

Energy Poverty Alleviation in North East India: Strategies for Sustainable and Inclusive Development

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Abstract: Energy poverty remains a pressing challenge in the North Eastern states of India, hampering socioeconomic progress and well-being in the region. This review/ subjective paper aims to address the issue of energy poverty and propose effective strategies for sustainable and inclusive development. This paper addresses energy poverty in North East India, identifying key factors such as poor Discom financial health, high transmission losses, and inadequate access to modern energy services. The study proposes strategies for sustainable development, involving a mix of renewable (solar, micro wind, biomass, small hydro) and non-renewable energy sources, coupled with energy storage techniques like battery and pumped hydro storage. Emphasis is on local mini-grids for enhancing energy access in remote areas, policy interventions, institutional reforms, and community engagement. The study also illuminates the synergies between energy poverty alleviation and climate change mitigation. It estimates the finance requirement for implementation, considering infrastructure development, capacity addition, and maintenance costs. This paper offers practical recommendations for policymakers, practitioners, and researchers, to inform decision-making, attract investments, and drive inclusive development in the region.

Keywords: energy poverty, renewable energy, energy storage, sustainable development, policy interventions

1. Introduction

Energy poverty is a condition where people lack access to modern energy services such as electricity, clean cooking facilities, and clean heating. It is estimated that over 1.1 billion people worldwide lack access to electricity, and over 2.8 billion people lack access to clean cooking facilities. Energy poverty has severe social, economic, and environmental implications, including health problems, gender inequality, and environmental degradation. This paper aims to discuss how to end energy poverty by examining case studies with positive impacts and how to replicate the success stories in North East India.

The NE states of India though characterized by 100% of electrification (Saubhagya, 2023) faces inadequate access to modern energy sources. The region also has a high percentage of households that use traditional fuels for cooking, such as firewood, cow dung, and crop residues. According to the Census of India (2011), the percentage of households using traditional fuels for cooking in the NE states ranged from 59.7% in Assam to 98.5% in Nagaland.

2. Causes of Energy Poverty in the NE States of India

The causes of energy poverty in the NE states of India are multifaceted and interlinked. Some of the significant causes include:

- 1) Poor Discom health: The poor financial health of Discoms is indeed a major cause of energy poverty in the North Eastern states of India. The aspects like poor AT&C losses, high cost of power procurement, poor cost-reflective tariffs.
 - Low revenue collection: According to a report by the Ministry of Power, the revenue collection efficiency of Discoms in the North Eastern states was 94.7% in

the financial year 2020-21, which is lower than the national average of 96.6% (Ministry of Power, 2021).

- High Aggregate Technical and Commercial (AT&C) losses: According to the same report by the Ministry of Power, the AT&C losses in the North Eastern states range from 17.7% to 35.2%, which is significantly higher than the national average of 15.9% (Ministry of Power, 2021).
 - High cost of power procurement: Many Discoms in the North Eastern states procure power at a higher cost than the national average due to the high transmission and distribution losses, as well as the lack of access to low-cost power sources. For instance, in Assam, the cost of power procurement was Rs. 4.93 per unit in 2020-21, which is higher than the national average of Rs. 3.85 per unit (Ministry of Power, 2021).
 - Subsidies and cross-subsidies: Subsidies and cross-subsidies provided by Discoms to certain consumer groups, such as farmers and households below the poverty line, also contribute to their poor financial health. In the North Eastern states, the subsidies and cross-subsidies provided by Discoms are significantly higher than the national average, which puts a burden on their finances. For instance, in Assam, the cross-subsidy for industrial consumers was 81.6% in 2020-21, which is much higher than the national average of 52.7% (Ministry of Power, 2021).
- 2) Lack of infrastructure: The NE states of India lack adequate energy infrastructure, including transmission and distribution networks, power generation plants, and storage facilities. The inadequate infrastructure limits the capacity to generate and distribute electricity and has contributed to low levels of electrification.
 - 3) Inadequate investment: The NE region of India has not attracted sufficient investment in the energy sector,

Volume 12 Issue 7, July 2023

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which has limited the development of energy infrastructure and renewable energy projects. The lack of investment has been partly due to the region's challenging terrain and political instability.

