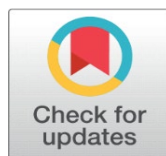
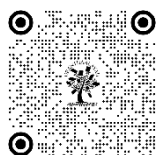


THE COMPLEXITIES ENCOUNTERED BY INDEPENDENT POWER PRODUCERS IN SMALL HYDRO POWER PROJECTS: A CASE STUDY OF HIMACHAL PRADESH IN THE INDIAN HIMALAYAN REGION

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ABSTRACT

The Indian government has undertaken various initiatives aimed at fostering the growth of the small hydropower industry in collaboration with the private sector. However, despite these efforts, there has been a consistent decline in the proportion of hydropower within the overall energy mix over the years. Given this context, the primary objective of this article is to pinpoint the challenges and obstacles encountered by Independent Power Producers in the establishment of small hydropower projects in Himachal Pradesh. The study, conducted through a combination of primary and secondary sources, aims to identify the factors hindering the successful implementation of such projects. The findings of the study indicate that despite the introduction of a new hydro power policy by the state of Himachal Pradesh in 2006, aimed at unlocking the underutilized power potential by promoting private sector involvement in small hydropower generation, there persists a significant disparity between the available capacity and the installed capacity in the state. This gap can be attributed to a multitude of financial and non-financial challenges faced by Independent Power Producers through out the planning, construction and operations phases of their projects.

Keywords: Green Energy, Renewable energy, Small Hydro Power Projects, Independent Power Producers, Hydroelectricity, Sustainable Power Production

1. INTRODUCTION

As non-renewable energy sources become increasingly scarce and environmentally detrimental, there is a pressing imperative for the development of sustainable and renewable energy alternatives. Among these, hydropower stands out as a well-established and eco-friendly energy source. Notably, despite the challenges posed by the COVID-19 pandemic, hydropower emerged as the sole electricity generation sector to register a net increase in total capacity in 2020, globally. According to the Renewables 2021 Global Status Report, the global installed capacity for hydropower reached 1,170 GW, with significant contributions from China, Turkey, and India, which collectively added 19.4 GW of capacity in 2020. The utilization of hydropower in developed nations, such as the United States of America, Japan, and France, has already surpassed 80% of their potential capacity as per the global status report, 2021. Conversely, the South Asian region, characterized by the presence of the Himalayan range, possesses substantial untapped hydropower potential. The Himalayan range alone holds a hydropower potential of 500 GW (Mukherji, Molden, Nepal, Rasul, and Wagnon, 2015). However, despite this potential, the region grapples with significant challenges stemming from rapid population growth, high population density, and widespread poverty, leading to a pronounced disparity between energy demand and supply (Agarwal and Kansal, 2017).

In this context, renewable energy sources, particularly the expansion of hydropower, offer a viable solution to address the region's energy needs and enhance energy security. By leveraging the abundant resources available, South Asia can mitigate its reliance on non-renewable energy sources and achieve sustainable energy development, thereby fostering economic growth and environmental preservation.

In India around 7% of annual growth in electricity supply is required in order to sustain the GDP growth of 8-9% annually (Hydropower @ Crossroads, 2016). Out of the total supply of electricity, approximately 70% of the total installed capacity get generated by thermal power with the 80% total units generated in the country (Hydropower @ Crossroads, 2016). This shows that coal-based electricity dominates the power generation in India, which presents the serious threat to energy security and environment as it is non-renewable and non-green source of energy with the lack of long-term economic viability. Therefore, it is very much required to use and develop renewable energy resources having huge potential.

According to the Report of Ministry of Power, 2022, India has harnessed only 26% of its hydropower potential, amounting to approximately 145,000 MW. Hydroelectricity constitutes roughly 12.8% of the country's installed power generating capacity. The Indian Himalayan region, which holds about 79% of the nation's hydropower potential, has utilized only 16% of this capacity. Despite, only making up about 36.4% of the region's total installed hydroelectricity capacity, 10.56% of it is still under development, and 53.05% of it hasn't yet been developed, the Northern Indian region leads in terms of contribution (Hydro Review of performance of hydro power stations 2018-19).

Among Indian states, Arunachal Pradesh boasts the largest share of installed hydropower capacity, followed by Himachal Pradesh. Notably, Himachal Pradesh leads Northern India in terms of installed hydroelectric capacity, followed by Uttarakhand. Small hydropower projects contribute 1.2% to the overall installed capacity of the hydro power sector, accounting for approximately 12.8% of the total. As per the Ministry of New and Renewable Energy (MNRE) classification, hydro power plants with a capacity of 25 MW or below are deemed small hydro power plants and are recognized as renewable energy sources.

