# The planned capacity growth failure of India's 1998 Policy on Hydro Power Development, and its negative environmental and community externalities.

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## Introduction

India's energy system has changed drastically since the 1990s, driven by rapid economic growth and subsequent electricity demand, as well as evolving energy security priorities and a renewed focus on environmental sustainability. In this context, hydropower has been a longstanding central position in India's power development scheme. Unlike coal, a highly emissive and polluting power source that has historically supplied most of India's electricity, hydropower is a longstanding technology that has been positioned as a clean, renewable, and domestically abundant resource capable of supporting economic development *and* environmental objectives. India possesses an estimated 84,044 MW of economically exploitable hydropower potential, largely focused on the Himalayan river basins (Central Electricity Authority, n.d.). However, by the late 1990s, hydropower's contribution to the national power mix fell well short of the 40:60 hydro-thermal power split that was a central goal of the Indian government.

It was against this landscape that the Government of India introduced the 1998 Policy on Hydro Power Development, meant to accelerate hydropower deployment and address the stagnation. It sought to address delays in project implementation, encourage private-sector participation, modernize tariff regimes, provide fiscal and procedural incentives, and streamline environmental clearances. However, the decade that followed demonstrates a more complicated reality, with the scale of expansion falling significantly short of national planning targets outlined in the Ninth and Tenth Five-Year Plans. There were issues of regulatory bottlenecks, delays in land acquisition, financing constraints, and environmental and social challenges. Furthermore, the focus on North-Eastern and Northern (Himalayan) areas intensified environmental impacts and created concerns about ecosystem fragility, sediment dynamics, river regulation, disaster risk, and community displacement. The central research question guiding this paper is:

### To what extent did the 1998 Policy on Hydro Power Development influence hydropower capacity expansion in India between 1998 and 2008, and how did these capacity outcomes relate to the environmental impacts experienced during this period?

In this paper, I will evaluate the goals of the 1998 Policy on Hydro Power Development and break down why it was unable to achieve its goals meaningfully

because of too much focus on institutional and financial reforms and a lack of focus on environmental drawbacks and community/population displacement, and damage. I will then evaluate the environmental implications of this policy and contribute to a limited knowledge base on the actual impacts of specific historical policy changes in the Global South in the sustainable energy, and particularly hydropower, space.

Understanding these dynamics is critical in the modern landscape, as India is now re-evaluating the role of hydropower in its contemporary energy transition. While hydropower offers low emissions and grid flexibility, the challenges encountered after the 1998 policy underscore the need for much more robust planning, environmental safeguards, and community-centered governance frameworks. This paper aims to contribute to a more nuanced understanding of hydropower's place in India's future energy strategy.

# Literature Review

Prior studies on hydropower development in India span policy and governance analyses, technical and environmental studies, and research on institutional capacity and social impacts. Overall, the literature on hydropower in India is not very extensive, with much evaluation needed regarding the efficacy of existing projects. By addressing the background of Indian policy, measurement metrics, and larger institutional challenges, this paper will explore the capacity-outcome success of this policy and how environmental, social, and other negative externalities affected the success of this policy throughout the following decade.

## Policy and Governance Literature

The foundational literature indicates issues in India concerning the specific policy, as well as the landscape. The Policy on Hydropower Development 1998 stated that "apart from technical, financial and tariff related issues, socio-political issues like land acquisition...resulted in a decline in hydropower capacity investment (Choudhury 2013)." Scholars generally agree that hydropower governance in India suffers from persistent regulatory fragmentation, though they differ on whether institutional weakness or political resistance constitutes the primary barrier (Singh, 2006; Choudhury, 2013). There were also general issues with the state of the Indian Power sector during the period of evaluation for this research question. Singh (2006) explores the major policy and regulatory challenges in the sector since 1991, spanning pre- and post-1998 Hydro Policy. It explains important context for the period, such as the 1995 Mega Power Policy, which dictated that plants above 1000MW capacity would receive additional tax incentives and exemptions from customs duty for imports. The specific regulatory issues were again explored by the World Bank (2012), stating that India was still in a situation with a key need for power. It essentially implies that the Policy on Hydro-Power Development was not as effective as it should've been, since India's hydropower capacity share has not kept up with its rapidly increasing need for power. It also explains the advantages of hydropower, such as producing renewable and clean energy, quick start-up/shutdown, not being subject to

