sunrise

POLICY BRIEF

Empowering Rural India Through Community Solar Energy

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Introduction

Current Energy Landscape in Rural India

India's solar potential, with nearly 300 days of sunshine annually, presents a significant opportunity for expanding renewable energy. A series of policy initiatives to boost renewable energy include the Pradhan Mantri Suryodaya Yojana[1] in 2024, which aims to install rooftop solar systems for **10 million households** by 2026, building on initiatives such as the National Solar Mission[2] in 2010. Decentralised renewable energy (DRE) technologies, especially off-grid solar, are the most cost-effective solution for over **70% of rural electrification.**[3] Another scheme launched in 2017 - Pradhan Mantri Sahaj Bijli Yojana-Saubhagya[4] - focuses on the last mile electricity connections to unelectrified households, providing standalone solar photoltaic systems for remote and inaccessible villages/habitations where grid extension is not feasible or cost effective.

However, many rural areas still face **unreliable and unaffordable electricity**, and lack the infrastructure, financial resources, or technical capacity for individual rooftop installations. The benefits of renewable energy (RE) are not always distributed equitably, particularly for women[4], older adults, smallholder farmers, and those from poorer socio-economic backgrounds.[5] **Community energy (CE) models** offer a more inclusive approach to solar energy access, offering shared resources, collective resilience, livelihood opportunities, and backup energy supply.

Based on the findings of SUNRISE (2018-23), an EPSRC GCRF project, this brief provides policy recommendations to facilitate community solar energy in rural India, focusing on **technology adoption and innovation, community participation and ownership**, and **sustainable funding models and policy support.** Addressing these areas will help ensure that no rural communities are left behind as India transitions towards renewable energy.

This policy brief covers participatory approaches and issues based on empirical evidence. The inputs for this policy are mainly derived from interactions with the most vulnerable section of the population, the Scheduled Tribes in India. However, to get inputs from all sections, a larger study is required.

Policy Recommendations

Technology and Innovation

- New technology should not be considered in isolation – but understanding specific demand, actual (and potential) performance of technology is as important as the design, delivery and optimization.
- Training and energy literacy are essential. There is often a lack of public awareness and understanding of RE technologies that can result in sub-optimal energy use.

Action Points

- Include monitoring and evaluation phase in the project to ensure energy is used to full capacity. Consider the potential for more responsive and diverse long-term options (e.g. could leverage funds from government schemes).
- Encourage partnerships for example with local NGOs in building energy literacy (who know specific locations and learning needs).

Community Ownership and Participation

- Community participation is essential in understanding capabilities and needs of all groups in specific contexts around their energy needs now and in the future.
- In addition to participation in delivery it is critical to ensure a sense of autonomous community ownership in the medium and long term.

Action Points

- Community participation (for example focus groups, interviews) should be a requirement in all projects.
- Transfer financial responsibility and ownership to communities for the management and maintenance of solar infrastructure (models include a village energy committee or including small upfront payments).

Funding and Policy Support

- Community energy can bring immediate sustainable, affordable and reliable energy to rural communities even where grid access is available and should be prioritised in policy and ensuring no one is left behind.
- Interdisciplinary partnerships to be encouraged in research and delivery of projects to ensure sustainability (including financial, environmental and social sustainability).

Action Points

- Securing diverse funding sources (e.g. climate funds, government, CSR- tribal area funding) can ensure project sustainability.
- Research Councils, e.g. UKRI, encourage multiple partners and stakeholders in projects and ongoing research, including non-traditional research partners working in the field (e.g. NGOs).
- Ensure the projects do not have unintentional impacts on other policy areas, i.e. increased energy impacts water use in agriculture (water, food , energy nexus).

About This Brief

This brief focuses on how a **just transition** to community solar energy in rural India can be better achieved. Through a combination of **policy recommendations**, **community participation** and **sustainable funding models**, this brief highlights strategies for empowering rural communities to participate actively in the energy transition. It emphasises the importance of tailoring energy solutions to the local context, ensuring that **social equity, economic opportunity,** and **environmental sustainability** are considered throughout.

Technology and Innovation: The brief emphasises the importance of considering local contexts (e.g. social, cultural, economic, environmental) to provide off-grid, **region-specific solar technologies** to meet the needs of rural communities. It stresses the need for **training and capacity-building programs** to equip rural populations with the skills to install, maintain, and operate these technologies.

Community Ownership and Participation: Central to the success of rural energy transitions is long-term community ownership. The brief advocates for models where local communities take ownership of solar infrastructure, managing and maintaining the systems long-term. It highlights the importance of **participatory approaches**, where community members are involved in the decision-making processes, ensuring that technologies are tailored to local needs and preferences. **Women's empowerment** is a key focus.