The Alternate Hydro Energy Centre (AHEC) of IIT Roorkee, in its small hydro database as of July 2016, identified 7,135 locations suitable for small hydropower projects, with a potential capacity of 21,135.37 MW. Notably, the mountainous states of India, including Arunachal Pradesh, Himachal Pradesh, Jammu & Kashmir, and Uttarakhand, account for half of this potential, according to MNRE. Despite the significant hydropower potential in India's hilly regions, there persists a severe shortage of electricity.

The Indian government has undertaken various initiatives to promote and enhance the small hydropower industry in recent years. These initiatives encompass a combination of financial and non-financial support mechanisms aimed at fostering private sector engagement in hydropower development. Despite these efforts, however, the proportion of hydropower within the overall energy mix has exhibited a steady decline, plummeting from 51 percent in 1962-1963 to approximately 11.3 percent in 2021-2022, as reported by the Ministry of Power, Government of India in 2023. Consequently, the primary objective of this article is to delineate the challenges and impediments encountered by Independent Power Producers (IPPs) in the realm of small hydropower projects in Himachal Pradesh.

To gather the requisite information for this investigation, a dual approach incorporating both primary and secondary sources was employed. Primary data was procured through consultations with key stakeholders, including the president and member IPPs of the Bonafide Himachalies Hydro Power Development Association, as well as representatives from the office of a chartered accountant specializing in matters pertaining to these power producers. These stakeholders hold significant insight into the operational landscape and interface extensively with the power departments of both the state and federal governments. Supplementary data was sourced from the website and office of Himurja, Himachal Pradesh, a pertinent authority in the domain of hydropower in the region.

By elucidating the challenges faced by IPPs in Himachal Pradesh through a combination of primary and secondary data, this article seeks to contribute to a deeper understanding of the factors constraining the growth and viability of small hydropower projects in the state.

The picturesque state of Himachal Pradesh, nestled in the Himalayan region of northern India, boasts abundant potential for minor hydroelectric power generation. This potential is attributed to the state's rich array of glaciers, frozen lakes, five snow-fed rivers and their tributaries, and numerous rain-fed rivers. As of March 2019, only 52.9% of the state's total capacity of 18,820 MW had been utilized, leaving a significant 36.93% of this capacity untapped. Remarkably, one-eighth of India's entire estimated hydropower potential resides within Himachal Pradesh, as indicated by the Hydro Review of performance of hydro power stations in 2018-19.

Hydropower stands as the primary source of power generation in Himachal Pradesh, followed by other renewable energy sources. Specifically, 71.8% of the state's installed capacity is attributed to hydropower, while other renewable sources contribute 21.5%. Thermal and nuclear power collectively constitute a smaller proportion, accounting for 6% and 0.7%, respectively, according to Singh (2017). Notably, 44%, 21%, and 35% of the total hydropower installed capacity is owned by the central government, state government, and private sector, respectively, as reported by the Ministry of Power in 2022.

To foster private sector participation in the development of small hydropower projects (SHP), the government of Himachal Pradesh has undertaken several initiatives. Beginning in 1995–1996, the private sector actively engaged in harnessing the potential of the small hydro sector. The state has promoted SHPs as dependable and environmentally friendly sources of power generation, particularly suited to the fragile ecology of the Himalayan mountains. These projects leverage small streams and medium rivers with sufficient water flow, offering advantages such as minimal capital investment, short gestation periods, and scalability. The establishment of Himurja (Himachal Pradesh Energy Development Agency) serves as a nodal organization tasked with encouraging and managing private sector involvement in the small hydropower sector, specifically projects up to 5 MW in capacity. Since its inception, Himurja has facilitated the commissioning of 84 small hydro projects, with a cumulative capacity of 312.45 MW, out of a total of 800 allotted projects with an aggregate capacity of 1740.5 MW, as of August 2019, as per Himurja's records.

In a bid to unlock the underutilized power potential and streamline private sector involvement in small hydropower generation, Himachal Pradesh implemented a new hydropower policy in 2006. Under this policy, the construction and maintenance of small hydropower projects are exclusively entrusted to the private sector. The overarching objective of this policy is to position Himachal Pradesh as a foremost "Hydro Power State" within the nation.

Himurja, designated as the governing body, is tasked with identifying suitable project sites and soliciting proposals from private investors for the allotment of identified sites for small hydropower project development. Alternatively, it is responsible for approving proposals submitted by Independent Power Producers (IPPs) for self-identified projects.

Upon receiving consent, IPPs are required to deposit security, processing fees, and an upfront premium based on the allotted capacity within two months of the consent date. Subsequently, IPPs must furnish a comprehensive feasibility report, prepared by a reputable consultant, adhering to the guidelines outlined in the hydro power policy of 2006, along with subsequent amendments.

