Renewable Energy for Sustainable Development in Rural Mountain Ecosystems, Northeast India

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Abstract: The North Eastern Region (NER) of India, particularly the mountainous rural areas, has been facing a severe energy crisis for decades and this has tremendously affected its social and economic development. This paper briefly discusses the current energy scenario and the potential for renewable energy generation in the NER. It highlights the political economy aspects of generating renewable energy in the region and suggests prospective pathways on the issues identified. In the light of the recent policy development that emphasizes renewable energy transition in the energy sector, it also argues for increased exploration of renewable energy by incentivising investments in the financial market. Targeting mountain specific renewable sources such as solar and small hydropower and locally producing them can ensure a reliable energy supply and complement the highly inadequate and weather-sensitive grid energy that are imported from outside the region. Apart from the various environmental benefits, the social and economic opportunities arising from such local production highlights how renewable energy can be an important part of integrated mountain development policy.

Keywords: Renewable energy, Political Economy, Off-grid electricity, Sustainable Development Goals, Mountain ecosystem, North East India

Introduction

The National Energy Policy (NEP 2017) drafted by NITI Aayog emphasizes the importance of renewable energy production through joint venture models such as private-public partnerships, industrial-commercial investment to overcome the country's energy deficit. These investments on renewable energy production will not only increase energy reliability and security and improve socio-economic development but also decarbonise electrical energy and alleviate climate issues (NITI Aayog and IEA, 2021). India's total share of all modern renewable energy accounts for only 9.8% in 2018 of the total energy consumption (IEA 2020). It primarily comes from wind and

solar renewable-rich states, including Tamil Nadu, Gujarat, Karnataka, Rajasthan, Andhra Pradesh, Maharashtra, Madhya Pradesh, Telangana, Punjab, and Kerala (NITI Aayog and IEA 2021). Moreover, India aims to achieve a renewable energy target of 175 GW (by 2022) and 450 GW (by 2030) in the total energy mix (IEA 2020). In this target, the short-term goal of renewable energy (175 GW) comprises 100 GW of solar, 60 GW of wind, 10 GW of biomass-based, and 5 GW of small hydropower power plants which is equivalent to 21% of total electricity production. This target of scaling up the share of renewable energy in the global energy mixis in alignment with the Sustainable Development Goal (SDG), specifically SDG 7 calls for ensuring universal 'access to affordable, reliable, sustainable, and modern energy for all' by 2030 (VNR 2018).

Although, renewable energy sector is characterized by high initial capital intensity, the resulting social and economic benefits can far outweigh the financial costs associated with their construction and installation. Beyond increasing energy security, efficiency, and accessibility, it could pave the way for socio-economic development (IRENA 2017a; IEA 2020). Renewable energy production and distribution can strengthen various rural socio-economic sectors such as small and medium scale enterprises, generate employment opportunities while also conserving regional resources (Bergasse et al., 2013; Amin et al., 2020). Locally sensitive and well-developed renewable energy models can contribute to sustainability in economic (cost-effective and affordability), social (adequate accessibility), environment (mitigate CO_2 emission) and institutional (local participation) dimensions through energy efficiency (Iddrusi and Bhattacharyya, 2015).

At the institutional level, an adequate and steady supply of energy has the potential to stimulate and integrate various sectors and dimensions of the economy; gender, employment, health, and education. At the household level, rural women are argued to be the principal beneficiaries of access to secured and stable energy. In the absence of clean sustainable energy, women (including children) devote a considerable amount of time collecting daily needs for fuel wood and suffer the brunt of indoor air pollution caused by direct combustion of biomass for cooking and heating (Larson and Kartha, 2000; Silwal and Mckay, 2015). Women's invisible labour-time, effort and energy on household drudgery also alter their economic opportunities and undervalue women's economic contribution (Cecelski, 2000). Thus, access to more reliable energy sources can improve women's health and free up their time which they can utilize on other economically productive activities at home or increase their chances of labour force participation. Similarly, children in rural areas who often trade off their schooling time with firewood collection activities can improve their education performance with the help of a secured energy system in the household.

