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Harnessing Himalayan Hydropower for a Sustainable Future: Policy Frameworks and Regional Strategies in India with a Focus on Jammu & Kashmir

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Abstract: ***The Himalayan region holds a significant share of India's untapped hydroelectric potential, critical for the nation's transition to clean energy. This paper analyses the evolving policy landscape at both national and subnational levels that seeks to harness this renewable resource. It explores the alignment of hydroelectric development with India's climate commitments, the challenges of implementation in mountainous regions, and innovative regional strategies particularly the Draft Hydro Power Policy 2025 of Jammu & Kashmir. Through a comprehensive review of official data, policy documents, and international climate obligations, the paper identifies critical gaps in existing frameworks and proposes a multi-dimensional strategy to accelerate environmentally sound, inclusive, and economically viable hydroelectric development in the Indian Himalayas. The study proposes a multi-dimensional and inclusive governance models that balances energy security with ecological preservation and community participation.***

Keywords: Hydroelectric Development, Renewable energy, Himalayan Region, Clean Energy Policy, Ecological Preservation, Community Participation

1. Introduction

India, as the world's third-largest energy consumer, is undergoing a transformative shift in its energy policy architecture, prioritising sustainability and carbon neutrality. With a net-zero emissions target set for 2070 (GoI, 2021), hydropower offers a viable complement to solar and wind due to its dispatchability and long operational life. Among India's renewable energy resources, the Himalayas spanning Jammu & Kashmir, Himachal Pradesh, Uttarakhand, Sikkim, and Arunachal Pradesh represent a strategic but underutilised asset. Housing nearly 50% of country's untapped hydroelectric potential, the Himalayan region is a major force in country's renewable strategy. The Central Electricity Authority (CEA) estimates India's total hydroelectric potential at approximately 145,320 MW, of which over 115,000 MW lies in the Himalayan belt (CEA, 2024). Even the Himalayan states with rich water resources have operationalized less than half of identified capacity.

The worldwide power utilization is seeing a major change due to increase population, industrialization, modernization and demand will keep on growing in coming years. It is believed that global electricity demand and utilization will see a multi fold increase by 2040(Amesh and Thakur,2017). India and China having the highest populations are anticipated to increase the electric energy utilization by two folds in coming decade (Pazehri *et.al.*,2014). Hydropower system with about 20% of total world's power generation is one of the main clean energy producers with minimum greenhouse gas emission (Kumar and Katoch,2016).

This paper reviews the policy instruments developed by the Government of India and the states/UTs of the Himalayan region to catalyse hydroelectric investments. It undertakes a case study of the Jammu & Kashmir Draft Hydro Policy 2025, which demonstrates an integrated approach by combining fiscal incentives, environmental safeguards, and institutional reforms.

2. Hydroelectric Power in India: National Policy Landscape

Solar, wind, biomass, geothermal are the major source for green and clean energy production. Hydropower after solar and wind constitutes around 11% of India's installed electricity capacity (CEA, 2025). Recognising its importance, the Ministry of Power (MoP) in 2019 reclassified large hydropower projects (>25 MW) as renewable energy, enabling them to avail renewable purchase obligations (RPOs) and other fiscal incentives like viability gap funding, tariff support mechanisms (MoP Notification, 2019).

The Hydropower Development Policy (2019) set the stage for several strategic interventions, with focus on the budgetary support for flood moderation components, support for cost-intensive infrastructure such as roads and bridges, besides introducing a transparent regime for tariff rationalisation and long-term Power Purchase Agreements (PPAs) to enhance bankability, and waivers on Inter-State Transmission System (ISTS) charges for projects commissioned by June 2025 (MoP, 2023).

Moreover, NITI Aayog's Energy Vision 2047 (2022) advocates regional tailoring of energy policy, decentralised renewables, and greater participation of state governments in clean energy development. The National Electricity Plan 2023–2027 also anticipates an addition of 13 GW of hydropower, with half expected from the Himalayan states. These policy transitions reflect a paradigm shift from isolated project-based planning towards a more inclusive and incentive driven energy development approach.