fluctuations in fuel costs, and an overall productive and long-lived lifespan for hydropower plants. It also explains some of the pitfalls that exist, such as environmental and social impacts such including public consultation of people affected by the projects, long-term monitoring of the environmental and social aspects, and issues regarding resettlement policy and practice. Hydropower's history in India is also explored, with hydropower contributing nearly 40% of total energy generation capacity at the time of India's independence until the 1980s, but sharply falling in the decades after to only 25% in the early 2000s (Pandit et. al 2023). Notably, India's per capita electricity consumption is extremely low, and expanded electricity generation in rural and underdeveloped areas (something that hydropower excels in) could help expand per-capita electricity use, assisting the country with development. While World Bank (2012) reports rely heavily on project-level performance metrics, they overlook cumulative upstream-downstream ecological effects that environmental scholars identify as critical (Ravindranath & Sukumar, 1998, Choudhury, 2013). There is also an exploration of the legal-economic design of hydropower development in Karambelkar (2017), which explored four phases of hydroelectric development in India in the periods of 1947-1967, 1967-2984, 1984-1991, and 1991 to the present. This is important to help set the stage for the exploration of this research question.

## Technical Foundations and Environmental Impacts of Hydropower

Technical information and statistics about hydropower in India are limited. Chala et. al (2019) explore trends in an increased dependence on hydropower energy utilization, particularly in countries with many hills and a lot of rivers. It also explains the advantages of hydropower, such as producing renewable and clean energy, quick start-up/shutdown, not being subject to fluctuations in fuel costs, and an overall productive and long-lived lifespan for hydropower plants. Furthermore, they explain that hydroelectric power plants offset high upfront costs with low operating and maintenance costs. Hydropower project costs vary greatly and are unpredictable, currently ranging from $1,050 to $8000 per kilowatt depending on the size and scope of the project. Capital expenditures also vary because there is an option to build on existing, non-powered dams. Technical and market-oriented studies (Chala et al. 2019; Srivastava & Misra 2024) tend to emphasize hydropower's cost-effectiveness and reliability, yet environmental analyses demonstrate that these benefits are contingent on geographic and ecological context. In Himalayan regions, studies show disproportionately high ecological, sedimentation, and disaster risks (Ravindranath & Sukumar 1998; Pandit et al. 2023), demonstrating a tension between hydropower's theoretical advantages and its realized impacts. As explained by the 1998 Policy on Hydro Power Development, India's goal for hydropower implementation was a 40:60 split between hydro and thermal

power. Mishra et al. (2015) explore the advantages and disadvantages of hydro power in India, exploring reliability, flexibility, vegetation, and fishery, and safety considerations in favor of the policies. They explain impoundment, diversion, and pumped storage hydropower variations, and concluded that hydropower plants have the lowest operating costs and longest lives. India also has small hydro generation, which is defined as 1MW-25MW capacity (Pillai and Banerjee 2009).

### Institutional Capacity, Social Impact, and Implementation Challenges

Choudhury (2013) highlights socio-political sources of delay. He explains the gamut of regulatory and cultural/political challenges, and how they can affect the process of launching a hydroelectric project. Verma (2024) explores rehabilitation and development in hydropower-affected communities in India, showing that there are concrete community-level impacts that make an overall evaluation of the success of hydropower policies more challenging. Raj (2025) complements this by discussing community-level displacement, livelihood loss, and administrative failures in resettlement and reconciliation. Collectively, these scholars reveal that failures in resettlement, compensation, and local governance are not peripheral issues but central determinants of hydropower project outcomes. The social disruptions documented by Verma (2024) and Raj (2025) reinforce Choudhury's argument that institutional weakness and socio-political resistance are structurally embedded, shaping both project timelines and lived experience in affected communities.

Overall, there are several glaring gaps in the literature for a concrete evaluation of specific hydro power policies in India. First, there is simply a lack of concrete data for these years. Much of the data is unavailable or has been pulled from the internet in recent years, making these types of evaluations difficult in the first place. Second, there is a gap in actual evaluative literature that explores specific energy policy in India, and in the Global South more generally. There are evaluations of the overall stage that is set, as well as an exploration of past policy and regulatory landscape. However, there is no exploration of how effective various policies are in India. This is an important contribution. The various hydro power initiatives in India, both before and after this bill, were less than effective at substantially increasing hydro capacity. By evaluating policy failures, both India and other emerging economies can learn and implement more effective policies for an energy transition.