These energy vulnerability challenges are further exacerbated in regions facing severe energy deficits, such as the North Eastern Region (NER). NER has been facing a severe energy crisis for decades and this has tremendously affected its social, economic and political developments. India's efforts for household electrification are progressing well with 97% coverage in 2020 as per IRES estimation (Agrawalet al., 2020). However,

many communities in rural India, particularly those in the mountainous and hilly regions such as the NER, undergo severe shortage of energy due to inadequate energy generation, operation and supply constraints. There are issues of delayed hydropower projects, outdated and insufficient energy infrastructure, inefficient energy management, and underdeveloped energy markets. More importantly, the factors that aggravate the energy crisis in the region can be attributed to specific geographical and geopolitical problems, strong dependence on energy imports and inadequate exploration of the vast amounts of renewable energy resources.

Therefore, in light of the recent policy development that emphasizes renewable energy transition in the energy sector, both at the national and international levels, this paper argues for increased exploration of renewable energy options and subsequent energy investments in the NER. It discusses the potential for renewable energy generation in the NER to ensure a reliable supply and complement the highly inadequate and weather-sensitive grid energy system in most parts of the rural areas. Adopting a decentralized off-grid renewable energy model can be a win-win solution (Celceski, 2000; Hussain et al., 2019) and additionally envisage the concept of 'non-energy service' or co-benefits of renewable energy such as local employment generation (Jeong, J. and H. Ko, 2021). More importantly, organically generated renewable energy from local areas can sufficiently complement the supply constraints of a geographically disadvantageous and often malfunctioning grid system. Such a new energy regime, particularly in remote hilly regions, can serve as a tool for combating rural energy poverty and ensuring power supply stability through energy diversification and security.

Furthermore, renewable energy is a widely and globally acceptable eco-friendly strategy for mitigating the ecological threat and the reduction of energy-related Carbon emission is one vital motive for energy transition (IRENA 2019). Therefore, the proposed local renewable energy model not only enables energy generation but also preserves the regional ecosystem. In a broader term, the off-grid renewable energy model envisages contributing towards national and global sustainable development goals that serve as a prospect for achieving SDG 7.The implementation of such an integrated renewable energy model should be achievable with the collaboration of multiple institutions and stakeholders such as financial(example, public-private joint ventures), and technical (project planning, accurate assessment of potential power production and storage) institutions by considering the right set of local conditions and developing a place-based approach to renewable energy deployment suitable to the local context.

The remainder of this paper is organised as follows. The next section provides and overview of the current energy scenario in the NER, highlighting the challenges and constraints in energy generation, distribution, and access. This is followed by a discussion on the potential for renewable energy production in the region, emphasising opportunities for decentralised and locally adapted energy solutions. The subsequent section examines the political economy of renewable energy in the NER,

analysing the institutional, policy, and governance factors influencing energy transition. Owing to the lack of well-developed financial markets in the NER, the following discussion on financing instruments for renewable energy at the national level is presented. The objective here is to strategize an increase in financial investment in the renewable energy market which could then be accessible to renewable energy project developers in the NER. The paper then examines the political economy of renewable energy in the NER, analysing the institutional, policy, and governance factors influencing energy transition. The paper then explores the market structure and financing instruments available to support renewable energy investments. Finally, the paper concludes with summarisation of the key points and suggestions for promoting sustainable and inclusive energy development in the region.

Current energy scenario in NER of India

The NER of India is characterised by fragility, marginality, inaccessibility, diversity in culture-ethnicity, and rich biodiversity (De and Singh 2017). The region is primarily a hilly region, except Assam and most parts of Tripura which represents the plain areas. NER largely comprises rural villages and small-medium sized towns and lie in the sub-mountain range of the Himalayas, sharing an international border with China, Bhutan, Myanmar, and Bangladesh. The region accounts for approximately 8% of the country's total geographical area and 3.76% of the country's total population (NCERT 2017). Living with steep slopes, hilly terrain, and being geographically isolated from the country's central region poses physical obstacles for accessing various life fulling needs and development facilities. These remote areas are geographically disadvantaged and are relatively more prone to energy deficiency and the supply constraints represent a critical concern to rural energy development. The existing grid electricity in particular poses technical and location barriers considering the fragile nature of rock formation and the high gradient of the hill slopes. For instance, landslides are a common phenomenon in the region during the rainy season that further hampers the reliability and consistency of the power supply. This is aggravated by the fact that energy investors and markets are less attracted towards rural, lower average per capita income sectors (Khandler et al 2010). There are also various proposed and implemented large conventional hydropower projects in NER such as Dibang (3,000 MW), Lower Subansiri (2,000 MW), Tipaimukh Dam (1500 MW), Middle Siang (1,000 MW), and Kameng (600 MW), with many clearances pending due to socio-economic and wildlife conflicts (Kothari and Wangkheirakpam 2003).

