliability benefits. India's captive coal capacity is ~17% of total coal capacity. "As per the latest available data for March 2024, captive coal-based installed capacity is about 46 GW [...] In the Current Policy Scenario, coal capacity rises from 268 GW in 2025 to a peak of 450–470 GW by 2050." NITI Aayog, 2026

[49] "Industrial electrification is not merely a technical shift but a systemic transformation requiring coordinated action across policy, technology, finance, and society." GGGI and CII, 2025

Assessment of Philanthropic Sub-Strategies

We identified five philanthropic sub-strategies and evaluated each sub-strategy's scale, feasibility, and funding need (see **Table 1**). For more information on these metrics and our research process, see Giving Green's Research Overview.

Table 1: Scale, feasibility, and funding need of approaches nonprofits use to support power sector decarbonization in India

Sub-strategy	Scale	Feasibility	Funding need
Advancing research and pilots to derisk underexplored deployment models, technologies, and geographies for scaling clean energy	High	High	Medium
Providing technical assistance to state utilities with policy design and planning to strengthen, expand, and modernize the power grid	High	Medium	High
Providing technical assistance and capacity building support to state governments and institutions for energy transition planning and implementation	High	Medium	High
Supporting research and pilots to accelerate adoption of electrification measures in the industrial sector	High	Medium	High
Enabling market and policy reforms to advance the adoption of energy-efficiency measures	Medium	Low	Medium

We chose to center sub-strategies with at least two 'high' assessments in our India power sector decarbonization strategy. **Based on the above evaluations, we think the first four philanthropic sub-strategies in the table are promising.**

We expand on our reasoning for prioritizing these sub-strategies below. Further information on our reasoning for deprioritizing the remaining sub-strategies is available on Giving Green's research dashboard.[50]

[50] In addition to the India-specific sub-strategies identified in this report, Giving Green's derisking clean electricity investment in LMICs strategy takes a cross-cutting, multi-country and regional approach. It identifies philanthropic opportunities to address common investment barriers and increase capital flows for clean electricity deployment across multiple countries. See our *Derisking Clean Electricity Investments in LMICs* report for a comprehensive overview of these cross-cutting strategies.

Advancing Research and Pilots to Derisk Underexplored Deployment Models, Technologies, and Geographies for Scaling Clean Energy

Scale	🟢🟢🟢 High
Feasibility	🟢🟢🟢 High
Funding need	🟡🟡⚪ Medium

Scale: High. India's energy demand is expected to rise substantially. To remain on a net-zero trajectory, clean electricity generation must increase nearly tenfold by 2050, requiring around 3,000 GW of new renewable capacity.[51] Although utility-scale solar and wind are already expanding due to favorable economics and strong policy support, deployment remains concentrated in a subset of states and technologies. Scaling utility-scale renewables beyond 300 GW will come with significant trade-offs (e.g., operating in regions with high land conflicts, land prices, and population density).[52] Hence, expanding clean energy deployment will require addressing gaps in underserved geographies, enabling non-utility-scale delivery models, and advancing other clean energy technologies such as offshore wind, nuclear, geothermal, and geologic hydrogen. Hence, we think diversification will play a critical role in sustaining progress as low-hanging opportunities across existing markets, technologies, and deployment models are exhausted.[53]

Feasibility: High. India's strong enabling ecosystem—including supportive policies, capital markets, and an experienced civil society—makes accelerating clean energy deployment highly feasible. We are uncertain about how scalable next-generation technologies such as nuclear, geothermal, and geologic hydrogen will be in India's energy mix, though these technologies could deliver significant emissions reductions if favorable techno-economic conditions emerge.[54] Overall, we expect the majority of the potential impact to be driven by accelerating the deployment of mature technologies through new models and in new geographies.

Funding need: Medium. We think philanthropic funding is limited relative to the scale of the opportunity, and philanthropic support is critical to absorb early risk, generate

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[51] Table E.1: A snapshot of the power sector by 2050 and 2070. NITI Aayog, 2026

[52] "In 300–750 GW range, there is a trade-off between significantly higher land prices and higher population density. Additionally, areas with higher population density are also associated with higher climate risk and conflicts (...) Beyond 750–1,500 GW, RE will need to be deployed in areas characterised as earthquake prone zones or in areas with higher seasonality, where generation is lower than one standard deviation from median generation for three months." CEEW, 2024

[53] "While India's renewable energy growth has been driven primarily by large utility-scale projects, decentralised renewable energy remains an underutilised opportunity. Such an approach would strengthen DISCOM finances by reducing technical losses, support rural economies through improved power quality, and generated local employment opportunities. Distributed solar, agricultural feeder solarisation, and community energy models can significantly complement grid-scale additions. Simplifying metering, enforcing ToD exports, and introducing performance-based incentives for DISCOMs will accelerate adoption." IEEFA and EMBER, 2026

[54] See our note in the "Key Uncertainties and Open Questions" section.

evidence, and create the conditions for private and public capital to follow.[55] While mainstream renewables like utility-scale wind and solar already attract substantial commercial and public investment, less mature pathways—such as community solar, agriPV, and offshore wind—remain underfunded due to higher perceived risk and policy and regulatory uncertainty.[56] Our assessment reflects an uneven and opportunistic spread of philanthropic funding across geographies, models, and technologies.

