Shared Power, Shared Prosperity—How Collective Ownership of Local Renewable Energy Sources Can Help to Build Resilient Rural Communities

BY PHILIPP RIEGEBAUER

Philipp Riegebauer is a board member of the German IAEE affiliate (GEE e.V.) and can be reached at philipp.riegebauer@gee.de

Community-owned solar power offers rural areas a decentralized, renewable energy solution that fosters local engagement, economic opportunities, and energy security. By promoting peer-to-peer energy sharing and sustainable practices, these systems empower communities, reduce dependence on centralized grids, and address broader challenges like waste management, driving social and economic resilience.

Access to reliable and affordable energy is essential for improving quality of life, enhancing productivity, and driving economic development. However, in many parts of the world, particularly in rural and underserved areas of Africa, millions of people still lack access to electricity, with globally over 745 million people lacking access in 2023. Sub-Saharan Africa continues to account for about 80% of this deficit, despite efforts to improve access through decentralized energy solutions like solar home systems, which have seen growth in some regions. **[IEA, 1]**, **[SEforALL]**

Energy poverty disproportionately affects low-income communities, where centralized energy infrastructure often fails to reach, deepening inequality and limiting opportunities for social and economic development. The transition to renewable energy, particularly solar power, presents a unique opportunity to address these challenges. Solar energy, as a decentralized and sustainable source of electricity, can empower communities to take ownership of their energy systems, fostering energy democracy and decentralization. Renewable Energy Communities (RECs) have the potential to improve energy access, promote community engagement, and ensure long-term sustainability.

This article explores the potential of solar power to overcome energy poverty in rural areas, focusing on community ownership, modular microgrids, and peer-to-peer energy sharing. By leveraging local energy sources and fostering pro-social behavior, rural communities can not only achieve energy security but also address other pressing challenges such as waste management and sanitation.

The challenge of community ownership

Energy poverty, defined as insufficient access to affordable and reliable energy for basic needs, is a significant issue, particularly in rural areas. Centralized energy systems, although beneficial for urban centers, often fail to reach remote and underserved