## Analysis

### Methodology

This paper uses a qualitative policy analysis that combines document review, secondary data analysis, and thematic synthesis. I start by analyzing the stated objectives and policy instruments of the 1998 Policy on Hydro Power Development using primary government documents, namely the policy text. I then compare these goals to actual hydropower capacity additions using installed-capacity statistics from the Central Electricity Authority (CEA). Finally, I

explore the environmental and social impacts by reviewing empirical studies, World Bank assessments, and independent environmental organizations. Combining these approaches has allowed an evaluation of both policy effectiveness and policy externalities, linking implementation outcomes to the institutional and ecological constraints identified in the literature.

## India's 1998 Policy on Hydro Power Development as a Capacity Expansion Strategy:

The 1998 Policy on Hydro Power Development was designed (at a high level) to "prevent a decline in hydro share and to undertake measures for the exploitation of vast hydro-electric potential in the country, especially in the North and Northeastern Region (India Ministry of Power)." India has enormous hydropower potential. The bill in question assessed that at a 60% load factor, the total hydropower potential in India was 84,044 MW. India listed their goals and plans for accomplishing them as follows in the initial policy:

"(I) Ensuring targetted capacity addition during 9th Plan;
(ii) Exploitation of vast hydroelectric potential at a faster pace;
(iii) Promoting small and mini hydel projects;
(iv) Strengthening the role of PSUs/SEBs for taking up new hydel projects;
(v) Increasing private investment.

The objectives would be achieved by using the following policy instruments:

(I) Providing adequate funds in the Central/State Government budget and organising supplementary funding through Power Finance Corporation.
(ii) Entrusting basin wise development to Central Hydel Public Sector Corporations.
(iii) Funding support for Survey and Investigations.
(iv) Establishing a Power Development Fund by levy of cess on electricity consumed and using two-third of the proceeds to promote power development by the State Governments. The remaining one-third will be utilised by the Central Government for promoting hydel projects in the Central Sector and for investment in transmission lines for evacuation of power from inter-State mega hydel projects.
(v) Providing a differential pricing for peaking power to facilitate greater investment in hydel projects which have the capability to supply peaking power in a cost effective manner.
(vi) Providing an institutional mechanism for dealing with geological risks.
(vii) Utilising the joint venture frame work for promoting hydel projects.
(viii) Simplification of procedures relating to transfer of clearances from State Government to Central Public Sector Undertakings and State Government to private sector.
(ix) Enhancing the ceiling limits for techno-economic clearance by CEA in respect of projects promoted on the MOU route.
(x) Transfer of work relating to the development of small hydel projects up to 25 MW capacity from Ministry of Power to Ministry of Non-Conventional Energy Sources and providing a suitable incentive package."

This policy is a response to a falling hydro capacity share. The policy explains that as of 7/31/1998, only 15% of the 84,044MW potential was being used, with

the completion of current construction projects bringing the utilization to 22%. This fell short of the 40:60 hydro-to-thermal mix goal stated in the policy. Furthermore, hydropower's share of installed capacity had steadily fallen, from over 50% in the 1960s and 1970s to under 25% by the late 1990s (Choudhury, 2013). This policy aimed to expand on this capacity.

At the core of the policy was a belief that hydropower development was being hindered by financial and procedural delays, so it focused heavily on streamlining project clearances, accelerating land acquisition, standardizing rehabilitation and resettlement procedures, and providing fiscal incentives (accelerated depreciation, a standardized two-part tariff, and 12% free power to host states (Government of India, 1998, Singh, 2006). However, as noted by Karambelkar (2017), the policy treated environmental review processes (e.g., Environmental Impact Assessments) as administrative bottlenecks. Given the focus on the North and North-Eastern (Himalayan) regions, rapid expansion to those regions endangered ecosystems, and the clearance processes were burdensome.