Funding Models and Policy: This policy outlines sustainable funding mechanisms that combine **public, private, and community financing**. It calls for the expansion of **microfinance, climate finance, public-private partnerships and Corporate Social Responsibility (CSR)** initiatives to drive the initial deployment and scaling of solar projects in rural areas. Additionally, this brief stresses the importance of creating an enabling policy environment that supports decentralised energy systems, transitioning away from fossil fuel-based energy sources, including wood, which is still heavily relied upon in rural communities.

After SUNRISE workshop, IIT Bombay, June 7th 2024

WORKSHOP EVENTS

Participatory Workshops were held in India (Khuded June 5th, Mumbai June 7th 2024) and Swansea (November 19th 2024) to inform the development of this policy brief. These workshops facilitated dynamic exchanges within local communities, and between academics, policymakers, private sector experts and non-governmental organisations to explore innovative approaches for supporting a just transition to community solar energy in rural India. Participants shared regional insights and challenges while developing actionable solutions for energy equity. The sessions built on recent research highlighting successful examples of community-driven energy projects and identifying the key strategies needed to ensure inclusive, sustainable solar energy transitions in rural areas.

Policy Actions

1. Technology and Innovation

Innovation in Technical Interventions: Solar power can provide **affordable, accessible, reliable and sustainable electricity** to remote and off-grid areas, improving quality of life and supporting economic activities.[6] However, CE technology must consider **local energy demands, community participation,** and **long-term maintenance needs.**

Automation and internet access are important for optimising the performance of CE solar systems, enabling remote monitoring and reducing technical failures. In the SUNRISE project, it was observed that the lack of internet limited data monitoring and community communication.

Energy literacy in rural communities remains a significant barrier, as lack of awareness and understanding of renewable technologies can lead to **sub-optimal use** and **inequitable access within the community**. Improving energy literacy through training and education is key to ensuring equitable and effective use of CE technologies. Programs like Barefoot College (https://www.barefootcollege.org/) that train women as solar engineers exemplify how community-driven innovation can empower local populations and enhance the ownership of renewable energy projects. Similarly, the CESET Project (https://cesetproject.com/) trained and equipped 20 female technicians to design and install clean energy systems (solar PV, wind, and hydro power) contributing to a more just energy transition in Malawi.

Installing the solar roof of the Solar OASIS building, May 2022

"Agricultural works have become easy due to the use of machines... and when everyone does farming together, we get a sense of enthusiasm and also get good yield."

- Participant, Khuded Village

ACTIONS

1. New CE technology should not be considered in isolation. Understanding **energy demand, needs** and **required performance** in the community is as important as the design, installation and optimization of CE systems. Selecting technologies suited to the **specific environmental and social conditions** in each region involves understanding community needs and **co-designing solutions** with local input to ensure relevance and effectiveness.
2. Including a **monitoring and evaluation** phase in CE projects ensures energy optimisation and performance checks, with potential for immediate responsive actions or diversifying energy use to meet other long-term options.
3. **Training and energy literacy** in the community includes encouraging partnerships between those involved in CE initiatives including researchers, co-operatives, SMEs, and local NGOs who understand the context, energy requirements and learning needs in the community.

2. Community Ownership and Participation

Community participation and sense of ownership is fundamental to ensuring the long-term success and sustainability of CE. Beyond simply engaging communities, it is vital to recognise the **embedded knowledge and expertise** that local populations bring, based on their **lived experiences and understanding of the local context.** Rural communities are experts in their unique environmental, social, and economic conditions, which can significantly inform the design, implementation, and maintenance of CE projects. By valuing this expertise, renewable energy solutions can be better tailored to meet the specific needs and constraints of the area.

Promoting open dialogue between communities and stakeholders ensures approaches build trust and ongoing interest. Additionally, establishing a **community energy committee or CE co-operative** promotes local ownership and more effective management. Agreeing on upfront payments or regular fees for energy use enhances both responsibility and reliability in the long-term operation of CE.

Gender-responsive solar policies that specifically engage women as energy entrepreneurs have shown multiple development benefits. UNDP's 'Solar Sakhi'[7] initiatives demonstrated both increased household energy access and women's economic empowerment.

Technical training—delivered through partnerships with NGOs or local technical schools—should begin early in the project and include women and older adults as trainees. This ensures that the necessary skills to maintain and operate the energy systems long-term are available, contributing to the sustainability and self-reliance of the village.

Dr Khushboo Ahire (TISS) engaging with a rural community in India as part of the SUNRISE project.

"Village energy committee we had great hopes - but these have largely been passive and this is what I have observed during my site visits after handing over the asset to them."

-Arunavo Mukerjee, Prof of Practice IIT Kanpur, previously with Tata Cleantech Capital

ACTIONS

1. **Ownership Models**: Develop community-led energy management systems, such as village energy committees or cooperatives, to foster a sense of ownership and long-term sustainability. In the SUNRISE project, a village energy committee was set up, but its effectiveness was limited due to narrow participation. Active engagement, training, tapered off support by NGOs, and potentially paid roles are crucial for these committees to function effectively. Lessons can be learned from both successful and less successful examples, such as the Dharnai Solar Microgrid in Bihar.[8]
2. **Autonomy in Maintenance**: Transfer financial responsibility and ownership of solar infrastructure to communities, with clear mechanisms for the management and upkeep of systems. Raising awareness and developing skills for ongoing project sustainability is crucial. Community-driven maintenance plans ensure long-term sustainability through local involvement.