Providing Technical Assistance to State Utilities With Policy Design and Planning to Strengthen, Expand, and Modernize the Power Grid

Scale	🟢🟢🟢 High
Feasibility	🟡🟡⚪ Medium
Funding need	🟢🟢🟢 High

Scale: High. Grid infrastructure is the single most significant bottleneck in India's power sector decarbonization. We think the importance of grid infrastructure will only grow, as even small reductions in curtailment could have a disproportionately large impact on emissions as the share of renewables in grid electricity increases.[57] Hence, fixing transmission and distribution challenges has a multiplicative effect as it unlocks the full value of clean energy investments, including storage. Without improvements in transmission, distribution, and grid flexibility, renewable energy deployment will increasingly face curtailment, integration challenges, and continued reliance on conventional energy sources for system stability.

Feasibility: Medium. State utilities are highly capacity-constrained and do not have the bandwidth to proactively respond to the evolving energy transition landscape. Our conversations with experts and nonprofits confirm that there is a genuine appetite among several state utilities to receive technical assistance and targeted support to enable policy

[55] "Private capital continues to concentrate in commercially viable sectors like utility-scale renewables and energy-efficient appliances, while Micro, Small and Medium Enterprises (MSMEs), adaptation infrastructure, and early-stage clean technologies remain underserved [...] In contrast [to mature renewables attracting private financing], low TRL solutions such as gridscale storage, hydrogen electrolysers, and CCUS face higher perceived risks, requiring blended finance, concessional loans, strategic equity, and risk-sharing mechanisms to attract investment." NITI Aayog, 2026

[56] "Backed by strong government commitment, the country is rapidly expanding clean energy adoption through large-scale projects and policy support [...] Foreign direct investment in India's renewable energy sector has increased significantly from Rs. 171.52 crore (US$ 195 million) in FY11 to Rs. 34,606.94 crore (US$ 4 billion) in FY25, reflecting strong investor confidence." IBEF, 2026

[57] "Yet, curtailment of renewable energy emerged as a key theme of the year, driven by transmission constraints and grid security concerns through emergency measures. In many ways, such curtailment defeats the very purpose of building this capacity. While grid security-related curtailment in 2025 may not be a major concern in isolation, as it was largely triggered by lower-than-expected demand, it served as a real-world stress test for a high-solar future. It highlighted a fundamental reality: clean energy cannot scale efficiently without flexibility." EMBER, 2025

and regulatory reforms, as well as grid modernization and flexibility.[58] Hence, we think there is strong buy-in for the implementation of priority reforms to modernize and expand the grid, though willingness to prioritize grid improvements will vary by state.

Funding need: High. We think the scale of philanthropic funding remains significantly below the magnitude of the challenge, particularly given the strong multiplier effects of grid investments in enhancing the effectiveness of clean energy investments across the power sector value chain.[59] Our conversations with nonprofits and funders indicate that opportunities to support technical assistance and capacity building for state utilities have historically been overlooked, as utilities are often perceived as profit-making entities that fall outside the scope of philanthropic funding. However, our theory of change suggests that the central role of these public utilities in India's power sector decarbonization necessitates targeted support for nonprofits to provide high-value technical assistance.

Providing Technical Assistance and Capacity Building Support to State Governments and Institutions for Energy Transition Planning and Implementation

Scale	🟢🟢🟢 High
Feasibility	🟡🟡⚪ Medium
Funding need	🟢🟢🟢 High

Scale: High. States play a central role in India's power sector decarbonization, with authority over tariffs, procurement, grid planning, and market access. Despite strong national policy, grid bottlenecks highlight gaps in state-level execution. We think state-level institutional constraints create a growing gap between national ambition and on-the-ground delivery across procurement, grid integration, industrial transition, and DISCOM reform. As the transition becomes more technically complex, we think the importance and role of state institutions will continue to grow.

Feasibility: Medium. There is demonstrated demand from state governments for technical assistance and capacity building, and several nonprofit organizations have a track record of shaping policy and planning through techno-economic analysis and technical assistance. We think these approaches are often more tractable because they respond to clear government demand and face few political barriers. However, such engagements and their effectiveness depend on the willingness and interest among states to engage in power sector decarbonization. We think engagement with states where NITI Aayog's Accelerating Sustainable State Energy Transition (ASSET) platform is

[58] As described in the previous sections, examples of targeted support include designing optimal tariffs and market structures, enabling battery storage ecosystems, improving planning and forecasting, integrating generation and transmission planning, developing models for performance-based asset utilization and monetization, procurement, and demand response.
[59] A promising example of grid investment unlocking downstream clean energy investment is that of the 'Grids of the Future' initiative by Global Energy Alliance for People and Planet, where the estimated impact of $100 million of catalytic philanthropic capital is to unlock $160 billion of financing. GEAPP, 2026

active can increase the likelihood of translation of policy intent into action due to existing political momentum.[60]

Funding need: High. Based on our conversations with other funders and nonprofits, we think that subnational climate action is generally underfunded. Strengthening state capacity has historically been particularly neglected, with limited systemic efforts to support various stakeholders, including state governments, key state departments, state-owned utilities, and state-owned enterprises. While initiatives such as NITI Aayog's ASSET platform are increasing attention to state-level energy transition, we think philanthropic funding remains limited relative to the scale of capacity-building and implementation needs across states.

Supporting Research and Pilots to Accelerate Adoption of Electrification Measures in the Industrial Sector

Scale	🟢🟢🟢 High
Feasibility	🟡🟡⚪ Medium
Funding need	🟢🟢🟢 High

Scale: High. India's industrial sector accounts for approximately 50% of final energy consumption, yet remains under-electrified at roughly 19% electricity consumption compared to a global average of 29%. We think shifting industrial demand away from conventional fuels through electrification impacts not only a significant share of current emissions but also prevents further lock-in into carbon-intensive infrastructure over the coming decades.