A clear assumption embedded in the policy was that capacity expansion itself was inherently environmentally beneficial because of the emission reductions. It did not distinguish between emissions reductions and localized ecological impacts (e.g., deforestation, altered sediment regimes, disrupted aquatic ecosystems, and displacement of tribal and rural communities (World Bank, 2012)). This reflected a broader trend in Indian energy governance: project-level EIAs were the primary environmental regulatory tool, and cumulative ecological impacts were rarely considered (Choudhury, 2013). As Pandit et al. (2023) show, the belief that hydropower is "clean" allowed for many Indian hydropower projects to produce disproportionately high environmental costs per MW in landslide-prone Himalayan valleys.

The policy also assumed that faster decision-making would reduce cost overruns and restore competitiveness with thermal and emerging renewable technologies. However, it led to rushed or inadequate environmental assessments, triggering litigation, public protests, and subsequent delays (Defending nature, defending lives: Activists' stories of resisting hydropower**,** n.d.). Choudhury (2013) observed that projects approved during this era experienced some of the highest delay rates and cost escalations in India's energy sector. Stalling in dam construction creates its own environmental impacts as well, such as collecting trash and debris in the partially completed dams, further disrupting ecosystems and living conditions for local communities (Incomplete hydroelectric dams collect debris, n.d.).

The 1998 hydropower policy was designed around two linked assumptions that proved too optimistic:

1. That institutional and financial reforms, rather than environmental constraints, were the primary barriers to capacity expansion, and
2. That hydropower's environmental benefits (low carbon intensity) outweighed its localized ecological risks, making rapid expansion more desirable.

These assumptions shaped the policy's design in a way that profoundly affected the relationship between hydropower capacity and environmental impact. There were virtually no environmental protections structurally embedded in the implementation framework, which massively hindered the success of the bill.

## Installed Capacity Outcomes, 1998-2008

The 1998 Policy on Hydro Power Development's goals of accelerating hydropower capacity additions by improving project clearance procedures, increasing private-sector involvement, and expanding access to financing mechanisms were ultimately unsuccessful. The actual capacity addition during the decade following the policy fell far short of national planning expectations. According to the Central Electricity Authority's historical dataset, India's installed hydropower capacity grew from roughly 21,658 MW in 1998 to about 34,534 MW by 2007, falling well short of the policy's goals of increasing hydropower's share to 40:60, which would have brought India's hydro share up to 54,800 MW (Central Electricity Authority, n.d.). Capacity growth based on Five-Year Plans can be explored in Figure 1.

Figure 2 demonstrates that, as of 2020, Northeast India remains the sector of India with the highest capacity yet to be developed for hydropower, showing a longstanding lack of development that was not addressed by the 1998 Policy on Hydro Power Development. Several factors contributed to this underperformance. As previously stated, these projects were focused on Himalayan states, where environmental factors such as difficult terrain, geological instability, and extreme weather lengthened construction schedules. Second, studies examining commissioning delays also show that hydropower projects more frequently experience 10–15-year gestation periods, compared to 4-6 years for thermal plants (World Bank, 2012). Third, land acquisition and rehabilitation requirements remained a significant bottleneck. As explained by Karambelkar (2017) in her legal-institutional analysis, state governments often lacked an administrative capacity to complete land surveys, negotiate compensation packages, and implement resettlement plans. This caused repeated project delays. Fourth, the private-sector investment that the policy dictated did not materialize. As explained by Singh (2006), hydropower presents many financing risks, such as unpredictable hydrology, high upfront capital costs, litigation risk, and the possibility of time extension on environmental clearances. As such, private-sector participation remained extremely limited following the 1998 policy, despite the policy's explicit focus on attracting private investment (Singh 2006, World Bank, 2012). Finally, the rise of coal and the early commercial availability of natural gas created an incentive mismatch: thermal projects offered a lower cost per MW, fewer regulatory hurdles, and shorter construction timelines. Hydro increasingly became a high-risk and slower-moving segment of the Indian energy system (Pandit et al., 2023).

Figure 1: Plan wise Growth of Installed Capacity in India Hydro Electric Power Stations. Central Electricity Authority, Oct. 2020.