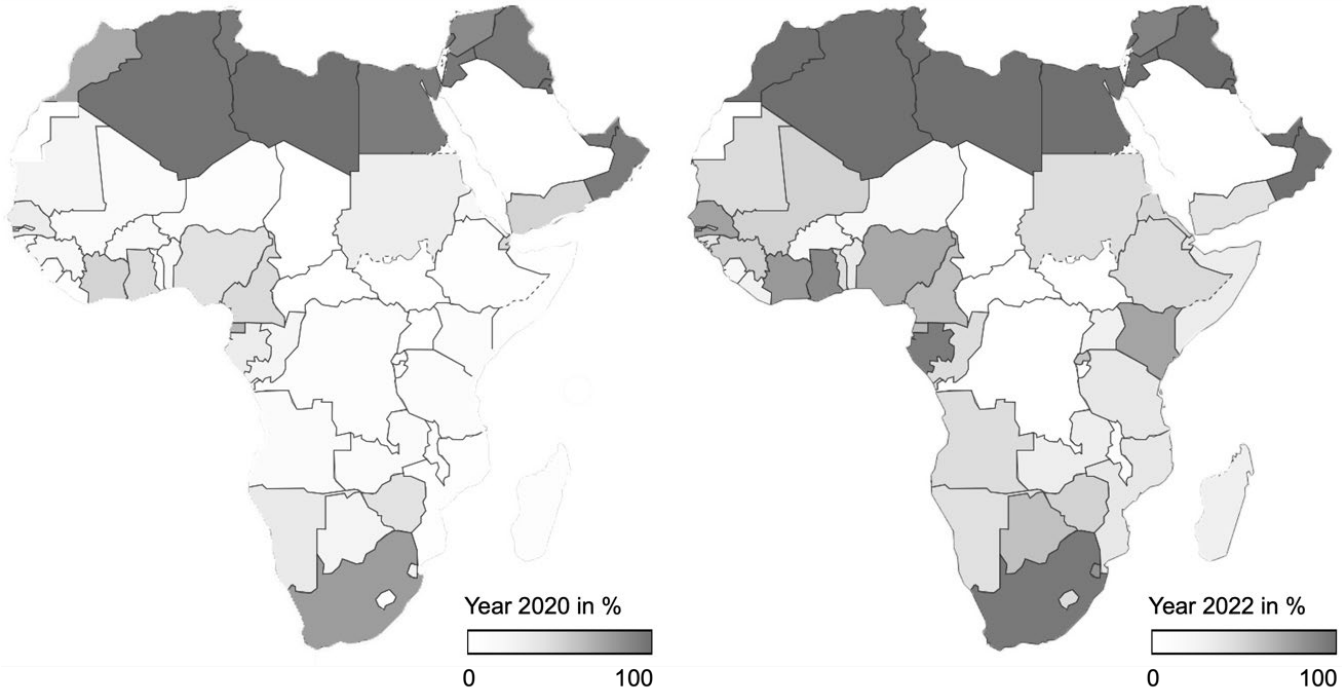

*Figure 1: Share of population with access to electricity in Afrika; Source **[IEA 2]***

areas. These systems tend to overlook community involvement, leaving residents dependent on external sources for their energy needs. Community ownership of energy resources is an emerging solution to these challenges. It fosters local engagement and provides a sense of control and empowerment. When communities are responsible for managing their energy systems, such as solar power installations, they are more likely to ensure the longevity of these systems. In rural areas, where centralized grids are either unreliable or entirely absent, solar energy represents a local solution that can be owned, managed, and maintained by the community.

Solar power and modular microgrids for reliable energy access

Solar power has emerged as one of the most promising solutions to energy poverty, particularly in rural and remote regions. The declining cost of solar photovoltaic technology, coupled with the abundant sunlight in many regions, makes solar power a cost-effective, local and scalable energy solution. In rural areas, solar energy systems can be deployed at various scales, from individual home systems to larger community-based projects. This flexibility is key to addressing the diverse needs of different communities.

However, one of the key challenges with solar energy is its intermittency. Solar panels generate electricity only when the sun is shining, and without affordable energy storage solutions, continuous electricity supply can be difficult to achieve. To address the intermittency of solar power and limiting the need for costly battery storage, modular microgrids and peer-to-peer energy sharing have gained traction as a solution. Microgrids are small, decentralized energy systems that can operate independently or in conjunction with the main grid. Solar-powered microgrids offer several advantages for rural communities. They can be designed to meet the specific needs of the community, with the ability to expand as demand grows. Moreover, because solar power can be locally generated and consumed, it eliminates the need for costly and complex transmission infrastructure that often makes centralized grid extensions unfeasible.

Peer-to-peer electricity sharing and tokenization

One of the most exciting developments in the field of decentralized energy is the concept of peer-to-peer (P2P) energy sharing. P2P energy sharing allows households and businesses to trade electricity directly with one another, without the need for a centralized utility. This approach is particularly well-suited to solar energy systems, where energy generation is distributed and often intermittent. Through blockchain technology and smart contracts, households who generate excess energy can sell their surplus to neighbors, creating a micro-economy around renewable energy generation. This not only improves energy access, ensuring that the entire community benefits from the collective solar energy generation, but also helps to build a more resilient local economy that is less dependent on external resources.

One of the key enablers for peer-to-peer networks and tokenization in Africa is the high penetration of mobile phones. Mobile technology has seen explosive growth across the continent, with smartphone adaption in Sub-Saharan Africa of 51% in 2022, and projections suggest that smartphone adoption will reach 88% by 2023. **[GSMA]** Many people in Africa, particularly in countries like Kenya and Nigeria, are already accustomed to using mobile-based financial systems like M-Pesa. This familiarity with mobile money and digital transactions makes it easier for communities to adopt token-based systems for energy trading. Second, while data privacy and protection are important issues, the lower regulatory barriers in most African countries allow for quicker adoption and innovation in decentralized technologies. Countries like Kenya and Nigeria have implemented Data Protection Acts, but these frameworks are generally less restrictive, offering more flexibility for peer-to-peer energy trading platforms.