Additionally, IPPs are mandated to submit a detailed project report, encompassing geological and geotechnical investigations, hydrology and water power studies, power potential assessments, design of civil engineering structures, electro-mechanical works, cost estimates, and an environmental impact assessment.

Furthermore, IPPs must secure No Objection Certificates (NOCs) from various departments, including Irrigation and Public Health (IPH), Public Works Department (PWD), Fisheries, and Wildlife (Forest Department). The involvement of the fisheries department is contingent upon the project's location within areas earmarked for conservation and development projects.

Consultations with Gram Panchayats are conducted by the Sub-Divisional Magistrate (SDM) to obtain NOCs, considering objections and suggestions. In case of disputes, aggrieved parties retain the right to appeal to the Deputy Commissioner (DC) and subsequently to the Principal Secretary (Power).

Notably, development activities are strictly prohibited within wildlife preserves or parks. If a project fall within these boundaries due to a redefinition of wildlife areas, IPPs are obligated to abandon the project without recourse to compensation.

Table 1 outlines the time-bound tasks that Independent Power Producers (IPPs) are required to undertake until the commissioning of the small hydro project. Additionally, IPPs are obligated to allocate a fixed percentage as free power royalty (energy) based on the rates established by the state government's policy for state and local area development.

Table 1. Milestones to be achieved by IPPs before Commissioning of the small Hydro Project

Sr. No	Milestones	Time period
1	Feasibility report Submission	Within the six months from the date of consent letter before preparation of DPR. Feasibility report shall be based on actual survey and investigation containing site detail, hydrological data, location of project components, power studies for capacity determination, land requirements, layout plan, single line diagram, E and M equipment specification. Extension of three months with extension fee @Rs. 10,000/-per months. Consequences-Cancellation of project.
2.	Feasibility Report Approval	Himurja will approve the Feasibility Report within two months from its submission or within 11 months (including extension obtained for submission of feasibility report if any) from the date of issuance of consent letter.

3.	Acquisition of Revenue record.	IPP has to obtain all the necessary revenue record required for implementation of project within nine months from the date of issuance of consent letter or within 12 months (including extension obtained for submission of feasibility report if any) from the date of issuance of consent letter.
4	Submission of application for all Clearances/ approval/ consent to different departments.	IPP has to submit applications for all the Clearances/approval/consent applied with in 11 months from the date of issuance of consent letter or with in 14 months (including extension obtained for submission of feasibility report if any) from the date of issuance of consent letter
5	Obtain of all clearances/ approval /consent.	IPP has to obtain of all clearances/ approval /consent within 24 months (including extension obtained for submission of feasibility report if any) from the date of issuance of consent letter
6.	Submission of DPR as per CEA/ CWC Guideline and within allotted/approved parameters with all clearances	Within 24 months from the date of issuance of consent letter or within 27 months including if 3 months extension obtained for submission of feasibility report (FR), if not availed at the time of FR, extension of 3 months can be availed for submission of DPR for valid reasons by levying extension fee @ Rs 1000/- per MW for first month doubling in the subsequent months.
7.	Grant of technical concurrence (TC), preparation and submission of documents for signing of implementation agreement	Technical concurrence shall be accorded by Directorate of Energy (DoE), on behalf of the government of India within 45 days from the date of receipt of the DPR or with in 28 months and 15 days (including extension obtained for submission of feasibility report, if any) from the date of issuance of consent letter and also complete all formalities for signing IA.
8.	Confirmation of interconnection point	Two months after the approval of FR, the IPP shall apply to the appropriate authority (Distribution/ Transmission/ Licensee) for Finalisation/ confirmation of interconnection point.
9.	Signing Implementation Agreement (IA)	Within 15 days of accordance of TC or within 29 months from the issuance of consent letter (including extension obtained for submission of feasibility report or DPR, if any) whichever is earlier.
10.	Achieving Financial closure including PPA if required and work started concurrent action: any balance clearances, consent/ approvals to be obtained.	IPP has to obtain the financial closure including PPA if required and obtain balance clearance/ consent/ approval, if any and start work on site within 6 months after signing IA or within 35 months (including extension obtained for submission of feasibility report, if any) from the date of issuance of consent letter.
11.	Project Commissioning	Project must be commissioned within 24 months from the date of start of work. However, 6 months extension in this period is allowable for valid reasons subject to deposition of extension fee or within 65 months (including extension obtained for submission of feasibility report, if any) from the date of issuance of consent letter. Extension Charges applicable @ Rs. 1000/- per MW for first month doubling in successive months, subject to maximum of Rs. 10,000. This part of the charge will be payable upfront or with interest at project borrowing rates, after commissioning.