Feasibility: Medium. Accelerating industrial electrification will require coordinated efforts to derisk electrified alternatives through pilots and demonstrations and to establish policy frameworks that promote and finance electrification. Cross-cutting electrification technologies such as heat pumps and electric boilers are commercially proven in mature markets, and early-stage demonstrations are needed to show technical viability in India. Sector-specific alternatives and MSME adoption will likely require greater financing support given fragmentation. While nonprofits can support early pilots and provide inputs to state-level policy design, we are uncertain about the pace at which structural barriers to industrial adoption can be overcome.

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[60] Through the ASSET platform, NITI Aayog plans to work with 10 states to advance their energy transition. So far, we are aware of their active engagement with civil society partners in three states of Maharashtra, Andhra Pradesh, and Odisha. "NITI Aayog, in collaboration with the Ministry of Power and the Ministry of New and Renewable Energy, launched the ASSET platform—Accelerating Sustainable State Energy Transition. ASSET platform is a timely initiative to support states in accelerating their energy transition. The platform will assist in formulating state energy transition blueprints along with aiding in its implementation, preparing a pipeline of bankable projects, showcasing best practices across states as well as upcoming technology and innovations in critical sectors like BESS, Green Hydrogen, Energy efficiency, e-mobility, offshore wind, etc." Press Information Bureau, GoI, 2024

Funding need: High. We think industrial electrification remains significantly under-resourced despite its importance as a demand-side driver of conventional energy use. Philanthropic funding for pilots, demonstrations, and evidence generation to support policy design remains particularly scarce.

Theory of Change for Philanthropic Engagement

Based on current barriers to the power sector decarbonization—including insufficient state capacity, policy ambition levels, and private sector commitments—we developed a high-level theory of change for how philanthropic actors can reduce emissions from the power sector in India. Theories of change enable us to better understand the pathways of influence, the likelihood of each pathway, and the avenues of greatest impact for philanthropic and civil society efforts.

We evaluate the main assumptions underlying the theory of change and rate our certainty in each as **low**, **medium**, or **high**.[61] Our assessment is based on both primary and secondary evidence, as well as our general impression of the assumption's plausibility.

[61] We describe our certainty as low/medium/high to increase readability and avoid false precision. Since these terms can be interpreted differently, we use rough heuristics to define them as percentage likelihoods the assumption is, on average, correct. Low = 0-60%, medium = 60-80%, high = 80-100%