Central suppliers of energy in the region are NEEPCO (North Eastern Electric Power Corporation Limited) under the ownership of National Thermal Power Corporation Limited, NHPC (National HydroElectric Power Corporation Private Limited), NTPC (National Thermal Power Corporation Limited), OTPCL (Odisha Thermal Power Corporation Limited). According to the Monthly Power Supply Position Report of the NER, POSOCO (2021), the current net power generation in NER is 1279.171 MU.

Renewable energy, primarily from hydro and solar, accounts for 18.335 MU (1.43% of the total power generation), mainly from Assam (7.027 MU), Meghalaya (5.409 MU), Mizoram (3.13 MU), and Tripura (1.893 MU). On the other hand, the generation of non-Renewable energy accounts for 1260.836 MU (98.56% of the total power generation), and other import sources from neighbouring countries such as Bhutan, accounting for 0.42 MU. The estimated peak demand in the region is recorded to be 2666.7645 MU. Given this level of power generation and peak demand estimation, NER faces a cumulative peak time power shortage of 4.1% with Assam and Manipur registering a high deficit of 3.5% and 5.2% respectively (CEA 2018-19 Load Generation Balance Report). Households in rural Assam experience the longest power outage in the country facing six or more hours of daily outage (Agrawal et al., 2020).Currently, the NER is a net importer of electricity, importing roughly 30% of its electricity supply from Bhutan and other parts of the country (Anbumozhi et al., 2019). The energy problem in NER is not just a story of supply deficit in terms of MW of power but also equally importantly is the issue of accessibility to regular supply of power, due to their geographical terrain. The existing energy transmission infrastructure is particularly vulnerable to the vagaries of monsoon and associated landslides which cuts the energy supply to an entire district for weeks altogether. Fig 1 below shows a dangerously arbitrary power transmission line in Tamenglong District of Manipur in the month of May, 2022.

Figure 1: A dangerously arbitrary power transmission line in Tamenglong District of Manipur in the month of May, 2022.

Potential for renewable energy production in NER

The NER is conducive to the production of RE due to its physiography and abundance of renewable energy sources. 64% of the total geographical area is covered with forest land with 16% of agricultural land use (Mishra and Francaviglia, 2021). The annual precipitation rate is 10% of the country's total (2000 mm), and the region accounts for about 58 notable rivers/tributaries besides numerous revulates/hill streams. Around 56 % of the area is under low altitude, 33 % mid altitude and 11% under high altitude (De and Singh, 2017). Based on the physiography and the regional natural resources availability, the Energy Statistic (2021) report estimated the potential production of renewable energy in NER to be 6 GW or 5.99% of the country's total potential output (Table 1). However, despite its high potential, the region is least explored and invested upon with regard torenewable energy generation, leading to severe underutilisation of renewable energy resources which adds to the energy crisis in the region. For instance, only 5.27 MW of solar energy from its total potential of 62300 MW (less than one percent) and barely 11 percent of hydropower potential has been realised (CSE, Factsheet North East India, 2016).

Table 1. Estimated Potential of RE in NER as on 31.03.2020 (in MW)

State	Wind Power	Small Hydro Power	Biomass Power	Co-generation Bagasse	Waste to Energy	Solar Energy	Total	Comparative potential at the country level (%)
Arunachal Pradesh	-	2064.92	8.2	-	-	8650	10723	0.98
Assam	-	201.99	211.8	-	8	13760	14182	1.29
Manipur	-	99.95	13.4	-	2	10630	10745	0.98
Meghalaya	-	230.05	11.11	-	2	5860	6103	0.56
Mizoram	-	169.9	1	-	1.5	9090	9261	0.84
Nagaland	-	182.18	10.2	-	-	7290	7482	0.68
Sikkim	-	266.64	2.3	-	-	4940	5209	0.47
Tripura	-	46.86	2.9	-	1.5	2080	2131	0.19
NER	-	3261.49	260.91	-	15	62300	65836	5.99

Source: Ministry of New and Renewable Energy (Energy Statistic 2021)