Source: Himurja, Government of Himachal Pradesh

The state government has stipulated provisions allowing the purchase of power from Small Hydro Projects (SHPs) up to 2 MW by the state, provided that the free power allocation to the state adheres to the 2006 policy. For SHPs ranging from above 2 MW to 5 MW, the Himachal Pradesh State Electricity Board Limited (HPSEBL) formulates a power purchase policy, taking into consideration factors such as load centre, evacuation cost, and hydrology.

Furthermore, IPPs have the option to utilize power for captive use or sell it to third parties (private entities) within or outside the state. In such instances, transmission and wheeling charges are determined by the Himachal Pradesh Electricity Regulatory Commission (HPERC) based on petitions submitted by the involved parties.

Independent Power Producers (IPPs) encounter a range of challenges and obstacles throughout the lifecycle of small hydro power plant projects, spanning from pre-construction to operation and maintenance phases. These challenges can be categorized into two main areas: financial and non-financial aspect

A. FINANCIAL ISSUES

Hydroelectric power generation represents one of the most capital-intensive renewable energy sources which results into heavy capital requirement. Even for relatively small hydroelectric projects, a substantial initial financial commitment is required. Independent Power Producers (IPPs) encounter various upfront financial obligations, including security deposits, processing fees, and upfront premiums, with the latter two being non-refundable. Additionally, the preparation of feasibility reports, Detailed Project Reports (DPRs), financial management models, construction plans, and the engagement of reputable consultants, valuers, technicians, and engineers contribute to the significant capital

investment. Moreover, factors such as land acquisition in remote locations and high-risk costs further diminish the attractiveness of these projects to investors and private developers. The capital cost of establishing small hydro projects typically comprises civil costs, electromechanical equipment costs, penstock costs, transmission and distribution costs, and installation charges (Ministry of New and Renewable Energy, 2017).

There is a lack of Proper Financial Model in funding of the projects. Many financial institutions that provide funding for small hydro projects often employ flawed calculations when determining the loan tenure, interest rates, and Equated Monthly Instalments (EMIs). The calculated interest rates frequently do not align with the monthly income generated by these hydro projects. Consequently, projects often fail to become operational within the moratorium period, leading to their classification as Non-Performing Assets (NPAs). Incorrect financial modelling by funding institutions has rendered small hydro projects less appealing for both financial institutions and private developers, contributing to their reduced viability as investment opportunities.

Delays in the disbursement of loan amounts by financial institutions contribute to project time overruns and increased Interest During Construction (IDC) costs, thereby impacting the financial viability of projects. High interest rates imposed by financial institutions, such as the HP State Cooperative Bank, significantly affect project viability. Despite recent reductions in interest rates, the previous high rates, such as 13.75%, were unsustainable for projects not yet generating income. Additionally, mismatches between loan repayment tenures and power generation periods, exacerbated by project delays and technical issues, further strain project finances. The demand for further interest rate reductions and extended loan terms, as well as provisions for one-time settlements (OTS) or outright sales, reflects the financial challenges faced by IPPs.

Independent Power Producers (IPPs) face challenges due to the insufficient availability of financing for small hydropower projects, as highlighted by the "Bonafide Himachalies Hydro Power Development Association." Many financial institutions remain hesitant to invest in small hydro projects due to uncertainties surrounding their success, and they often prefer to finance well-established corporate entities. This poses a barrier for first-generation entrepreneurs seeking funding. The Power Financial Corporation of India (PFC), a government-controlled funding institution, aims to provide financing for electricity production, transmission, and distribution. Similarly, the Indian Renewable Energy Development Agency (IREDA), another central government organization, is responsible for funding renewable energy initiatives. These institutions receive significant prime security and guarantees from the government for funding state and central power projects. However, for private power projects and non-government institutions, the prime security and bank guarantee requirements are set at 110% of the loan amount, making the funding process complex for IPPs.

There is deficiency in awareness concerning financial assistance opportunities. The Indian Renewable Energy Development Agency Limited, established in 1987 under the administrative control of the Ministry of New and Renewable Energy (MNRE), is a government enterprise tasked with promoting, developing, and providing financial assistance for projects related to new and renewable energy sources. It has been observed that some IPPs are not fully aware of the process for obtaining financial assistance from IREDA, which offers loans at lower interest rates compared to other banking institutions and does not require security from the promoter. IREDA sanctions loan amounts based on the feasibility of hydrology reports for projects, with assistance provided by IIT Roorkee.

IPPs face challenges in obtaining subsidies. The Bonafide Himachalies Hydro Power Developer's Association reports that only a minority of commissioned small hydro projects have received full or partial subsidies, with the majority receiving no subsidy at all. IPPs may be ineligible for MNRE subsidies if they fail to apply within six months of project commencement or maintain a healthy bank account within six months of receiving the first instalment of the term loan. Moreover, the discontinuation of the small hydropower scheme subsidy by the Ministry of New and Renewable Energy (MNRE) from April 1st, 2017 has posed significant hurdles for Independent Power Producers (IPPs).