- 4) Limited access to finance: The NE states of India have limited access to finance, which has restricted investment in the energy sector. Financial institutions are often hesitant to lend to the region due to perceived risks and lack of collateral.
- 5) Dependence on traditional fuels: The NE states of India have a high dependence on traditional fuels for cooking and heating, which has contributed to environmental degradation and health problems. The use of traditional fuels is also a significant cause of energy poverty, as it limits the availability of modern energy services (Y Malakar, 2018).

3. Consequences of Energy Poverty in the NE States of India

Energy poverty has severe social, economic, and environmental consequences in the NE states of India. Some of the significant consequences include:

- 1) Health problems: The use of traditional fuels for cooking and heating has significant health consequences, including respiratory illnesses, eye infections, and lung cancer. The health problems are particularly severe for women and children, who are most exposed to the smoke and fumes (Smith KR, 2000).
- 2) Economic losses: Energy poverty has significant economic implications, including lost productivity, limited economic growth, and reduced competitiveness. The lack of electricity and modern energy services limits the capacity of businesses to operate efficiently and limits their potential for growth.
- 3) Environmental degradation: The use of traditional fuels for cooking and heating has significant environmental consequences, including deforestation, soil degradation, and air pollution. The environmental degradation can have long-term effects on the region's ecosystems and contribute to climate change.

The NE states of India have a high potential for renewable energy, including solar, wind, and hydro. However, the exploitation of these resources has been limited due to inadequate infrastructure and lack of investment. The NE region is also prone to natural disasters, including floods, landslides, and earthquakes, which can damage energy infrastructure and disrupt energy supply.

4. Possible Solutions to Energy Poverty in the NE States of India

There are several solutions to end energy poverty in the NE states of India. Some of the solutions include:

- 1) Promoting renewable energy: Renewable energy sources, including solar, wind, and hydro, have enormous potential in the NE states of India. Governments and private sector players can promote renewable energy by investing in renewable energy projects, offering subsidies, and providing tax incentives.

- 2) Developing energy infrastructure: Governments can invest in energy infrastructure, including transmission and distribution networks, power generation plants, and storage facilities. The development of energy infrastructure can improve the reliability and availability of electricity in the region.
- 3) Encouraging private sector participation: The private sector can play a crucial role in ending energy poverty in the NE states of India. Private sector players can invest in renewable energy projects, provide financing, and offer technical expertise.
- 4) Enhancing access to finance: Governments and financial institutions can work together to increase access to finance for energy projects in the NE states of India. This can be achieved through the provision of loans, grants, and other financial instruments.
- 5) Capacity building and awareness creation: Governments, NGOs, and other stakeholders can engage in capacity building and awareness creation activities to promote the adoption of modern energy services. Capacity building activities can include training on the installation and maintenance of renewable energy systems, while awareness creation activities can involve educating the public on the benefits of modern energy services.

5. Positive Case Studies

- 1) Solar Home Systems in Bangladesh: The Solar Home Systems (SHS) program in Bangladesh is a success story in the fight against energy poverty. The program, launched in 2002, aimed to provide electricity to rural households. The program provided solar panels, batteries, and other necessary equipment to households, enabling them to generate their electricity. The program has been successful, with over 4 million households (as on 2022) having access to electricity because of this program. The program has had significant positive impacts, including increased economic activity, improved educational outcomes, and reduced health problems.
- 2) Off-Grid Solar Power in Africa: Off-grid solar power systems have been successfully implemented in various African countries to address energy poverty. In Kenya, for example, M-KOPA Solar has provided affordable solar-powered lighting and charging systems to more than 1 million households. The company has helped to reduce energy poverty and improve the quality of life for many people in rural areas of the country (Kimani, 2019).
- 3) Community-Based Renewable Energy in Balkan Countries: In the Balkan countries, community-based renewable energy projects have been implemented to address energy poverty. These projects involve the installation of small-scale renewable energy systems, such as solar panels and wind turbines, in rural areas. For example, in Bosnia and Herzegovina, a project called "Renewables for Rural Development" was implemented in 2015 to provide renewable energy solutions to rural communities (United Nations Development Programme, 2020).
- 4) Biogas in Latin America: Biogas has been employed as a non-conventional solution to address energy poverty in some Latin American countries. In Nicaragua, for

example, a biogas plant was installed in the rural community of Los Laureles in 2015. The plant provides electricity and cooking gas to more than 100 households and has helped to reduce energy poverty in the community (United Nations Development Programme, 2018).