3. Environmental and Geopolitical Considerations in the Himalayas

The Himalayas, while rich in hydro potential, pose significant challenges for large infrastructure projects. These include- a fragile geology and frequent seismic activity (NDMA, 2023), glacial lake outburst floods (GLOFs) and climate change-induced variability, and high social and ecological costs, including displacement and biodiversity loss. Recent climate change driven devastating events like Chamoli disaster (Uttarakhand), Sikkim flash floods (2023) have highlighted the cumulative impact assessment for infrastructure projects in high-risk zones (Wangchuk & Tashi, 2024; NDMA, 2024). A recent study by ICIMOD (2022) emphasizes the need for climate-resilient hydro development, integrating glaciological risk assessments, tunnel-based minimal surface disruption, and improved early warning systems. The micro and mini hydroelectric power projects present both a climate-resilient and disaster risk reduction regime while offering sustainable clean energy production.

In Himalayas the hydropower development (large dams) comes with the significant ecological and social costs. There is loss of biodiversity, deforestation and indigenous community displacement (Agarwal & Narain, 2020). 65% of hydropower conflicts in India are mainly concentrated in Himalayas and poor rehabilitation being the main reason for the conflicts (EJA, 2023). In comparison to large dam's micro and mini hydropower projects offer an alternative that are more decentralised, compatible and ecofriendly for energy production in hilly remote areas. This makes them climate adaptive and socially inclusive energy production strategy for Himalayas (Shrestha et al., 2021; Singh & Sharma, 2020).

The geopolitical transboundary river sensitive issues with our neighbours like China, Pakistan, Bhutan and Nepal, makes hydropower development more complicated. The recent intensified geopolitical tension with neighbouring country Pakistan especially after Pahalgam terror attack the central government has suspended the Indus water treaty in view of resource sovereignty and energy security. Thus, considering together these environmental and geopolitical issues, there is need of robust policy shift that balances development, ecological vulnerability and transboundary prudence.

4. The Jammu & Kashmir Scenario: Policy Innovations and Practical Action

Jammu & Kashmir's theoretical hydro potential exceeds 20,000 MW, yet less than 15% has been harnessed to date (JKPDD, 2025). In response, the Draft Hydro Power Policy 2025 seeks to tap capacities up to 100 MW through Independent Power Producer (IPP) and Public-Private Partnership (PPP) models. The key features of the draft Hydro Policy moved by the Department of Science and Technology include a two-tier Project Classification: Category-I (up to 25 MW) and Category-II (25–100 MW), covering Run-of-River (RoR) and storage types, a transparent Allotment Processes through e-tendering and the Swiss Challenge method, offering developers who identify potential projects the first right of refusal, and diverse range of incentives including waiver of water usage charges in line with MoP's direction (April 2023), ISTS waiver for 18 years (for PPAs signed by June 2025). Other significant incentives are Carbon credit eligibility and support under the J&K Industrial Policy 2021–30, and deferred/staggered free power sharing to enhance developer confidence.

The policy was shaped through deliberations involving Ministry of New and Renewable Energy, IIT Roorkee, and private developers. Over 35 hydroelectric projects have been tendered in June 2025 under this framework, as a part of over 700 MW of planned capacity this fiscal. Moreover, land acquisition provisions under the policy emphasise minimising agricultural disruption and leasing of government land at nominal rates, addressing socio-political concerns that have hindered earlier initiatives in many cases.

The new draft hydropower policy,2025 of Jammu and Kashmir can be used as a replicable model for other Himalayan regions as it offers a clear fiscal innovation and social sensitivity with hydropower development in countries most complex and strategically important regions.

Jammu and Kashmir possess immense untapped hydropower potential estimated at about 18,000 MW out of which 15000 MW has been identified as technically feasible and 3540.15 MW has been harnessed till date. Present capacity of UT sector is 11974.4 MW and of central sector is 2250 MW (NHPC Ltd.). About 92.75 MW developed by independent power producers (IPPs). Recognizing the importance of hydropower as a cornerstone of sustainable and clean energy the UT government has embarked on an accelerated hydropower development strategy.