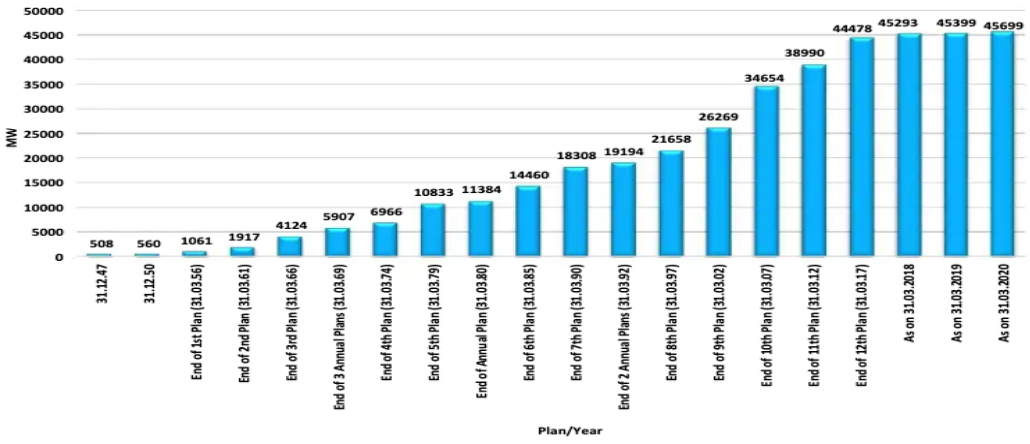
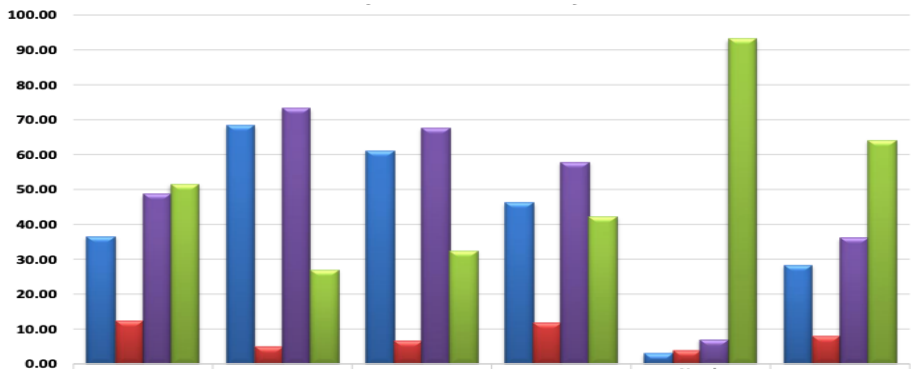



Figure 2: Region wise Status of Hydro Electric Potential Development In terms of Installed Capacity above 25 MW %wise (As on 31.03.2020). Central Electricity Authority, Oct. 2020.



| | Northern Region | Western Region | Southern Region | Eastern Region | North Eastern Region | All India |
|---|---|---|---|---|---|---|
| % Capacity Developed /Under Operation | 36.40 | 68.28 | 60.97 | 46.09 | 2.96 | 28.15 |
| %Cap. Under Construction | 12.21 | 4.92 | 6.67 | 11.73 | 3.94 | 7.84 |
| %Cap. Dev. +Under Construction | 48.61 | 73.20 | 67.65 | 57.82 | 6.90 | 35.99 |
| % Capacity yet to be Developed | 51.39 | 26.80 | 32.35 | 42.18 | 93.10 | 64.01 |

Hydropower capacity between 1998-2008 *did* increase, but not at the scale or pace that was outlined in the 1998 Hydro Power Development Policy. That said, the environmental footprint of these projects was incurred nonetheless and had some devastating impacts on ecosystems and communities.

## Environmental Implications of Limited and Uneven Capacity Expansion

Hydropower development has environmental impacts that are front-loaded upon construction, not during operation (U.S. Energy Information Administration, n.d.). These include obstruction of fish migration, changes in natural water temperatures, water chemistry, river flow characteristics, and silt

loads. All of these can affect the ecology and physical characteristics of a river. This can result in damage to native plants and animals in and around the river, as well as the relocation of people. Overall, the environmental impact not only affects the area in which a reservoir is created, but a much wider radius around the dam as well.

Projects launched after 1998 were heavily concentrated in the Himalayas (Choudhury 2013), and these basins are characterized by steep slopes, dense forests, and high biodiversity. The World Bank (2012) notes that hydropower development in these regions often requires access to roads, repeated blasting, and tree-felling, even before generating any power. Ravindranth and Sukumar (1998) show that even "run-of-river" projects can lead to fragmentation of wildlife habitats and reductions in forest cover.

