

Can Energy Accessibility Reduce Inequality and Foster Innovation?

BY INÊS CARRILHO-NUNES

Abstract

This article explores how innovation in energy access, through technological advancements, policy solutions, and community-based projects, can reduce inequalities, including those related to income and gender, while promoting economic growth, improving health outcomes, enhancing education, and increasing productivity, ultimately contributing to a more sustainable and equitable future.

Introduction

Energy is a fundamental pillar of economic development, directly affecting the quality of life, economic opportunities, and social inclusion. However, millions still lack access to essential energy services, exacerbating poverty and inequality. Energy poverty disproportionately affects low-income households and communities, particularly women, who face greater energy challenges within their households and in the workforce (Acheampong et al., 2021). Indeed, energy poverty is a global problem with multiple concerns and definitions that vary and are highly dependent on the context or country. Energy poverty can be defined as the “inability of households to ensure their energy needs” (European Commission, 2023). However, there are different approaches to energy needs, and, consequently, energy poverty and its indicators, can be described with different approaches. First, energy poverty can refer to households without access to sufficient elemental energy services and commodities. These can include the lack of access to electricity and non-solid clean fuels (e.g., natural gas, biogas) and modern utilities for clean cooking. Typically, these households use kerosene, coal, and solid biomass as energy sources for cooking, which is highly damaging to the environment and public health. This definition focuses on the lack of access to modern energy sources essential to satisfying energy needs in an adequate lifestyle. It has a perspective based on primary energy access and is more commonly used to describe energy-poor households in lower-income economies, where access to electricity and clean cooking facilities is not guaranteed. The concepts of energy access and energy poverty are thus tidily connected. Yet the energy poverty bracket can also encompass individuals who struggle to afford energy services and are forced to lower their energy consumption bills to a degree that negatively affects the quality of their energy-related activities. Accordingly, energy poverty also includes cases where citizens spend most of their income (~10%) on energy debts. As a result, their inability to keep their homes warm or cold increases, or their arrears on utility bills surge (European Commission, 2023; Zhao et al., 2022). This second definition is more commonly used when studying energy poverty in higher-income countries.

The United Nations internationally recognizes the urgency of addressing energy poverty, underpinning several SDGs to the theme. Even though the seventeen objectives are tightly connected, it is possible to highlight three immediate goals for energy poverty and its implications: SDG 1 (“End poverty in all its forms everywhere”); SDG 7 (“Ensure access to affordable, reliable, sustainable and modern energy for all”); and SDG 13 (“Take urgent action to combat climate change and its impacts”). Combining these SDGs, there is potential for countries to improve their energy systems to bridge the poverty gap while fostering a cleaner energy transition.

At the intersection of these challenges lies the potential of technological change and innovation. Technological advancements in energy generation, distribution, and consumption can create new opportunities to address energy poverty while promoting inclusive economic growth (Capasso et al., 2019). The importance of bridging this energy gap is not only a technical issue but also a social one, with wide-ranging implications for economic inequality, education, and health.

Energy Accessibility and Inequality

Energy poverty has both direct and indirect effects on inequality. Households without access to clean, affordable energy are more likely to face health issues, miss educational opportunities, and remain economically marginalized. Research shows that energy accessibility is strongly linked to income inequality: regions with greater energy access tend to exhibit lower income disparities (Acheampong et al., 2021). This relationship emphasizes the critical need to ensure that vulnerable populations are prioritized in energy access initiatives. In addition, energy access plays a crucial role in reducing gender inequality. Women, especially in low-income and rural areas, disproportionately bear the brunt of energy poverty due to their traditional roles in household activities such as cooking and gathering fuel (IEA, 2017). Access to clean and modern energy reduces the time women spend on these labour-intensive tasks, allowing them to pursue education, economic opportunities, and improved living standards (Bouzarovski & Petrova, 2015; UNDP, 2018). Studies further show that reducing energy poverty promotes gender equality in the workforce and improves women’s health outcomes (Nguyen & Su, 2021; Sovacool, 2012).

Energy poverty also directly impacts health, with millions exposed to harmful indoor air pollution from burning solid fuels for cooking (Sovacool, 2012). Women, children, and the elderly are particularly vulnerable, as they spend more time indoors, exposed to dangerous levels of pollutants. This exposure is linked to respiratory diseases, heart conditions, and

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millions of premature deaths annually (IEA, 2017; WHO, 2006). The lack of affordable, clean energy also leads to inadequate heating in colder climates, contributing to poor mental and physical health, particularly in underprivileged households (Adom et al., 2021; Hills, 2011). Moreover, energy accessibility is integral to improving education and productivity. In many developing regions, children, particularly girls, miss school to perform household chores like gathering firewood (Acheampong et al., 2021, 2024). Access to reliable energy not only enables children to attend school but also enhances learning environments through better lighting and technology. Energy access also increases productivity, especially in agriculture and manufacturing, by providing power for essential services like irrigation and machinery, contributing to job creation and economic growth (Shi et al., 2022).