Furthermore, projects seeking disbursements upon commissioning must provide evidence of achieving 80% monthly generation for three consecutive months or 80% annual generation, as specified in the Detailed Project Report (DPR) from the Alternate Hydro Energy Centre (AHEC), Roorkee. The complexities and challenges associated with run-of-the-river small hydro projects often hinder IPPs from meeting these requirements. Additionally, while the government offers subsidies through the "Industrial Development Scheme for Himachal Pradesh (HP) & Uttarakhand, 2017" for new and expanding hydropower units, the assistance is limited to 30% of plant and machinery investment, up to a maximum of Rs. 5.00 crore, without consideration for cost escalations.

IPPs also grapple with low tariff rates, particularly when projects are commissioned after significant delays. Despite signing Power Purchase Agreements (PPAs) with HP State Electricity Board Limited (HPSEBL) during earlier control periods, projects may face delays in commissioning, resulting in outdated tariff regulations being applied, which can

render projects financially unviable. The requirement to provide free power to the state for local development further exacerbates these financial burdens.

Inflation and project commissioning delays contribute to the escalation of project costs, rendering hydropower projects increasingly unviable. The Chief Minister of Himachal Pradesh, Jai Ram Thakur, acknowledged in the state assembly that the establishment of hydropower projects faces viability challenges due to cost escalation and local resistance. Project costs have risen substantially, from approximately Rs. one crore per MW to Rs. fifteen crore per MW. Despite the state's potential to generate 27,000 MW, focus has shifted to only 23,000 MW due to these challenges.

Setting up hydro projects involves numerous risks and issues, including environmental, geological, social, and legal concerns. Consequently, risk premiums on project financing are elevated, placing a significant burden on developers. Limited availability of advanced survey equipment during the planning stage leads to increased risk and uncertainty during project construction. Geological challenges in the Himalayan region, such as fault/shear zones and unstable terrain, often lead to project delays. Additionally, local resistance and ensuing legal battles further complicate matters for IPPs.

The Bonafide Himachalies Hydro Power Development Association and Himalaya Power Producers Association highlight the exponential increase in Capital Cost and Operation and Maintenance (O&M) charges, particularly for bays, imposed by the HP State Electricity Board Limited (HPSEBL) on IPPs. HPSEBL's method of charging O&M fees on a per bay basis rather than project capacity has escalated the financial burden on developers. Furthermore, discrepancies between regulatory definitions regarding interconnection points and associated transmission infrastructure costs further burden developers. Small hydro projects, typically situated in remote areas, face challenges in acquiring land and obtaining clearances for transmission infrastructure, leading to delays and additional costs. The obligation for developers to bear the O&M costs of transmission lines and associated facilities exacerbates financial pressures. MNRE reports indicate shortages of evacuation infrastructure in certain regions of Himachal Pradesh, adding uncertainty to IPP plans. Additionally, the disparity in Goods & Service Tax (GST) rates—5% for wind and solar compared to 18% for hydro power—further affects the financial viability of hydro projects.



Damaged 33 KV Transmission Line

Source: Bonafide Himachalies Hydro Power Developer's Association

B. NON-FINANCIAL ISSUES

Land acquisition for small hydro projects in Himachal Pradesh has emerged as a critical aspect, marred by challenges. Owners of the land demand prices exceeding normal market rates, leading to prolonged negotiations aimed at reducing costs. This, in turn, causes delays in project implementation. Additionally, even minor alterations in the project site necessitate a reworking of the Detailed Project Report (DPR), further exacerbating time overruns.

Issues pertaining to obtaining Necessary Official Certifications (NOCs) constitute another significant bottleneck. Delays in acquiring certifications, particularly the Forest Rights Act (FRA) certificate and final clearance under the Forest Conservation Act, 1980 (FCA), significantly impede project commissioning. For instance, obtaining final clearance from the forest department can stretch up to 2 to 4 years, disrupting the entire project schedule.