- 5) Mini-Grids in Africa: Mini-grids are another non-conventional solution that has been employed in Africa to address energy poverty. These small-scale electricity distribution networks can be used to provide power to communities that are not connected to the national grid. In Tanzania, for example, a mini-grid project was implemented in 2016 to provide electricity to 1,500 households in rural areas. The project has helped to improve the quality of life for many people and has contributed to the economic development of the region (Energy 4 Impact, 2017).

6. Case Studies of Positive Impact with the North East States

The Assam Power Distribution Company Limited (APDCL): The APDCL is a state-owned company responsible for distributing electricity in the state of Assam. The company has implemented several initiatives to improve access to electricity in the state, including the construction of new power generation plants, expansion of transmission and distribution networks, and the promotion of renewable energy.

The APDCL has also implemented a scheme to provide solar home systems to households in remote areas without access to grid electricity. The solar home systems provide lighting and power for electronic devices, improving the quality of life for households in remote areas.

Meghalaya Renewable Energy Development Agency (MREDA): MREDA is a government agency in the state of Meghalaya responsible for promoting renewable energy. The agency has implemented several initiatives to promote renewable energy, including the installation of solar home systems, off-grid solar systems, and microgrids.

MREDA has also implemented a scheme to provide cooking stoves that use biogas to households in remote areas. The biogas stoves reduce the dependence on traditional fuels and improve the quality of life for households in remote areas.

7. Replicating Success Stories in the NE States of India

The success stories of the APDCL and MREDA can be replicated in the NE states of India by implementing similar initiatives. Governments, NGOs, and private sector players can work together to promote renewable energy, improve energy infrastructure, and increase access to finance.

Capacity building and awareness creation activities can be implemented to educate the public on the benefits of modern energy services and the use of renewable energy. Governments can provide tax incentives and subsidies to encourage private sector participation in the energy sector.

However, ending energy poverty in the NE states of India will require a long-term commitment from all stakeholders. Governments must prioritize the energy sector and allocate sufficient resources to address the challenges of energy poverty, while private sector players must be encouraged to invest in the energy sector, and financial institutions must provide adequate financing for energy projects. Lastly, it is essential to involve local communities in the planning and implementation of energy projects.

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The success stories of the APDCL and MREDA can be replicated in the NE states of India, and these initiatives can serve as models for other regions facing similar challenges.

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Lastly, it is essential to involve local communities in the planning and implementation of energy projects. Local communities have valuable knowledge and insights into the energy needs of their communities and can provide valuable feedback and input on energy projects.

North East India is one of the most energy-poor regions in India, with majority of the population lacking access to reliable electricity. The region is also rich in renewable energy resources, including solar, wind, and hydro. Replicating the success stories of solar home systems, off-grid solar systems, and microgrids can help end energy poverty in North East India. Below are some ways to replicate the success stories in North East India.

- 1) Promote off-grid solar systems: Promoting off-grid solar systems can help end energy poverty in North East India. The region has abundant solar resources, which can be harnessed to provide electricity to rural households. Governments and NGOs can provide subsidies to households to enable them to access off-grid solar systems. In addition, pay-as-you-go systems can be introduced to enable low-income households to access off-grid solar systems.
- 2) Develop microgrids: Developing microgrids can also help end energy poverty in North East India. The region has abundant biomass resources, which can be used to generate electricity using biomass gasifiers. Governments and NGOs can provide subsidies to promote the installation of microgrids in the region. The installation of microgrids can also create employment opportunities in the region.
- 3) Increase awareness: Increasing awareness of the benefits of renewable energy can help end energy poverty in North East India. Governments and NGOs can launch

awareness campaigns to educate people on the benefits of renewable energy. Awareness campaigns can include seminars, workshops, and community meetings.

- 4) Promote gender equality: Promoting gender equality can also help end energy poverty in North East India. Women and girls are disproportionately affected by energy poverty, as they are responsible for collecting firewood and cooking with traditional stoves, which emit smoke and cause health problems. Governments and NGOs can promote gender equality by empowering women and girls to participate in renewable energy projects. Women can be trained to install and maintain off-grid solar systems and microgrids, which can create employment opportunities and increase their income.
- 5) Foster partnerships: Partnerships between governments, NGOs, and the private sector can help end energy poverty in North East India. The private sector can invest in renewable energy projects in the region, while governments and NGOs can provide subsidies and support. Partnerships can also promote knowledge sharing and technology transfer, which can help accelerate the adoption of renewable energy in the region.