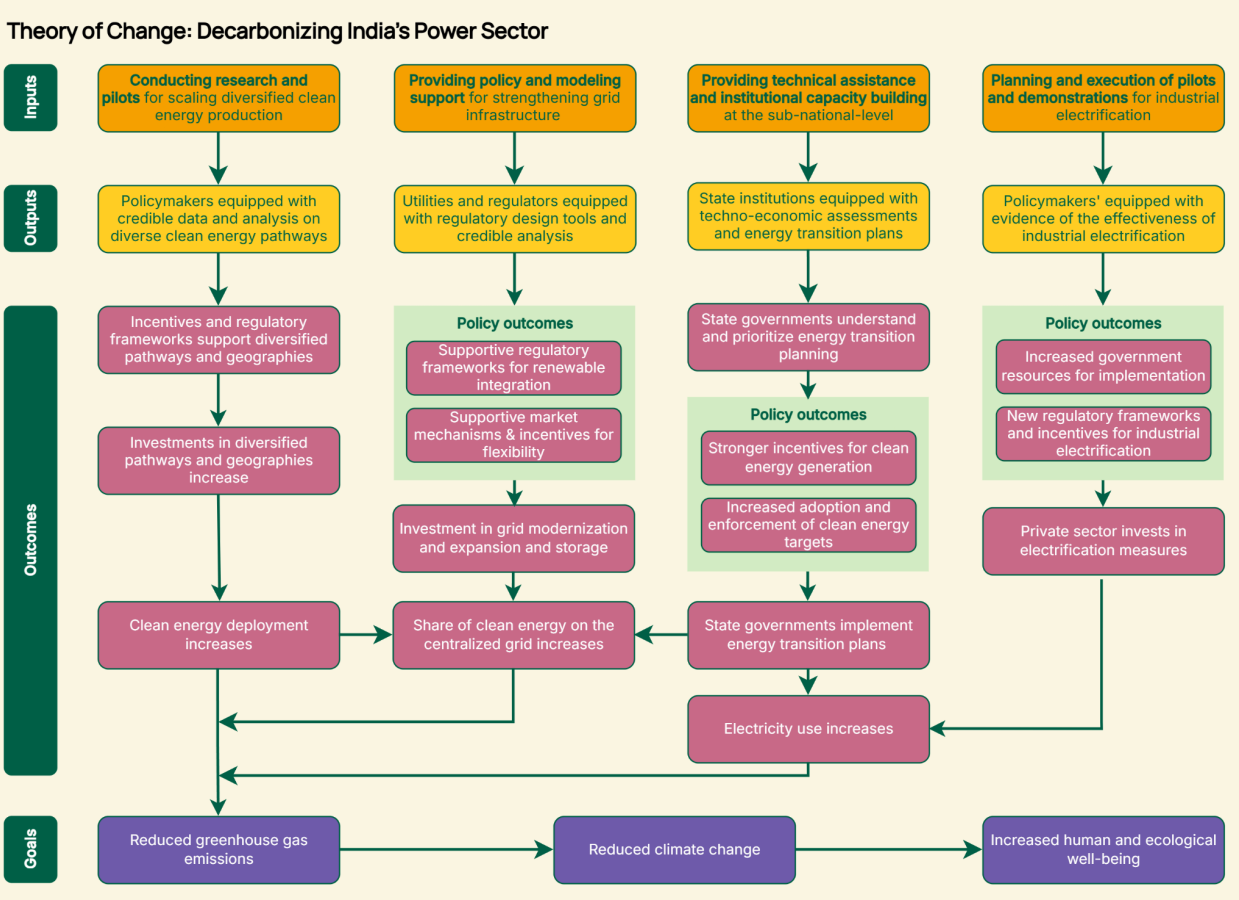


Figure 1: Theory of change diagram for India's power sector decarbonization

Evaluating Key Assumptions

1. Technical assistance and capacity building will lead to durable improvements in state-level decarbonization planning and implementation. (high certainty)

We think that targeted technical assistance and institutional support to state governments and stakeholders will accelerate India's power sector decarbonization, particularly in states that have already demonstrated political willingness to reform.

The effectiveness of capacity-building support varies considerably across states and depends on institutional relationships and long-term trust with decision-makers. As energy and power systems become more complex, demand for technical assistance and capacity building is increasing, particularly in grid modeling and integration, storage procurement, and industrial transition planning.[62] Experts confirmed that the states of Maharashtra, Andhra Pradesh, Telangana, Tamil Nadu, Uttar Pradesh, Odisha, and Madhya Pradesh are actively engaging with nonprofits on various aspects of power sector decarbonization as well as their energy transitions more broadly.

We think early successes in these receptive states may create cascading effects that support broader adoption in other states and influence national policy reform. We also expect significant spillover benefits, as institutional strengthening in the power sector is likely to enhance broader governance capacity. Additionally, NITI Aayog's ASSET platform, established in 2024, is actively engaging with select states to provide strategic guidance on developing their energy transition plans. As a result, states are actively seeking nonprofit partners for technical assistance as they design and implement these plans.[63] We think the ASSET platform can be effectively leveraged to accelerate action across these states, reduce duplication of efforts, and facilitate the sharing and scaling of best practices, knowledge, and learnings.

We view partner selection as the primary risk mitigation lever, prioritizing nonprofits that demonstrate established state-level relationships, a track record of sustained advisory engagement, techno-economic expertise, and implementation capability. While such an approach does not eliminate execution risk, it improves the likelihood of philanthropic support translating into durable policy and implementation gains.

2. Credible analysis and regulatory tools will meaningfully influence key decision-makers for improved policy design. (medium certainty)

We think techno-economic analysis, policy research, and modeling can meaningfully influence decision-makers where policy design is driven by complex cost trade-offs, system planning choices, and implementation sequencing rather than purely political negotiation. Key policy choices around tariff reform, storage procurement, transmission

[62] We base this assertion on expert interviews and engagement with nonprofits with deep experience and understanding of the political economy of power sector decarbonization in India.
[63] In India, state and national governments typically rely on externally funded technical partners for analytical and implementation support, rather than directly funding nonprofit policy work at scale.

planning, and market design involve navigating significant fiscal, political, and operational complexity, and credible analytical support is therefore a prerequisite for well-designed outcomes.

For instance, there is a strong precedent in India for nonprofits and think tanks providing inputs to the Central Electricity Regulatory Commission (CERC) and the State Electricity Regulatory Commission (SERC) proceedings, contributing to power sector decarbonization-related task forces, and collaborating directly with state-level utilities on implementation challenges.[64] However, the degree of influence remains highly context-dependent. Trust, institutional access, and sustained engagement are critical to ensuring that evidence shapes decisions. As with technical assistance and capacity building, we think that supporting analytical work through partners with established credibility and relationships with key decision-makers increases the likelihood that philanthropic support will lead to durable policy and regulatory gains.

3. Evidence from pilots and demonstrations will reduce perceived risk and catalyze scaling of state energy transition programs and adoption of favorable clean energy policies. (medium certainty)

We think pilots and demonstrations for evidence generation play a critical role in derisking new clean energy pathways, particularly emerging deployment models and technologies. India's evolving power sector landscape—shaped by heterogeneous regulatory, demographic, and development contexts across states—requires context-specific evidence to support policymaking.[65] Experts confirmed that state policymakers and regulators often demand demonstrated feasibility before scaling new models, although uncertainty remains regarding whether pilot results reliably translate into broad adoption.

One promising example is the Global Energy Alliance for People and Planet's (GEAPP) Delhi battery energy storage pilot, India's first utility-scale standalone battery deployment.

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[64] It is, in fact, quite common in India for nonprofits and think tanks to support policymakers, national departments and ministries, and state governments with techno-economic analysis. As an example, Council on Energy, Environment and Water (CEEW), a leading climate research and policy think tank in India, describes its state-level activities as follows: "The Council has a footprint in over 20 Indian states, working extensively with 15 state governments and grassroots NGOs. Some of these engagements include supporting power sector reforms in Uttar Pradesh, Rajasthan, and Haryana; energy policy in Rajasthan, Jharkhand, and Uttarakhand; driving low-carbon transitions in Bihar, Maharashtra, and Tamil Nadu [...] " CEEW, 2025, p. iii. Similarly, Prayas (Energy Group) regularly provides direct recommendations and inputs to CERC and Centre for Energy, Environment and People (CEEP) actively engages with Rajasthan Electricity Regulatory Commission. Beyond the above-mentioned organizations, several organizations are similarly engaged with CERC and SERCs privately in shaping various aspects of electricity policy design.