Presently 15 major projects with a total capacity of 7768 MW are at various stages of implementation which include 3063.5 MW of projects under construction. In addition to this around 641 MW are at the tendering stage and 4063.5 MW in advanced stage of DPR preparation, appraisal, pre-tendering.

Major Ongoing and Upcoming Projects include

- Parnai HEP (37.5 MW, UT sector): As of June 15,2025, the project had achieved 64% physical progress and is targeted for commissioning by Dec, 2027
- Karnah HEP (12 MW, UT sector). With 74.5% progress recorded by May 30,2025. This project is expected to be completed by November ,2025
- Pakaldul HEP* (1000 MW), under JV Sector (CVPPL) has achieved 70% physical progress (as of June 30, 2025). It is anticipated to be completed by December 2026.
- Kiru HEP (624 MW), taken under JV Sector (CVPPL), has shown 64% physical progress (as of June 30, 2025), this project is expected to be commissioned by December 2026.
- Kwar HEP (540 MW), had achieved the progress of 22.15% (as of June 30, 2025), therefore anticipated for commissioning by March 2028.
- The mega Ratle HEP (850 MW), also taken up under JV Sector (RHPCL) has achieved significant excavation progress, including 81% for the powerhouse and transformer cavern, 100% for dam abutment, and 95% for TRT. It is anticipated to be commissioned by August 2029, the meeting was informed.

Tendered projects include

- New Ganderbal (93 MW)
- Lower Kalnai (48 MW)

The upcoming projects

- Sawalkote (1856 MW, NHPC)
- Kirthai-II (930 MW, CVPPL)
- Dulhasti-II (260 MW, NHPC)
- Uri-I Stage-II (240 MW, NHPC)
- Kirthai-I (390 MW, JKSPDC)
- Bursar Storage (800 MW, NHPC)
- Ujh Multipurpose (89.5 MW).

JKSPDC is also diversifying into solar power with plans to develop a 10 MW grid-connected Agro-Solar Power Project at Pampore in phases. A 5 MW plant is in progress. DPRs are also prepared for floating solar projects at Lower Jehlum HEP (4.2 MW) and Baglihar reservoir (2.1 MW).

Regional Focus: Jammu Province

A substantial portion of J&K's hydropower infrastructure is concentrated in the Jammu province. Key ongoing or planned projects in this region include:

1) Pakaldul (Kishtwar)
2) Kiru
3) Kwar
4) Ratle
5) Kalnai
6) Sawalkote
7) Kirthai-I and II
8) Dulhasti-II
9) Ujh Multipurpose

5. Comparative Analysis with Other Himalayan States

Compared with Himachal Pradesh, Uttarakhand, and Sikkim, Jammu & Kashmir's hydro policy is notable for a dual-tier empowered committee model (based on project capacity), integration of tourism and hydropower development (for projects up to 25 MW) and specific fiscal strategies like deferred free power for 10 years to reduce initial financial stress.

Hydropower development across the Indian Himalayan region reflects a diverse policy landscape shaped by ecological sensitivities, local economic priorities, and administrative capacities. While all states recognize the strategic value of hydroelectric power, their approaches vary in regulatory design, incentive structures, and project facilitation mechanisms. Jammu & Kashmir's Draft Hydro Power Policy 2025 introduces several distinctive features—such as a two-tiered project oversight system and integration of tourism components—that set it apart from other Himalayan counterparts. Himachal Pradesh earlier a frontrunner in hydropower development now faces public resistance, environmental degradation and siltation (Rao & Singh, 2021). In comparison Uttarakhand hydropower policy offers a more comprehensive disaster management in sensitive zones (Uttarakhand Jal Vidyut Nigam, 2023; NDMA, 2022). Sikkim is working for promotion of small and medium hydroelectric projects with special focus on biodiversity and community participation especially tribal and council and local cooperatives (Sikkim RE Department, 2022). The following table (Table:1) offers a comparative snapshot of hydroelectric policies in Jammu & Kashmir, Himachal Pradesh, Uttarakhand, and Sikkim, highlighting both innovations and implementation challenges:

Table 1: Comparative hydroelectric policies in Jammu & Kashmir, Himachal Pradesh, Uttarakhand, and Sikkim

Feature	Jammu & Kashmir	Himachal Pradesh	Uttarakhand	Sikkim
Project Oversight Structure	Dual Empowered Committees based on capacity (10 MW cut-off)	Centralised through PCC and HPSEB	State Hydropower Development Cell (single-window)	Centralised through state agencies
Integration with Tourism	Permitted up to 25 MW projects with approval	Not specified	Not included	Not specified
Free Power Mechanism	Deferred/staggered royalty (10–12%) for initial 10 years	Immediate royalty (12–18%) from COD	Mixed approach depending on capacity	15-year royalty holiday
Land Acquisition Support	Nominal lease rate (₹1/sqm) for government land	Land lease plus 1.5% project cost for local area funds	Fast-track allotment through district administration	Government-facilitated with simpler norms
Transmission Incentives (ISTS Waiver)	Full waiver aligned with MoP notifications (till 2025)	Waiver in line with central guidelines	Follows GoI norms	Applicable as per GoI directives
Green Financing/Carbon Credits	Explicit eligibility for carbon credits under climate frameworks	Limited adoption of carbon markets	Not yet mainstreamed	Early adoption of green bond mechanisms
Challenges	Historical underutilisation, rugged terrain, coordination needs	Local resistance, environmental and social issues	Project delays due to judicial scrutiny and disasters	Limited scalability, sensitive ecosystems

6. Challenges and Recommendations

Despite progressive policy reform, several bottlenecks remain:

- **Clearance Delays**: A unified clearance window under the Ministry of Jal Shakti and the MoEFCC is recommended.
- **Financing Gaps**: Blended finance models involving multilateral institutions, carbon markets, and sovereign green bonds can derisk projects.
- **Community Engagement**: Mandating local employment quotas and revenue-sharing models will reduce opposition and ensure equitable development.

- **Climate Adaptation**: Integration of glacial monitoring, dam safety regulations, and environmental flow standards is crucial.

7. Discussion

Himalayan hydropower development presents a paradox of immense natural potential versus underutilized potential and underwhelming implementation. There are multiple interlinked challenges like prolonged clearance delays, high capital cost, evolving regulatory environment and geopolitical issues with neighbours. Despite these constraints the future of hydropower in Himalayas is showing a reoriented approach through innovative and ecologically friendly strategies. Hydropower in the Himalayas is a strategic national asset, one that can accelerate India's journey toward sustainable, reliable, and indigenous energy security. The evolving policy frameworks at both the Union and regional levels offer a promising pathway to unlock this potential. Jammu & Kashmir's Draft Hydro Power Policy 2025 exemplifies how a well-crafted, consultative, and context-sensitive strategy can convert latent hydrological resources into tangible developmental gains. Jammu and Kashmir with its new hybrid models is coming up as a policy innovator. Innovation and sustainability both are to be kept for such models. Sustainability becomes an important aspect in any hydropower project. Small hydro power projects are considered more sustainable and easier to manage when it comes to green and clean energy production. These SHP have the ability to full fill the power demand to some extent if used to full potential. In these projects the water is re-entered the mainstream after power generation thus producing green and clean energy. The integration of hydropower into India's climate strategy must now move beyond planning to precision implementation—grounded in science, inclusive in approach, and resilient to change. The comparative analysis of Himalayan states shows a unique policy implementation with each state using institutional capacities and ecological imperatives. However, the environmental governance remains a critical weak link in all the hilly states. The recent suspension of Indus water treaty suggests a more comprehensive This comparative study for Himalayas is very useful for understanding how these regions can contribute to nation goal of clean energy production.

8. Conclusion

India's ambitious clean energy production necessitates a reimagining of Himalayan hydropower as a climate friendly, community integrated and strategically governed energy source. J&K with the recent developments is positioning itself as a national leader in hydropower innovation.

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