Improving energy accessibility is thus a vital step toward addressing inequality in its many forms. From enhancing gender equality to improving health, education, and productivity, access to clean and affordable energy has the potential to transform lives and reduce disparities. However, achieving these outcomes requires more than just expanding energy infrastructure. It demands innovative approaches—both technological and policy-driven—that can effectively bridge the gap between energy access and economic empowerment. By fostering new technologies and creative solutions, innovation plays a pivotal role in addressing energy poverty and driving inclusive development.

The Role of Innovation in Addressing Energy Poverty

Innovation serves as a critical enabler of energy accessibility. Technological advances, such as off-grid solar systems, clean cooking technologies, and decentralized energy solutions, have already demonstrated their ability to reduce energy poverty in regions where traditional energy infrastructure is unavailable (Alola, 2024; Gui & MacGill, 2018). Moreover, the digitalization of energy systems offers new pathways to bring affordable energy to underserved populations by optimizing energy distribution and reducing inefficiencies (Bianchini et al., 2023; Vasconcelos-Garcia & Carrilho-Nunes, 2024). However, the transformative potential of innovation in energy systems is not limited to technology alone. Policy innovation, financial instruments, and new business models can also play significant roles in ensuring that the benefits of the energy transition reach marginalized communities.

A prime example of such policy and business model innovation is the development of community-based energy projects. These initiatives, often spearheaded by local innovators, enable regions that are traditionally underserved by national grids to achieve reliable and affordable energy access (Chapman et al., 2021). These localized solutions, ranging from renewable microgrids to cooperative energy systems, empower communities to manage their energy needs autonomously while also contributing to broader societal goals of sustainability and equity.

Innovation also fosters significant economic and social improvements by creating employment opportunities and promoting gender equality. By integrating renewable energy projects with community empowerment strategies, these innovations can drive economic growth in rural and disadvantaged areas. For instance, solar energy projects have been shown to create new opportunities for micro-entrepreneurs, particularly women, by providing them with reliable power for small businesses (Nguyen & Su, 2021). Moreover, the combination of digital tools and decentralized energy systems allows for enhanced energy efficiency and affordability, further driving down the cost of energy for low-income households (Bouzarovski & Petrova, 2015).

Beyond immediate energy provision, these innovative approaches have a ripple effect on reducing inequality. As energy becomes more accessible, women and other vulnerable groups spend less time on energy-related domestic tasks, such as gathering fuel, enabling them to pursue educational and economic opportunities (Acheampong et al., 2021, 2022, 2024; Rustagi et al., 2024). Innovation, therefore, not only addresses the issue of energy poverty but also becomes a mechanism for fostering broader societal changes, ultimately reducing inequality and promoting inclusive economic development.

Fostering a Just Energy Transition

A just energy transition requires that we address the unequal distribution of opportunities and resources both within and between countries. As the world shifts toward a low-carbon energy system, policymakers and energy stakeholders must ensure that this transition is inclusive and sustainable, leaving no one behind. A truly just transition goes beyond technological advancements; it incorporates social equity as a foundational principle. This means prioritizing the needs of the most vulnerable populations, who are often the hardest hit by both energy poverty and the adverse effects of climate change (International Labour Organization, 2022).

Innovation, when combined with sound policy frameworks and strategic investment, creates the enabling conditions for a just energy transition. By aligning energy access initiatives with broader efforts to reduce inequalities, we can foster a sustainable and equitable energy future. This alignment is crucial, as energy access alone does not guarantee social progress unless it is paired with policies that address structural inequalities. For instance, gender-sensitive policies that ensure women have equal access to the benefits of clean energy can have transformative impacts on communities, enhancing health, education, and economic outcomes for all.

Conclusion

Addressing energy poverty and promoting energy accessibility are fundamental steps toward reducing global inequality. Energy is deeply interconnected with critical societal dimensions, from economic development to health and education, and the lack of access to modern, reliable energy services perpetuates cycles

of poverty and inequality. Innovation, whether through technological advancements, like off-grid solar systems or policy reforms aimed at supporting decentralized energy solutions, plays a pivotal role in transforming energy systems to be more inclusive and sustainable. By expanding access to clean and affordable energy, we not only improve living conditions but also drive progress in broader development goals. The ripple effects of energy access extend beyond simple electricity provision — accessible energy enhances health by reducing reliance on harmful fuels, boosts education by allowing students to study in well-lit environments, and strengthens local economies by empowering entrepreneurs and enhancing productivity. In this sense, energy accessibility serves as both a catalyst for growth and a pathway to equity.

However, achieving this vision of universal energy access is not without its challenges. Energy poverty disproportionately affects women, rural communities, and other vulnerable groups, highlighting the need for tailored approaches that prioritize social equity. Policymakers must recognize that energy is not just an economic issue but a social one, with far-reaching implications for poverty, gender, and overall inequality. Achieving universal energy access and reducing energy poverty is key to meeting the broader goals of sustainable development. This demands a multi-dimensional approach that prioritizes both technological solutions and equitable policy frameworks.

Achieving a just energy transition requires a coordinated effort that integrates technological progress with social justice. Only by bridging the gap between innovation and inclusivity can we ensure that the energy transition leads to shared prosperity, alleviating both energy poverty and inequality. In this way, the shift to clean energy becomes not only an environmental necessity but also a powerful tool for reducing inequality and fostering long-term, inclusive economic growth.

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