The process of obtaining approvals for forest land use entails a convoluted bureaucratic journey. Starting from inspection by the projects committee, the case progresses through various levels of government hierarchy, from the forest guard to

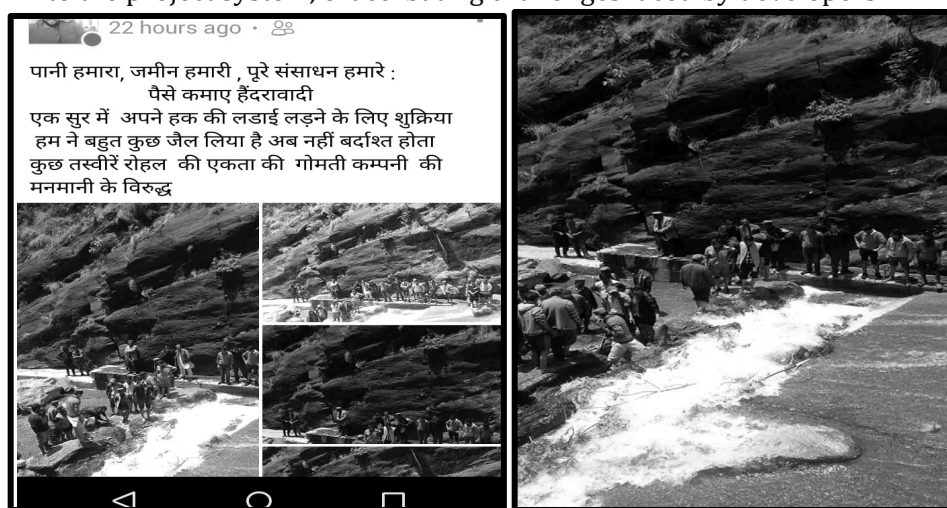
the forest minister, and ultimately to the Ministry of Environment, Forest and Climate Change, Government of India, in Delhi. This process, irrespective of land area, involves extensive scrutiny and multiple layers of approval, including payment for tree cutting and forest land usage. Subsequently, the lease of land requires no-objection certificates from various authorities, including the Sub Divisional Officer and the Directorate of Energy, Government of Himachal Pradesh. Despite prior notifications, objections are invited anew, prolonging the process. The final approval from the Government of India is followed by district-level procedures, further delaying the leasing process.

Similar bureaucratic hurdles are encountered in purchasing private land, involving a circuitous route from the patwari to the Chief Minister's office and revenue officers. Despite state cabinet permissions, the process necessitates repetitive documentation and approvals, resulting in extensive delays. Consequently, the viability of projects is jeopardized, and their fruition is significantly delayed, casting doubts on their feasibility.

Local resistance poses a significant challenge to the viability of hydroelectric projects in Himachal Pradesh, a concern acknowledged in the state assembly also. Construction and operation of projects often face delays due to opposition from local communities or until developers acquiesce to local demands. In one instance, a project on the Suil river in Chamba district was abandoned by the company despite being halfway completed, citing local resistance, although the company expressed willingness to resume and complete the project.

Local residents' demands, sometimes exceeding the parameters of the Land Acquisition, Rehabilitation and Resettlement Act (LARR), create additional obstacles, escalating both nominal and real project costs and placing substantial pressure on developers. The Hydro Power Developer's Association of Himachal Pradesh highlights instances where project authorities endure threats from local troublemakers, with reported cases of physical assault on project officials. Despite lodging FIRs, perpetrators often go unpunished. Furthermore, even with all requisite approvals, villagers may unlawfully divert or block water inflow into the project system, exacerbating challenges faced by developers.

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(* "Our water, our land, all resources are ours. Hydropower generates money. Thank you for fighting for our rights in one voice. We have endured a lot, we can't tolerate anymore. Some pictures depict the unity of Rohal, protesting against the Gomti Company's defiance".)

Local agitation: Gautami Hydro- 5 MW Project

Source: Bonafide Himachalies Hydro Power Developer's Association

In 2006, the Himachal Pradesh High Court, in conjunction with the state's Non-Conventional Energy Sources Department, imposed a ban on small hydro projects within the Tirthan river watershed in Kullu district. The development of such projects has elicited mixed reactions from local communities, directly or indirectly impacting them. While these projects have contributed to local employment and rural electrification, concerns have been raised regarding their adverse environmental and geological effects.

Local communities' express apprehension over various repercussions associated with small hydro projects. These include detrimental impacts on traditional livelihoods dependent on river resources, such as fishing, as well as concerns about the irrigation of agricultural land. Additionally, there is a perceived loss of the area's aesthetic and economic value due to the projects, which has prompted public protests against their establishment. These concerns serve as significant barriers to the implementation of small hydro power projects in the region.

Geological challenges pose significant hurdles in the implementation of small hydro projects, particularly in the Himalayan region characterized by its youth and geological activity. The construction process often encounters

unforeseen geological complexities, leading to delays and escalated construction costs. Additionally, these projects can trigger landslides, resulting in environmental damage and jeopardizing project integrity.