[65] "Although India has made commendable progress in national economic indicators and business reforms, there exists considerable heterogeneity across states that influences growth trajectories. Understanding these differences is essential for crafting effective, state-specific policies that foster inclusive and sustainable economic development (..) The federal structure allocates significant economic policymaking and implementation responsibilities to states, which differ substantially in institutional quality, infrastructure endowment, and socioeconomic characteristics." Mani and Roy, 2025

The project achieved a levelized tariff approximately 55% below the prior benchmark by integrating demand–supply assessment, regulatory design, and financing within a single intervention. The integrated design helped generate actionable evidence and build regulatory confidence.[66] Based on this pilot and our expert interviews, evidence-generation pilots appear most effective when implemented collaboratively with state governments and led by organizations with strong prior relationships with state agencies and regulators.

We think that the "pilot template" approach can serve as a functional workaround for limited state capacity, generating context-specific evidence while strengthening decision-makers' confidence.[67] These pilots can create cascading effects, as well-documented outcomes may increase appetite for replication in states without initial political buy-in. A key risk-mitigation factor, as noted earlier, is prioritizing partner nonprofits with established credibility, strong government relationships, and clear ambition and capability to scale impact beyond the initial intervention.

Cost-Effectiveness of Decarbonizing India's Power Sector

As a rough plausibility check, we developed a cost-effectiveness analysis (CEA) to estimate the cost per metric ton of CO_2-equivalent (CO_2e) mitigated by targeting emissions reductions in India's power sector (in terms of dollars per metric ton of CO_2e removed/avoided). As a proxy for these efforts, we estimated the effect that integrated transmission and distribution modeling has on emissions reductions. Focusing this CEA on one sub-strategy—providing technical assistance to a state DISCOM with planning and modeling—means this CEA is likely not generalizable to assess the overall cost-effectiveness of decarbonizing India's power sector. Instead, it serves as a high-level sense-check of whether decarbonization efforts might be highly cost-effective. We chose to develop a more specific CEA because we think a CEA of decarbonizing India's power sector overall would include too many highly subjective guess parameters for us to have any confidence in its results.

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[66] "GEAPP, in collaboration with IndiGrid and AmpereHour Energy, assisted BSES Rajdhani Power Limited (BRPL) in commissioning the 20 MW/40 MWh BESS project in New Delhi at a record-breaking 20-month delivery schedule. GEAPP's catalytic capital attracted strong private sector interest and led to a BESS cost ~55% lower than the previous benchmark tariff in the country." GEAPP, 2025

[67] A "pilot template" approach uses early demonstration projects to generate evidence, test implementation models, and create replicable blueprints for scale-up. In the context of power sector decarbonization, it helps derisk emerging pathways, inform policy design, build institutional capacity, and crowd in larger pools of public and private investment.

The CEA estimates the emissions impact of funding integrated grid modeling in one Indian state, extending existing transmission modeling to sub-transmission and distribution networks that remain largely unmapped.[68] We assume the state's 7 GW distributed renewable energy (DRE) ambition is achieved three years earlier than in a business-as-usual scenario, and estimate emissions avoided during the additional three years, including displaced grid generation and reduction in transmission and distribution losses from locating supply closer to demand. Given actual deployment also depends on developer, financing, land, and offtake availability, we conservatively attribute only a share of this acceleration to the modeling efforts. For this CEA, we add the full cost of distribution network modeling and half of transmission network modeling costs.[69] In this analysis, we consider two scenarios, a high-impact and a low-impact, reflecting the range of acceleration of DRE deployment from the modeling work. In the high-impact scenario, we assume the modeling brings deployment forward by four years and can be attributed to 50% of the acceleration in deployment, while in the low-impact scenario, these assumptions are two years and 25%, respectively. We hold the cost of the modeling constant across scenarios.

Our best guess is that this integrated grid modeling work would avoid one tCO_2e for around 15 cents (range: 7 to 42 cents). We exclude the potential benefits of replication of the modeling framework in other states or updates to national distribution planning guidelines, as these are difficult to quantify robustly. Including these benefits would likely improve cost-effectiveness, suggesting our current estimates may be conservative.

Despite the narrow focus of this CEA, it still includes highly subjective guess parameters and should not be taken literally. Overall, our analysis estimates that decarbonizing India's power sector is highly cost-effective. We have low confidence in the ability of our CEA to estimate the general cost-effectiveness of this strategy, and focusing this analysis on one aspect of the strategy is unlikely to generalize to its overall cost-effectiveness, but we generally view it as a positive input to our overall assessment of this strategy's effectiveness. See the model for a high-level explanation as well as additional notes and citations.

[68] Such a study involves field surveys, load-flow analysis, hosting-capacity assessment, and land-suitability mapping to identify viable sites for DRE and BESS integration, reducing the need for slower trial-and-error siting.

[69] The transmission modeling is not exclusively undertaken for DRE enablement and serves multiple other purposes, but its outputs are a necessary input to the integrated model. Full allocation would therefore overstate the DRE-attributable cost, and zero allocation would understate it. Hence, we split the difference at 50% in the absence of a defensible basis for a finer allocation.

Is There Room for More Funding?