Table 1 above is highly indicative of the strong potential for renewable energy from various sources which are indigenously available in the region. Solar energy constitutes the biggest source of potential renewable energy in the NER yet it is the most underutilised renewable energy in the region. In this regard, Solar photo voltaics (PV) is a mature technology and could be effectively explored. PV is particularly suitable in mountain regions for several reasons. First, they receive 50% higher irradiation per square meter than lower territories and therefore can produce electricity more consistently. Second, PV panels are also more efficient in mountain regions because the operating temperature is reduced due to cold air. Also, given the

predominance of agrarian economies in the NER, pilot agrivoltaic (AV) projects can also be experimented on a large scale. AV is an emerging effective and efficient land use approach of solar power generation with a power capacity range between 3kWp to 3MWp (REN21 2020), where the project integrates solar energy and agriculture. This approach is known for improving food and energy security and rural livelihoods simultaneously with lower carbon emissions, resulting in overall cost-effectiveness (Proctor et al., 2020).

The NER is exceptionally well-endowed with hydropower resources, owing to its numerous river, streams, and steep gradients across hilly and mountainous terrain. While large-scale dams are not advisable in this ecologically sensitive and biodiversity-rich region, mini- and micro-hydro projects present a sustainable alternative. These small-scale projects have minimal social and environmental impacts, require lower capital investment compared to mega-dams, and can be deployed in a decentralised manner to provide electricity to remote villages. Despite occupying only 8% of India's landmass, the NER possess 34% of the country's total water resources, with the highest per capita availability of water in the country (Das, 2013). This abundant water endowment provides a strong natural basis for scaling up hydropower generation. Mini-hydro projects, typically ranging from 100 KW to 25 MW, can be integrated into local energy grids conventional grid extension is economically or technically challenging.

In addition to energy generation, mini-hydro projects can contribute to multiple socio-economic co-benefits (Arnaiz et al., 2018). They can create local employment opportunities during construction, operation, and maintenance, strengthen community engagement, and support income generating activities at the household level. Technologically, advances in low-head turbines, run-of-the-river systems, and modular designs make mini-hydro projects highly adaptable to the NER's topography, ensuring both efficiency and minimal ecological disruption. Furthermore, mini-hydro projects can complement other renewable energy sources such as solar and biomass, providing a reliable and hybrid energy mix that can address seasonal variations in water flow and solar insolation. By promoting decentralised, community-managed energy solutions, the NER can reduce its dependence on imported fossil fuels, enhance energy security, and foster sustainable rural development. When implemented thoughtfully, mini-hydro projects have the potential to serve as cornerstone of the region's renewable energy portfolio, balancing energy production with ecological preservation and social inclusivity.

Political economy of renewable energy in NER

Renewable energy policy intervention in India rarely displays a holistic approach. Current mechanism and policy instruments such as Feed-in Tariff (FiT), Renewable Purchase Obligations (RPO) on utilities Renewable Energy Certificate (REC) training, Accelerated Depreciation (AD) and preferential-grid access only address techno-economic barriers towards renewable energy sector. However, as noted by Sreekumar

and Chitnis (2014), it is imperative to have a political perspective beyond the techno-economic consideration. Such a consideration is even more important in the context of NER, a region marked by geo-political instabilities and militancy unrest. In such a region, with a very poor ease of doing business and risky investments for the developers, the government should assume a more proactive role in building political support at various levels. Particular challenges for project developers would arise in the case of land-use uncertainty as most lands in the NER are owned by the communities; it would mean that project developers would have to acquire land for individual projects and could face steep resistance from the local populace. This is particularly true and expected because local opposition to specific development projects historically are largely responses to the disempowerment of local rights and dis-entitlements to land and resources. There is a need to ensure local social acceptance by clearly specifying the benefits to local communities and engaging them in the process. This necessitates a participatory governance structure and organisational formats which are inclusive and sensitive to the needs of the local people. Local oppositions can significantly slow down the process of land acquisition and RE infrastructural development in a region. In such a context, the government should support expeditious land procurement with minimal impacts upon the local community. Where land procurement is particularly challenging, land leasing models should be explored (Kumar and Thapar, 2017) to facilitate renewable energy deployment. The government can design and standardise 'model land lease policy', specific to renewable energy development in the NER, incorporating the concerns of the stakeholders, land-owners, financiers and investors.