For instance, the Terailla small hydro project in the remote area of Chamba district exemplifies the risks associated with geological unpredictability. While comprehensive geological studies prior to site selection can mitigate these risks to some extent, the effectiveness of such measures is limited by the lack of advanced technical equipment and skilled personnel. Although geological surprises are inherent to the Himalayan region, insufficient technological capabilities on the part of government bodies and developers exacerbate project delays and financial losses.

Difficult terrain and accessibility challenges compound the difficulties faced by developers of small hydro projects. The locations of these projects often feature narrow and steep approach roads, dictated by the region's rugged topography. During the monsoon season, these roads become further compromised by rainfall and landslides, rendering project sites inaccessible. Moreover, constructing basic infrastructure to accommodate the workforce adds to the financial burden of developers. Remote project locations exacerbate logistical challenges, prolonging the delivery of equipment, manpower, and materials, thereby impeding construction and maintenance efforts.

Hindrances for non-Himachali investors present additional obstacles in the development of small hydro projects. The Himachal Pradesh government restricts allotment of projects up to 2 MW exclusively to Himachali bonafide individuals. For projects with capacities above 2 MW and up to 5 MW, non-Himachalis can invest, albeit with preference given to Himachali bonafide investors during allotment. Share transfers within projects entail stringent conditions, with maximum limits on share dilution and disinvestment. However, prolonged project commissioning timelines and declaration of projects as Non-Performing Assets (NPAs) by funding agencies prior to commissioning exacerbate these conditions, transforming them into significant liabilities for developers. Furthermore, non-Himachali investors often lack awareness of local hindrances, making them susceptible to exploitation by unscrupulous agents.

According to Clause 14.3.1 of the New Power Policy 2021, outlined in Chapter XIV concerning Safety and Quality Aspects of Hydroelectric Projects, there is a stipulation to restrict project operation beyond 110% of the prescribed capacity to maintain safety standards. However, the Bonafide Himachalies Hydro Power Developer's Association contends that the MNRE (Ministry of New and Renewable Energy) has engaged AHEC-Roorkee to assess project safety at 120% overload capacity, indicating that many projects can safely operate at this increased capacity.

Due to the intermittent availability of abundant water resources, Independent Power Producers (IPPs) advocate for permission to operate projects at 120% capacity, provided that transmission lines can adequately handle the increased power transmission. Failing to allow this operational flexibility not only impacts the overall viability and Prime Load Factor (PLF) of the projects but also diminishes revenue generation for the government of Himachal Pradesh.

Water availability is a critical factor determining the operation of hydro power projects, particularly in run-of-the-river small hydro projects where operation hinges on stream flow. However, seasonal variations in weather patterns disrupt continuous operation throughout the year. During summers, water availability diminishes, while in winters, water freezes, and during monsoons, operational challenges such as floods and landslides arise when projects run at full capacity. These factors collectively shorten the duration of power generation annually. Furthermore, climate change has adversely impacted hydro power production by altering rainfall patterns, exacerbating extreme weather events, and causing droughts in rainfall-dependent regions. These unpredictable changes have introduced uncertainty into project scheduling, power generation, and income generation.

The government of Himachal Pradesh mandates the purchase of power from projects with capacities less than 10 MW under the "must buy" provision. However, small hydro projects ranging from 10 MW to 25 MW, despite facing similar operational challenges to those under 10 MW, encounter difficulties in pursuing third-party power sales. According to Independent Power Producers (IPPs), this complicates their ability to explore alternative avenues for power sales.

Upon awarding a project to a private developer for implementation, a separate agreement known as the Implementation Agreement (IA) is executed to outline the terms of royalty provision. The developer is obliged to supply royalty to the government in the form of free power for state and local area development, in adherence to the rates specified by state government policy.

For small hydro projects allocated up to 2 MW post the 2006 hydro policy, royalty rates are set at 2% for the initial 12 years, escalating to 12% for the subsequent 18 years, and further to 18% for the remaining 10 years. Similarly, for projects with capacities up to 5 MW, royalty rates are set at 12%, 15%, and 24% for the same respective periods. Although the government has deferred the 12% royalty for 12 years for upcoming projects, the same concession has not been extended to already commissioned projects. This provision of providing free power to the state imposes additional costs on the project.

In addition to the free power royalty, Independent Power Producers (IPPs) are required to allocate an additional 1% free power, over and above the royalty rate, for the Local Area Development Fund (LADF). This fund is designated for income generation, welfare schemes, infrastructural development, and communal facilities within the local area throughout the project's lifespan, provided as an annuity.

Under the new policy guidelines outlined in the 2021 power policy, developers are mandated to deposit the first installment of the LADF upon signing the IA, along with providing a bank guarantee for the subsequent installments. However, the Association of Himachali IPPs argues that commencing work on the project site within six months of signing the IA is often unfeasible, as it typically takes 2 to 3 years to obtain final Forest Conservation Act (FCA) approval. The linkage of LADF deposit with the signing of the IA, rather than the initiation of construction on the site, places a cumulative burden on developers.