Tokenization, the process of creating digital tokens to represent energy credits, can further enhance P2P energy sharing by encouraging energy-saving behaviors. Tokens can be earned by generating excess energy and spent by consuming energy from the grid. This system can incentivize households to participate in the energy market and manage their energy consumption more effectively. Therefore, in addition to providing reliable

Table 1: Tokenization in the context of energy systems and peer-to-peer energy sharing

Steps	Description
1st Energy Generation	In a community with solar panels or other renewable sources, electricity is generated and fed into a local energy microgrid or stored in batteries.
2nd Creation of Tokens	The energy generated can be quantified, and tokens are issued to represent this amount of energy. For example, one token might represent one kilowatt-hour (kWh) of electricity.
3rd Trading	Using blockchain technology, participants in the energy network can trade tokens among themselves. If one household generates excess energy, they can sell their tokens to a neighbor who needs more electricity.
4th Smart Contracts	Transactions are governed by smart contracts, which are self-executing contracts with the terms of the agreement directly written into code. These contracts automate the process of buying and selling energy, ensuring transparency and efficiency.
5th Incentives	Tokenization also allows for incentivizing pro-social behaviors, such as reducing consumption during peak times. Users can earn tokens for contributing to the energy grid or for participating in sustainable practices, which can be spent on energy or other services.

electricity, P2P networks encourage community engagement and foster pro-social behavior. When community members share energy, they develop a stronger sense of interconnectedness and responsibility for one another, laying the groundwork for addressing other community challenges. Despite challenges, decentralized renewable energy systems, such as solar-powered microgrids, offer a promising pathway to overcoming energy poverty and building resilient communities.

Leveraging pro-social behavior to build sustainable communities

A sustainable community can be seen as a community in which development is maintained over time. The sense of shared responsibility of RECs can lead to broader social and environmental benefits. Communities that develop strong networks around shared energy resources are more likely to collaborate on other infrastructure projects, such as sewage and waste management. For example, the use of tokenization can be expanded beyond energy to incentivize pro-social behaviors in other areas. Residents could earn tokens for participating in waste collection programs or maintaining communal sanitation facilities. These tokens could then be redeemed for electricity credits, creating a virtuous cycle of community engagement and infrastructure development. Moreover, the development of local carbon markets, as seen in the wake of the COP28 summit, presents an opportunity for communities to benefit financially from sustainable practices. In conclusion, solar power, when combined with decentralized energy systems, P2P sharing, and community-driven solutions, has the potential to address not only energy poverty but also broader social and economic challenges in rural areas.

Table 2: Challenges and Opportunities for Renewable Energy Communities

Core Aspect	Challenges	Opportunities
Energy Poverty in Africa	Limited access to electricity, high cost of extending the grid to remote areas, and reliance on fossil fuels.	Improving energy access can drive economic growth, enhance education and healthcare, and reduce inequality.
Solar Power Installation	Intermittency of solar generation, high initial investment for solar panels and and lack of affordable battery storage. Absence of finance mechanisms and opportunities for loans.	Decreasing costs of solar technology, renewable and abundant resource, scalable for local needs. Development of sustainable finance mechanisms.
Decentralized Energy Systems	Cost of establishing microgrids, lack of expertise and maintenance in rural areas.	Increased reliability and energy security, flexibility to scale, reduces reliance on central grids.
Community Ownership	Low levels of community involvement and initial community reluctance to maintain energy systems.	Fosters social engagement, long-term sustainability, promotes local ownership and responsibility.
Peer-to-Peer (P2P) Energy Sharing	Challenges in implementing blockchain, potential inequality in energy sharing.	Encourages community cooperation, can optimize energy use and distribution, enhances resilience.
Barriers to REC development	Insufficient regulatory frameworks, lack of funding, poor governance and community support.	Opportunity for growth with better policies and funding, development of local jobs and expertise.
Distribution of REC benefits	Ensuring equitable access to benefits, securing community engagement, and aligning with local economic needs.	Improves energy access, fosters local economic development, helps addressing broader social challenges.

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