India's power sector decarbonization is severely underfunded relative to the scale of the challenge. NITI Aayog's latest modeling estimates that India's net-zero transition requires approximately $20 trillion in cumulative investment by 2070 or roughly $450 billion per year, with the power sector alone accounting for nearly half of total needs.[70] The power sector investment requirements are 12 times the current annual climate finance flows of approximately $24 billion.[71] By 2070, the cumulative financing gap is estimated to be $6.5 trillion, with the power sector comprising 82% of this shortfall.[72] Within the power sector, current flows are concentrated in mature and commercially proven technologies like utility-scale solar. Investments in grid infrastructure, long-duration storage, and industrial electrification remain largely outside the scope of mainstream finance.[73]

Within this landscape, philanthropic capital plays a small but catalytic role. Total annual philanthropic funding from foundations for climate mitigation in India averaged about $134 million between 2019 and 2023. The largest share went to clean electricity in the power sector at roughly $45 million per year, with notable funders including the Children's Investment Fund Foundation, Hewlett Foundation, MacArthur Foundation, SED Fund, and Sequoia Climate Foundation.[74]

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[70] "Of this, about $20 trillion is required specifically for the low-carbon transition, translating to $450 billion annually, almost nine times higher than the current flow of around $50 billion (annual average of FY2020-22) [...] The power sector dominates, accounting for nearly half of total investment needs." NITI Aayog, 2026

[71] "During FY 2020-22, tracked mitigation-related financial flows in India averaged INR 3,712 billion per year (approximately $50 billion) [...] In terms of sectoral allocation, clean energy attracted the largest share of 47% of total flows [$23.5 billion] [...] This gap [in the power sector] more than doubles by 2070 as financing requirements rise sharply to $12.33 trillion [$274 billion between 2025 and 2070]." NITI Aayog, 2026;

[72] "India faces a cumulative financing gap of USD 6.5 trillion by 2070, led by the power sector [...] Power constitutes 82% of this gap followed by industry & transport." NITI Aayog, 2026

[73] "Private capital continues to concentrate in commercially viable sectors like utility-scale renewables and energy-efficient appliances, while MSMEs, adaptation infrastructure, and early-stage clean technologies remain underserved [...] In contrast (to mature renewables attracting private financing), low TRL solutions such as gridscale storage, hydrogen electrolysers, and CCUS face higher perceived risks, requiring blended finance, concessional loans, strategic equity, and risk-sharing mechanisms to attract investment." NITI Aayog, 2026

[74] Table 1. Known foundation funding by region, sectors and strategies, annual average, 2019 to 2023, USD millions. ClimateWorks Foundation, 2024. ClimateWorks Foundation provides a breakdown of foundation funding by country and sector and hence, there is little to no visibility into breakdown of individual giving. Based on our conversation with other funders, we think foundation giving is the primary source of philanthropic funding for climate mitigation in India, with total annual philanthropic funding estimated at approximately $120 million to $150 million.

We think that, relative to India's emissions profile, the philanthropic funding landscape represents a significant misallocation. Philanthropic support for climate mitigation in India stands at roughly 3 cents per tCO_2e, which is five to six times lower than levels in the United States and the European Union, at 19 cents per tCO_2e and 14 cents per tCO_2e, respectively.[75] Even within the power sector, capital remains concentrated in visible, commercially proven solutions. An assessment by India Climate Collaborative (ICC) found that efficient transmission, distribution, and storage were among the least-funded sub-sectors across all funder categories from 2018 to 2023. The ICC assessment indicates a striking neglect of high-leverage philanthropic approaches. Overall, implementation support for grassroots work accounted for 62% of all climate philanthropic capital in India, while capacity building, evidence generation, policy support, and innovative financing—crucial to strengthening India's climate ecosystem—received limited attention and remained severely underfunded.[76]

Against this backdrop, a few recent developments suggest growing momentum toward select underfunded areas. GEAPP—a philanthropic alliance backed by the Rockefeller Foundation, IKEA Foundation, and Bezos Earth Fund—launched its India Grids of the Future initiative with a $25 million commitment for grid modernization. The initiative aims to build a flexible and renewables-ready grid infrastructure targeting 15+ utilities and mobilizing $100 million in financing by 2030.[77] This initiative inherently has a subnational focus as its primary engagement is with state utilities. We see a similar shift from other funders to support subnational climate action as the role of states becomes more relevant in India's power sector decarbonization.[78]

On the public sector front, NITI Aayog launched the ASSET platform to support state energy transitions. Along with civil society or nonprofit partners, it aims to facilitate prioritization and structuring of green infrastructure projects for investment, targeting early wins in storage, grid modernization, and electrification where aggregation and standardized contracting can quickly improve bankability for private capital. We see philanthropic support for ASSET's state-level activities as a high-leverage opportunity, given the strong likelihood of scale-up driven by national and state-level buy-in.

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[75] Calculated based on emissions data from EDGAR and foundation giving data from ClimateWorks Foundation. India: 4.3 billion tCO_2e emissions, $134 million funding; United States: 5.9 billion tCO_2e emissions, $1.3 billion funding; European Union: 3.2 billion tCO_2e emissions, $447 million funding. Crippa et al., 2025; ClimateWorks Foundation, 2024

[76] "Implementation support (62%), evidence building (15%), and capacity building (12%) were considered key levers for climate action in India – capturing a total 89% of mapped capital. The power sector, which receives the bulk of funding across sectors, seemed most focused on implementation–that is funding moved towards deployment of solutions for end-beneficiaries (~39% for grassroot support) and testing out innovations in financing solutions, instead of evidence building." ICC, 2024

[77] "Through this integrated approach, the initiative aims to support 15 or more utilities[...]The Accelerator will onboard an initial cohort of utilities for early implementation, convene government partners, technology providers, investors, and philanthropic funders into a delivery-focused coalition, and build toward a three-year, $100 million fundraising effort from 2026 to 2028 to unlock large-scale public and private investment." GEAPP, 2026

[78] Noted based on our conversations with funders in India as well as public announcements by funders such as Children's Investment Fund Foundation. CIFF, 2024

We have been deliberate in designing our four sub-strategies to target the most underfunded and highest-leverage opportunities for India's power sector decarbonization. Specifically, our focus on grid infrastructure, subnational capacity building, diversified clean energy, and deployment in underserved and lagging regions aims to directly address the identified gaps. In parallel, our emphasis on systemic philanthropic levers such as policy support, state-level technical assistance, capacity building, and evidence generation helps strengthen the foundations for long-term change in critical areas that remain relatively underfunded today.