2. CONCLUSION

In Himachal Pradesh, the underutilization of hydropower resources, despite substantial capacity, highlights the need for strategic interventions and supportive policies. The state's rich hydrological resources, including glaciers, rivers, and rainfall, present a promising landscape for small hydropower projects. However, various hurdles, ranging from regulatory and procedural complexities to financial and logistical barriers, obstruct the progress of these initiatives. The involvement of multiple departments and the requirement for numerous clearances add to the bureaucratic delays, while the financial burden of upfront costs and security deposits poses significant challenges for Independent Power Producers.

The initiatives taken by the government, such as the introduction of the hydropower policy in 2006 and the establishment of Himurja, have aimed to streamline the process and encourage private sector participation. Nonetheless, the steady decline in the proportion of hydropower within the overall energy mix of India indicates that more needs to be done. The state's ambition to position itself as the leading "Hydro Power State" necessitates addressing these challenges head-on.

To foster a conducive environment for the growth of small hydropower projects, it is crucial to simplify the regulatory framework, provide financial incentives, and ensure a clear, time-bound process for project approvals and implementations. Furthermore, enhancing the involvement of local communities and addressing environmental concerns can help in mitigating resistance and fostering a collaborative approach to development.

The financial challenges faced by Independent Power Producers (IPPs) in the small hydropower sector of Himachal Pradesh are significant and multifaceted. These obstacles range from high initial capital investment requirements to issues related to financial modelling, loan disbursement delays, and elevated interest rates. The sector's capital-intensive nature demands substantial upfront financial commitments, which can be prohibitive for smaller or first-time developers. Furthermore, financial institutions often exhibit hesitancy in funding small hydro projects due to perceived risks, leading to a lack of adequate financial support and an unfavorable loan repayment structure.

Compounding these financial difficulties are the procedural complexities and regulatory hurdles, such as obtaining multiple clearances and navigating the requirements for subsidies, which add to project costs and delays. The discontinuation of certain subsidies and the strict conditions for receiving financial assistance from bodies like IREDA have further strained the viability of these projects. Additionally, the mismatch between project timelines and financial repayments, coupled with low tariff rates, High operation and maintenance costs, especially those imposed by the HP State Electricity Board Limited (HPSEBL), and the burden of providing free power to the state, and inflation-induced cost escalations further erode the profitability of small hydro projects.

Small hydro projects in Himachal Pradesh also face a range of non-financial challenges that significantly impede their successful implementation and long-term viability. Land acquisition difficulties, bureaucratic delays in obtaining necessary certifications, and complex approval processes for forest land use contribute to substantial project delays and increased costs. Local resistance further complicates matters, as community opposition can lead to prolonged negotiations, threats to project officials, and even abandonment of projects.

Geological challenges inherent to the Himalayan region, such as landslides and unpredictable terrain, add layers of risk and financial burden, often leading to delays and escalated costs. The rugged topography and difficult access to remote project sites exacerbate logistical challenges, complicating the delivery of equipment and construction materials. Restrictions on non-Himachali investors and stringent regulations on project capacity and royalty obligations create additional hurdles, limiting investment and operational flexibility.

Moreover, the seasonal and climate-induced variability in water availability affects the continuous operation and power generation capacity of small hydro projects. These environmental factors, combined with the need for local community support and the complexity of regulatory compliance, pose significant barriers to project viability.

To ensure the sustainable development of small hydro projects in Himachal Pradesh, it is crucial to address these financial and non-financial issues comprehensively. Solutions could include revising financial models to better align with project revenue flows, reducing interest rates, and extending loan repayment terms. Increasing awareness and access to financial assistance programs, simplifying the subsidy application process, and ensuring timely loan disbursements would also help alleviate some of the financial pressures on IPPs. Additionally, government policies should focus on providing consistent and adequate financial support, reducing operational costs, streamlining land acquisition processes, simplifying bureaucratic procedures, and enhance coordination between government bodies and developers. Addressing local community concerns through transparent communication and fair compensation practices and offering incentives that make small hydropower projects more attractive to investors and developers. Furthermore, adopting flexible operational policies that accommodate environmental variations and providing consistent financial and regulatory support can enhance the attractiveness and success of small hydro projects.

By tackling these challenges head-on, Himachal Pradesh can better harness its substantial hydropower potential, contributing to sustainable energy development and enhancing the state's overall energy security. This will require coordinated efforts from government bodies, financial institutions, and industry stakeholders to create a more favourable environment for small hydropower development.

CONFLICT OF INTERESTS

None.

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