The Solar OASIS: A Case Study

The Strategic University Network to Revolutionise International Solar Energy (SUNRISE - https://www.sunrisenetwork.org/) project exemplifies the importance of context-specific solutions. SUNRISE constructed a Solar Community Building, known as the Solar OASIS, in a village in Maharashtra, India. This collaboration involved academic institutions from India and the UK, and industrial partners like Tata Cleantech Capital, Avesta Solar, and BIPVco. The project aimed to provide sustainable energy access, mitigate climate change, and improve socio-economic outcomes.

The SUNRISE project employed various participatory arts based activities within the village, including body mapping and participatory diagramming at the pre-building stage, and participatory video with most significant change as a means of monitoring and evaluation. These approaches ensured that local residents, particularly vulnerable groups like women and older adults, were involved in shaping solar energy solutions, fostering a sense of ownership and creating energy systems tailored to their specific cultural and socio-economic needs.

For instance, villagers in the SUNRISE project were keen to engage in income-generating activities like bamboo crafts. Such initiatives not only empower individuals economically but also strengthen the local economy, reducing the need for migration to urban areas.

The SUNRISE project included follow-up workshops with diverse stakeholders, including villagers, policy makers, NGOs, academics, and businesses. This approach highlighted the importance of continuous feedback and adaptation to ensure that the benefits of solar energy are equitably distributed.

Khuded villagers using their new rice husking machine.

The bamboo slicing machine inside the Solar OASIS building.

Residents using healthcare equipment inside the Solar OASIS.

Khuded villagers taking part in the 'participatory video with most significant change' monitoring activity.

Children drawing the Solar OASIS building as part of the 'After SUNRISE' follow-up workshop.

3. Funding and Policy Support

The SUNRISE project identified several barriers hindering the success of decentralised community solar PV systems, including:

1. **Disconnect between policy and implementation,** where national strategies do not easily translate at local levels in rural communities that are hard to reach and cash poor.
2. **Poor long term coordination among project stakeholders**, including academics, businesses, NGOs, and communities, with lack of monitoring energy data and weak sense of ownership.
3. **Lack of representative community involvement throughout the entire process**, leading to CE solutions that do not fully meet local needs or preferences.
4. **Inadequate financial and technical support** for ongoing deployment, maintenance and uptake of further opportunities.

To overcome these practical barriers, **enabling policy frameworks** should encourage collaboration across stakeholders, ensuring clear roles and ownership, better communication, and inclusive community participation for sustainable outcomes.

Securing **diverse funding sources** is crucial for the sustainability of CE projects. For example, the Barefoot College in Rajasthan has successfully mobilized funds from international donors, government grants, and CSR initiatives to establish solar electrification projects in remote villages, ensuring these projects continue to thrive even after the initial funding ends. Planning for long-term financial stability should involve creating revenue streams that support ongoing operations. A microfinance model could make solar systems affordable, allowing rural families to pay in installments and ensuring the sustainability of the project through continuous cash flow.

Policy Alignment and avoiding unintended consequences: Ensuring that projects align with broader policy directives can enhance their impact. Reliable and affordable electricity must be considered in conjunction with how and where energy is used, particularly the nexus between energy, water, and farming, to avoid unintentional impacts. For example, solar energy projects should be carefully integrated with agricultural practices to prevent pushing farming into water-intensive methods.

ACTIONS

1. Secure funding from a range of sources, including climate funds, government initiatives, corporate social responsibility (CSR) programs, and tribal area funding. A **diversified funding base** ensures **long-term sustainability** and reduces dependency on short-term grants. UKRI, for example, should prioritize innovative funding models that emphasise 'non-traditional' research partnerships between international experts, government entities, private sector players, and local energy providers.
2. Align solar community energy initiatives with broader national policies on rural electrification and renewable energy. Policies should promote **decentralised energy solutions** despite grid access and individual solar installations to **ensure no community is left behind.**

Summary

This case study highlights the transformative potential of community solar energy projects in rural communities. It emphasises the need for **participatory approaches** to achieve scalability of affordable and reliable community solar energy and integration with broader socio-technical systems. The brief outlines strategic recommendations for CE focusing on **technology innovation, community-driven solutions,** and **sustainable funding and policy support** to ensure that the transition to renewable energy is inclusive and equitable for all, and **no community is left behind**. These findings are relevant not only for India's solar energy expansion but also for global energy development in both developing and developed contexts.

Thanks

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Members of the Khuded Village Energy Committee outside the Solar OASIS building.

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