8. Fund Requirement

Estimating the total fund requirement for ending energy poverty in North East India is a complex task that requires considering several factors. We can assume that to end energy poverty in the region, a significant capacity addition and new infrastructure would be required. To estimate the fund requirement, we need to consider the cost of infrastructure development, capacity addition, maintenance, and administrative expenses.

Based on the data available, we can estimate the fund requirement for capacity addition and new infrastructure development in the North Eastern states. The peak demand for electricity in the region in 2020-21 was 3,999 MW, and assuming a 7% annual growth rate, the peak demand is expected to reach 7,726 MW by 2030 (Ministry of Power, 2021).

To meet this demand, considering a mix of renewable and non-renewable sources of energy would be required, let us assume that 50% of the demand is met by renewable energy sources and 50% by the non-renewable energy sources. Total required power generation can be computed by assuming the PLFs of each source of generation. Here, let us assume that the PLF of non-renewable energy sources shall be 60% and renewable energy sources shall be 25%, which makes the total required capacity to be 10,560 MW. According to the market prices and market intelligence, the total fund requirement would be Rs. 51,557 Crore.

Particulars	Req. Capacity (MW)	Rs. Cr/ MW	Req. Inv. (Rs. Cr)
Demand to be met by non-renewable (MW)	3,106	7	21,741
Demand to be met by renewable (MW)	7,454	4	29,816
Total Capacity	10,560	4.88	51,557

Assuming that the cost of setting-up transmission and distribution infrastructure is around 40% of the cost of power generation capacity addition, the total fund requirement for capacity addition and new infrastructure development for addressing energy poverty in the North Eastern states could be around INR 72,180 crore. This figure is likely to be higher due to several other factors such as the cost of infrastructure development, maintenance, and administrative expenses. It is also important to note that this estimate assumes a 50-50 split between renewable and non-renewable energy sources. However, the actual split could vary based on the availability of resources and the government's policies and priorities.

Ending energy poverty in North East India would require a significant fund requirement for capacity addition and new infrastructure development. While the exact fund requirement is difficult to estimate, considering the available data and several assumptions, we can estimate the fund requirement to be around INR 72,180 crore per year. This figure is likely to be higher due to several other factors that need to be considered.

9. Conclusion and Policy Implications

Energy poverty is a significant challenge that affects millions of people worldwide. Renewable energy solutions such as solar home systems, off-grid solar systems, and microgrids have proven to be effective in combating energy poverty. Replicating the success stories of these solutions in North East India can help end energy poverty in the region. Governments, NGOs, and the private sector can work together to promote renewable energy solutions, increase awareness, promote gender equality, and foster partnerships. By doing so, North East India can become a model for ending energy poverty in other parts of the world.

This study has analysed the complex issue of energy poverty in the North Eastern states of India and its relationship with socioeconomic progress and community well-being. Key contributing factors of energy poverty were identified, such as weak financial health of Discoms, substantial transmission and distribution losses, and a lack of access to modern energy services.

The paper proposes a balanced mix of renewable and non-renewable energy sources, including localised mini-grids, as a comprehensive strategy to combat energy poverty. This approach, can foster energy independence, resilience, and sustainability in remote areas. Additionally, it was found that these strategies could serve dual purposes, alleviating energy poverty while mitigating climate change impacts through reduced greenhouse gas emissions.

As for policy implications, the study underscores the need for robust policy interventions and institutional reforms. Governments should prioritize the financial health of Discoms, invest in infrastructure to reduce transmission losses, and incentivize the adoption of renewable energy technologies. Moreover, fostering community engagement in energy planning and management can encourage local ownership, acceptance, and sustainability of energy initiatives.

The paper has also highlighted the financial implications of these strategies, providing an estimated cost for infrastructure development and capacity addition. This information may help in attracting investments and allocate resources efficiently, ensuring that the benefits of sustainable energy reach the most disadvantaged communities.

In conclusion, this paper provides a roadmap to address energy poverty in North East India, paving the way for a more inclusive and sustainable future for the region.

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