Another strategy to facilitate local community involvement in renewable energy development is to allow for equity participation or subscription of shares in the project. This could facilitate land procurement by making the local community participate meaningfully in the project development. Such attempts at streamlining land procurement can further be enhanced by providing relevant information on the availability and type of land (revenue, community owned or private ownership) to developers for setting up renewable energy projects. It would also be beneficial to carry out social impact assessment in the early stage of project planning in a region dominated by indigenous communities. Indigenous groups tend to develop a very strong sense of attachment to their land and resources and therefore, the substantial non-economic impacts of land acquisition need to be captured in the assessment.

A fundamental factor in a rural region's ability to design and benefit from renewable energyis the centralised grid system. Currently, there is no coordination between grid infrastructure and renewable energy deployment. The transmission and distribution lines are designed to facilitate electricity flow produced by few large centralised power plants and favours large scale installations over small and diffused renewable power plants. There is no scope to accommodate small-scale and localised power generation and this constitutes a huge challenge on renewable energy deployment in the rural regions. If the costs of connecting the renewable energy to the grid are borne by the

project developer or the generator, then renewable energy will be less competitive in the market due to its higher price. This is truer in the context of geographically challenging terrains such as in the NER. Whether or not the Government responds to this cost of transmission grid expansion is a crucial issue.

The political economy of renewable energy development should also be assessed in the light of centre-state relations. All the current discourses on renewable energy are situated within the National Action Plan of Climate Change (NAPCC). This has enormous implications on how various state government's view and understand RE deployment. The deep focus of the Centre on renewable energy deployment to mitigate climate change sends a misleading signal to the states. Rather than seeing renewable energy as the tool to combat energy deficits or to reduce electricity imports, states regard RE targets merely as a compliance strategy under NAPCC. This response of the state is coupled by market entry barriers of comparatively higher priced renewables in the face of challenging grid integration. The Centre should aggressively work towards easing the grid infrastructure constraints and effective RE deployment in the region. Green Energy Corridor Project (GECP) such as the one in Karnataka which seeks to synchronise the transmission of conventional and renewable energy sources should be developed and introduced in the NER. The Power Grid Corporation of India limited (EGCIL) should be made to coordinate with the state-own transmission and distribution corporations in the region to facilitate inter–state green energy transmission. The poor financial health of distribution utilities and the consequent under-investment in the distribution network in the region needs to be strengthened and augmented through such corridors.

The regional or state level roadmap for renewable energy delivery to under-served areas in the NER is also unclear, although the Decentralised Distribution and Generation (DDG) under Deendayal Upadhyaya Gram Jyoti Yojana (DDUGJY), in principle, exists to cater in areas where grid extension is technically and financially unfeasible. The continuing irregular supply of electricity in rural areas of NER indicates that such generic central government schemes are inadequate to meet the local needs of the population whose remote locations and landslide-prone terrains make grid extension unfeasible. Other central schemes, such as, Rural Village Electrification Program (RVEP) exists to cater to small hamlets but the state nodal agencies are most often reluctant to facilitate their implementation because the Ministry of New and Renewable Energy (MNRE) financial subsidies are characterized by delayed disbursement. Effective coordination in the state-central sharing of responsibilities is important with energy being a concurrent subject in a federal political structure (Sarangi, 2018). It would otherwise create uncertainty and market segmentation as both the centre and state governments are involved, posing a peculiar set of risks and barriers to investors in the renewable energy investment market. In this context, a single window clearance facility should be formulated across all states in the NER to streamline investment into the renewable energy sector.

Market structure and financing instruments for renewable energy

Technological infrastructures in the renewable energy system hugely differ from the conventional energy system, and therefore, the cost structures also differ accordingly. renewable energy projects are typically highly capital intensive in nature and in a country like India, the responsibility of developing the renewable energy sector hugely lies with the private players. An important question is on how to mobilise private capital at par with the renewable energy policy targets. In such a scenario the government needs to create an enabling framework to incentivise private capital flow into the renewable sector. Currently, the renewable energy sector is driven by private investors with heavy reliance on banking institutions to mobilise the financial requirement. However, there has been a predominant reluctance by the banking community to finance renewable projects largely because of the related risk and uncertainties with these projects.