Expanding on river flow alteration and sediment disruption, hydropower projects built during this period significantly altered natural river flows through diversion tunnels, barrages, and peaking operations (IFC n.d.). Furthermore, environmental researchers note that projects left incomplete or delayed still cause river alteration because of how early in the construction timeline river diversion is. Environmental harm is incurred even when capacity never materializes (Sandrp, 2025).

Finally, there were substantial social and community impacts. Projects undertaken after the 1998 policy had significant amounts of displacement (e.g., in Himachal Pradesh, Uttarakhand, and the Northeast (Planning Commission, n.d., Raj, 2025)). Numerous cases also show instances where displaced households experienced loss of livelihood well before hydropower capacity became operational, e.g., Sardar Sarovar Dam, Tehri Dam, and the Indira Sagar Project. Between river flow and sediment disruption, forest and ecology change, and the social/community impacts of this policy, there was clearly a high environmental cost per MW for this hydropower. This ties into issues of energy equity, where the benefits of sustainable energy initiatives are not equally distributed to all populations and disproportionately affect certain communities. As Pandit et al. (2023) note, hydropower can be environmentally efficient if projects deliver high, stable output, but that assumption can collapse in the face of:

- Delays,
- Low plant factors,
- Cost overruns,
- Or non-commissioned projects.

In the case of the 1998 Hydro policy, the environmental costs (land loss, construction impacts, and displacement) were incurred upfront, and the capacity benefits were delivered years later, at a smaller scale, or not at all. Overall, the policy was not supported by a basin-level cumulative impact assessment framework. Each project underwent a stand-alone Environmental Impact Assessment, which did not account for the environmental fallout. The Ministry of Environment, Forest and Climate Change has since addressed this issue by standardizing its EIA criteria (Ministry of Environment, Forest and Climate Change, n.d.). The environmental impacts of this policy were not taken into consideration at the point of its inception, which delivered both a shortfall of their target capacity and intense

environmental and community negative externalities.

# Conclusion:

## Was the 2008 Policy on Hydro Power Development Environmentally Effective?

Overall, hydropower expansion did not substantially reduce emissions intensity. Between 1997 and 2009, energy industry emissions increased by 288,571,910 tons of CO2 annually in India (Worldometer, n.d.). The proposed hydropower emissions reductions did not scale along with the increased need for energy and the subsequent increase in emissions. Furthermore, there was lasting ecological and community damage, which brought into question the policy's true sustainability and raised concerns about energy equity and negative externalities. The policy design in no way anticipated or accommodated long-term ecological costs, which limited the true impact that this policy could have.

## Implications for Energy Policy Design

Future policy designs can learn many lessons from this policy failure. They could learn about the need for basin-level planning by requiring individual evaluations of each of the sites, with more stringent and standardized Environmental Impact Assessments. These could be achieved by aligning with European Commission Strategic Environmental Assessment standards, for example. There needs to be evaluations of ecological impacts, river flow impacts, cultural/community impacts (e.g., displacement, fishing disruptions, etc.), and disaster resilience evaluations. In general, countries should develop frameworks to give cumulative impact assessments for each project, in the process of which aligning output targets with ecological limits.

## Lessons Beyond India

Hydro power is a tempting and often plentiful resource in emerging economies and in the Global South. Lessons from this could be used to help emerging economies more sustainably develop hydropower and choose wisely when, where, and why they should implement hydropower solutions. One of the most important lessons to learn is to frontload your policy evaluations with environmental regulations and equitable planning, before committing to these hydropower solutions.

## Contribution

This paper adds value to the existing literature by explicitly linking policy to output and comparing that against environmental impacts. This framework is important for learning from the successes and failures of environmental and energy policy. Furthermore, exploring these policy successes and failures, particularly in the Global South, allows for a more realistic and measured example for other developing economies. Evaluating policy frameworks in the Global North can set expectations that are not realistic in the Global South due to government capacity limitations, economic limitations, etc. By exploring other successes and failures in the Global South, there can be a better example set for countries in a similar economic basket, so to speak. Understanding these dynamics is increasingly important in the modern landscape, as much of the Global

South is now re-evaluating the role of hydropower in its contemporary energy transition. This paper contributes to a more nuanced understanding of hydropower's place in India's future energy strategy, as well as generates an applicable example for other developing economies to take note of when planning their own energy transitions.

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