Are There Major Co-Benefits or Potential Risks?

Co-Benefits

- **Expanded energy access and local economic development:** New deployment models—particularly agriPV, community solar, and floating solar—can expand energy access in rural and agrarian areas, as well as in communities with limited grid connectivity or high dependence on biomass and conventional energy sources. Improved electricity access can, in turn, support higher economic productivity, better quality of life, and improved livelihoods.[79]
- **Energy security and reduced import dependence:** India imports a significant share of its oil and natural gas needs.[80] Accelerating domestic clean energy capacity can reduce import dependence and strengthen energy security, a key national priority with broad political support.[81]
- **Air quality and public health benefits:** Combustion of conventional energy sources and biomass is a major contributor to India's severe air pollution burden, with conventional energy use for power generation estimated to account for

[79] "This paper identifies rural electrification, water conservation, yield improvement, sustainable income generation, and reduction in the usage of pesticides as the strengths of agrivoltaics. The research concludes with the findings that agrivoltaics have the potential of meeting multiple objectives such as meeting global commitments, offering employment, providing economic stability, increasing clean energy production capacity, conserving natural resources, and succeeding in several others." Mahto et al., 2021

[80] "Local oil and gas producers, including state-run Oil and Natural Gas Corp and Oil India, produce only a fraction of India's overall demand, forcing the nation to rely on imports to meet more than 90% of its oil requirement and half of its natural gas needs." Reuters, 2026

[81] "India, the world's third biggest oil importer and consumer, has been hit hard by the U.S.-Israeli war on Iran that has badly disrupted energy shipments via the Strait of Hormuz." Reuters, 2026; "India's own energy transition goals have always been pursued within the broader framework of its domestic energy security, with an all-of-the-above approach to capacity addition." Sustainable Futures Collaborative, 2025

5–10% of deaths from ambient fine particulate matter exposure.[82] The economic losses associated with the health burden of air pollution are expected to reach $86 billion by 2050 under a business-as-usual scenario.[83] Increasing the share of clean power generation is therefore critical to reducing air pollution-related health burden and associated economic losses.

- **Job creation for the power sector:** A well-managed energy transition in a net-zero scenario can increase employment by 11-14% across clean energy manufacturing, installation, grid infrastructure, and services.[84] This transition could also support 1.28 million full-time jobs in renewable energy manufacturing and operations and maintenance, highlighting the employment potential of India's ambition to become a global clean energy manufacturing hub.[85]

Potential Risks

- **Affordability and energy access:** A rapid transition away from conventional energy could create affordability or energy access challenges if energy demand outpaces clean energy deployment, or if transition costs are borne disproportionately by low-income and vulnerable communities. Decarbonization efforts should therefore prioritize maintaining reliable and affordable power supply alongside the continued expansion of energy access.

- **Regional inequalities:** Without targeted intervention, the benefits of India's power sector decarbonization will remain concentrated in states with stronger infrastructure, regulatory capacity, and access to capital.[86] Our focus on

[82] "Thermal power plants, pollution from vehicles, industrial emissions, burning of crop residue and the burning of wood and dirty fuels for cooking and heating are some of the main causes of air pollution in India." Clean Air Fund, 2024; "Exposure to ambient fine particulate matter (PM2.5) pollution is estimated to account for 0.98 million (95% uncertainty interval: 0.77–1.19 million) premature deaths per year in India, approximately 10% of total annual deaths in the country. Numerous studies have estimated the aggregate premature mortality burden of India's coal fleet by combining air quality models with concentration-response functions, as well as quasi-experimental methods, and their estimates range from just under 50,000 to approximately 100,000 deaths per year." Singh et al., 2025

[83] "If India follows the BAU pathway, the aggregated annual economic loss attributable to air pollution health burden would be 75.5 billion (58.9–92.1) Euros by 2050, in which premature deaths and DALYs would account for 62.1 billion (53.4–70.8) and 13.4 billion (11.4–15.4), respectively." Sarkar et al., 2025

[84] "With rapid expansion in clean energy, energy sector jobs will increase to 7 million by 2050 (1 million or 14% higher than Current Policy Scenario) and 4.5 million in 2070 (0.5 million or 11% higher than Current Policy Scenario)." NITI Aayog, 2026

[85] "India's target of 500 GW of non-fossil fuel capacity (including nuclear) and goals under the National Green Hydrogen Mission are projected to generate more than 4.4 million FTE jobs [by 2030]. Renewable energy sectors analyzed as part of this study are estimated to create more than 4.1 million FTE jobs. Of these, approximately 12.8 lakh (1.28 million) FTE jobs are expected to be under the operations and maintenance and manufacturing phases which are sustained over the lifetime of the project and plant." MNRE, CEEW and NRDC, 2026

[86] "An energy transition that advances unevenly across states risks producing a two-speed India: one that attracts green capital, new industry, and infrastructure, and another that remains

geographic diversification, alternative deployment models, and economic diversification directly addresses this risk, though limited institutional capacity and buy-in from lagging states may lead to slower adoption.