There is a need, therefore, to draw in a variety of private investors such as private equity investors, institutional investors, and other development banks such as IREDA, IFCI, SIDBI, etc. Registered equity investors like Venture Capital should play a more active role in the renewable energy space. The government on its part should design a variety of incentives and instruments to facilitate financing in the renewable energy sector. Provision of credit guarantees to local banks and other financial institutions could increase the financial capabilities to support lending to the developers in building the renewable projects (IEA 2021). The Ministry of New and Renewable Energy (MNRE) should be instrumental in developing a competition-based incentive regime through relaxation of tax liability on financial investment towards renewable energy. At present, such an incentive scheme is available only for wind projects and should be extended to encompass all other renewable projects.

Another policy instrument could be a Generation-Based Incentive Mechanism (GBIM) to incentivise power generation instead of a singular focus on setting up projects by providing tax holidays to such investors. A government should also revive and pursue other incentive schemes such as Viability Gap Funding (VGF). The Solar Energy Corporation of India (SECI) has introduced the VGF scheme for solar energy generation but instead of such selective incentivisation, the government should introduce a similar mechanism to the entire renewable energy sector. Apart from these, sincere efforts should be made in creating new institutions (both banking and non-banking), mechanisms and innovative financing instruments to foster renewable energy development in the NER.

Policy reforms can also be introduced within the RBI's mechanism of Priority Sector Lending (PSL). For instance, the renewable energy sector should be a separate unit and not be clubbed with the larger umbrella of single code energy, which would otherwise result in a large volume of capital flow into the non-renewable energy sector. This tagging of renewable energy as a constituent component of the power sector is problematic because funds for renewable energy tends to be crowded out by loans earmarked for conventional power projects (GoI, 2015). There is a need for building investor's confidence in the renewable energy project in order to counter

disproportionately large investments on conventional energy projects. Regulatory concerns on project financing and delay in loan sanctioning should also be seriously looked into in order to smoothen financing the renewable energy sector. Another financing mechanism that could be employed successfully in the rural renewable electrification space is Crowd-Funding. The objective here is to mobilise and generate funds from a large number of small private investors to attain the desired scale. What is required would be a proper regulatory framework for such innovative financing mechanisms to evolve. Finally, given the paucity of green finance devoted to renewable energy production in India in general and NER in particular, the Government should take advantage of the global green financing initiative. For instance, the Climate Investment Platform (CIP) established by the International Renewable Energy Agency (IRENA), United National Development Program (UNDP), and Sustainable Energy for All (SE4A), in cooperation with the Green Climate Funding (GCF) is one such avenue. CIP aims to mobilize capital towards developing countries to accelerate the scale of RE technologies deployment to meet Nationally Determined Contributions (NDCs) targets and achieve compliance with SDGs (Jeong, J. and H. Ko, 2021). GCF on the other hand, is a partner institution that can provide a full range of financing instruments, including loans, equity, guarantees, and grants to de-risk investment and crowd in both public and private investment.

Conclusion

In this paper, we discuss the significance and the way forward to achieve sustainable goals of generating renewable energy suited to the local mountain ecosystems of the NER. The massive potential that the NER holds for producing renewable energy should be realised to address the energy security and accessibility concerns, given the difficult geographic terrains where the grid coverage is limited and inconsistent. This study underlines the need for a shift in the approach to renewable energy which is place-specific and also grounded in differential local conditions and resource endowments. The renewable energy strategy developed in this paper is therefore mainly driven by local needs and concerns rather than a national action plan or global climate imperatives although it has implications for them. This means that the project sites, choice and scale of renewable energy production should reflect compatibility with the local concerns and localised resource endowments.

The renewable energy approach highlighted in this paper can provide the remote rural regions of the Northeast with the opportunity to produce their own energy, bypassing the supply constraints of the grid system which are particularly vulnerable during the monsoon season and complement the erratic supply of conventional energy from outside. The study also pointed out some of the crucial political economy dimensions of renewable energy development in the NER and discussed potential approaches to dealing with them. A fundamental aspect of renewable energy is capital investment and the paper outlines some of the mechanisms and financial instruments which need to be incentivized to develop the financial market for renewable energy. This paper

proposes a regional framework for renewable energy development for combating energy poverty, increasing accessibility and energy security while also promoting sustainable development in the North-eastern rural mountainous ecosystems of the country.

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