Key Uncertainties and Open Questions

- **Development–decarbonization trade-offs:** A shift in the political landscape and priorities could weaken support for decarbonization if it is perceived to be in conflict with affordability, industrial growth, or energy access. Our focus on lowering system costs, improving grid reliability, and supporting economically viable transition pathways is intended to reduce these trade-offs, though a shift in political priorities could lead to slower adoption and implementation.

- **Significance of emerging clean energy technologies:** We are uncertain about the pace at which nuclear, geothermal, and geologic hydrogen will achieve cost competitiveness in the Indian context.[87] Global cost trajectories are unlikely to directly translate due to differences in supply chain networks, infrastructure readiness, workforce availability, and site-specific conditions.

  As an example, offshore wind faces several implementation constraints despite its technological maturity. Early large-scale tenders in India have seen limited developer participation, reflecting dependence on imported components, underdeveloped port infrastructure, and limited availability of specialized vessels. Initial viability gap funding mechanisms have not yet been sufficient to attract competitive bids, leading to ongoing revisions in commercial frameworks by Solar Energy Corporation of India (SECI).[88] For geothermal and geologic hydrogen, uncertainty is even greater given the early stages of exploration in India.[89] We

burdened by stressed DISCOMs, stranded assets and rising political resistance. Such asymmetry does not just slow the transition; it undermines the federal coherence of the transition itself." ORF, 2026

[87] Among these technologies, nuclear energy appears the most promising due to strong government support through the Nuclear Energy Mission (2025). However, even with a target of 100 GW by 2047, it is expected to account for less than 3% of the energy mix. NITI Aayog, 2026 (see Table E3: Power Sector Summary of Results)

[88] "The Viability Gap Funding (VGF) Scheme aims at supporting infrastructure projects that are economically justified but fall marginally short of financial viability." Invest India, 2026; "Two landmark auctions [for offshore wind] found little interest from developers and were eventually called off in 2025 (..) India's tendering model even produced an uncovered gap: even after VGF subsidy, the levelised cost of generating electricity was about INR 5/kWh higher than the pre-determined tariff at INR 4.5/kWh." EMBER, 2025

[89] India's geothermal sector remains nascent, as reflected in the Ministry of New and Renewable Energy's first draft geothermal policy (2025) which focuses on conventional systems while acknowledging the future potential of enhanced and advanced geothermal systems.

therefore see a stronger case for philanthropic engagement focused on research, techno-economic analysis, and identification of enabling conditions for future scale-up, rather than implementation-oriented policy reforms and finance mobilization.

- **Tractability and effectiveness of targeted DISCOM reforms:** DISCOM financial distress has persisted despite repeated central and state-level reform efforts over the past two decades, raising legitimate questions about the extent to which philanthropic interventions can shift outcomes. Our interviews with experts and nonprofits working with utilities indicate that increasing strain on the grid has become a driving force more recently for DISCOMs across several states to actively seek support to navigate the evolving power sector landscape.[90] We see potential in a geographically targeted strategy to provide technical assistance and capacity building support in states demonstrating political and administrative willingness, where early gains can build momentum for broader adoption.

Bottom Line and Next Steps

India's power sector decarbonization represents one of the highest-leverage opportunities in global climate philanthropy. The scale of potential impact—driven by India's large and growing emissions, ambitious clean energy targets, and role as a pioneer for LMICs—is matched by deep structural barriers that philanthropy is well positioned to address. Further, supporting India's power sector decarbonization can generate actionable lessons and models for other LMICs navigating similar challenges around rising energy demand, affordability, reliability, and decarbonization.

Based on our research into relevant mitigation sub-strategies, we believe advancing research and pilots to derisk underexplored pathways for scaling clean energy, providing technical assistance to state utilities, governments, and institutions with policy design, planning, and implementation, and supporting research and pilots to accelerate industrial electrification could substantially reduce emissions. Due to the low level of funding that decarbonization of India's power sector has received relative to its projected share of future emissions, we plan to consider organizations working on these topics for our Top Climate Nonprofits and as potential grantees from the Giving Green Fund.

We plan to actively identify and support organizations working toward the interventions outlined in this report. The findings will inform the grantmaking strategy for the Giving Green Fund and our list of Top Climate Nonprofits. We will continue to refine our assessment of the most effective interventions within each sub-strategy, with particular attention to organizations working in lagging states and in the most under-resourced areas. Donors interested in supporting this work can consider donating directly to the Giving Green Fund.

[90] Experts noted that DISCOMs in Delhi, Tamil Nadu, Chandigarh, and Andhra Pradesh are seeking support on wholesale market design, distributed renewable integration, and system planning.

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Giving Green

Giving Green was founded to help donors cut through the complexity of climate philanthropy and direct their resources for maximum impact.

Our founder, Dan Stein, Ph.D., spent 15 years developing evidence-based strategies in global philanthropy. He saw people eager to fight climate change but paralyzed by its scale. In 2019, with support from IDinsight, he launched Giving Green to rigorously evaluate solutions and share clear guidance.

What began as a side project is now a team directing tens of millions of dollars to high-impact initiatives. Our success is shared—with donors ranging from kids donating allowances to retirees investing in a better future. We believe anyone can start small and still make a huge difference.

Thank you for joining us on the path to net zero. Together, we keep moving forward.