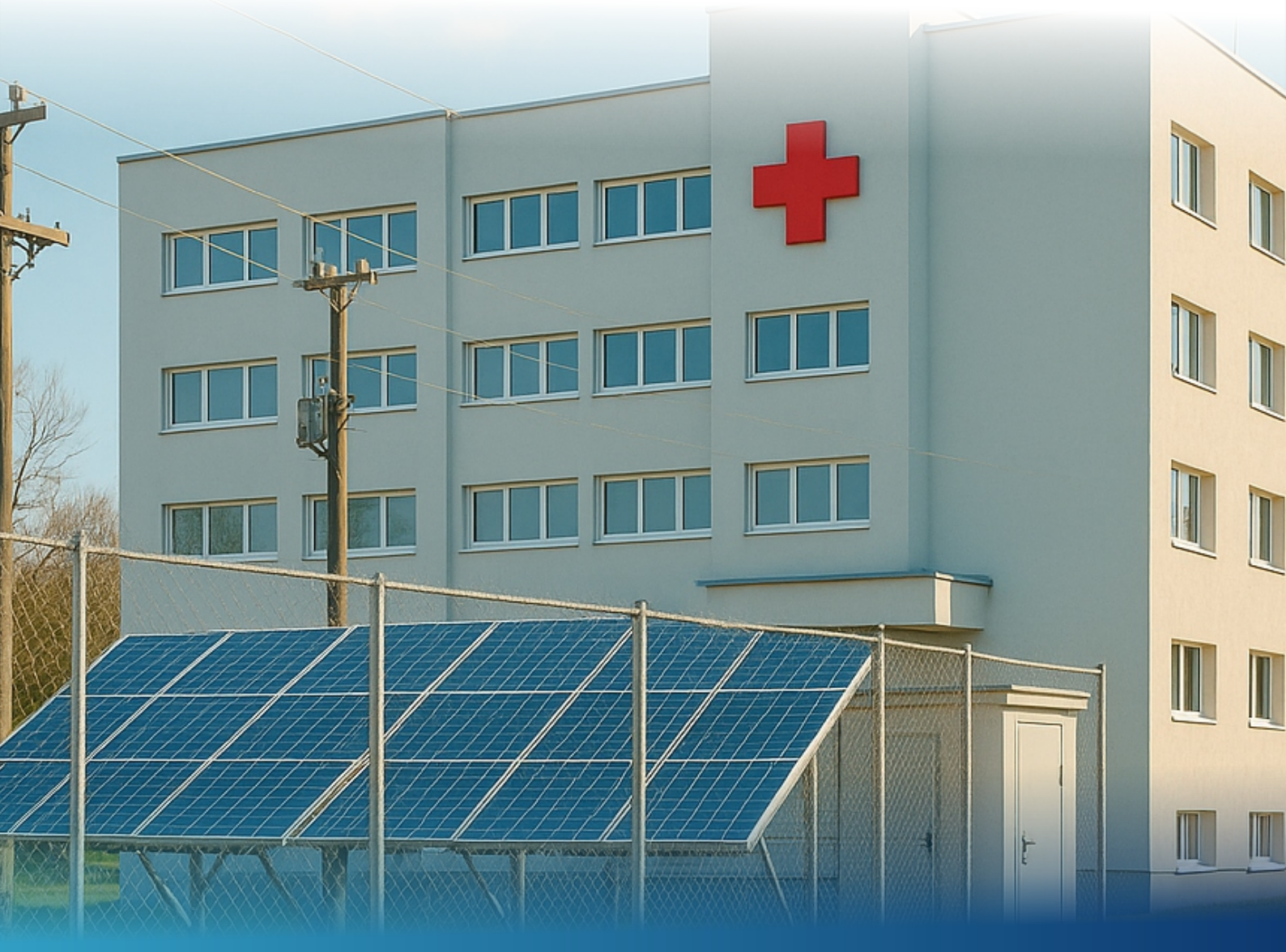


Clean Technology Hub
Energy Innovation Centre

Powering Healthcare in Nigeria: The Role of Standalone Solar Home Systems In Strengthening Primary Healthcare Delivery

written by Kolade Kolawole

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Overview

Nigeria is confronted with a critical healthcare-energy crisis as 40% of primary healthcare centres (PHCs) do not have electricity and as 80–83% are dependent on non-renewable sources of energy, which severely limits service delivery, storage of vaccines, and provision of emergency care. With stand-alone Solar Home Systems (SHS), gains of 60-65 % vs diesel generators and modular solutions can be adapted for PHC needs; this represents a scalable, cost-effective solution. Lessons from Rwanda and Ethiopia highlight successful SHS integration through decentralized energy policies, standardized implementation, and capacity building. While Nigeria's 2023 Electricity Act and the Rural Electrification Agency (REA) initiatives like the Energizing Healthcare Programme (EHP) show progress, challenges persist: high upfront costs, technical skill gaps, and slow state-level policy adoption.

1. State of Healthcare & Energy Access in Nigeria

Despite boasting one of Africa's largest economies, with an estimated GDP of 199.62 billion U.S. Dollars in 2024¹ and the continent's largest population, with over 232.6 million people², Nigeria struggles with achieving sustainable development, especially where inclusive and resilient healthcare is concerned. The challenges plaguing Nigeria's healthcare system range from overstretched and inadequately resourced primary healthcare centres to severe power (electricity) access, among others—about 60.5% of Nigeria's population have access to electricity³ with a significant distribution gap—89% of residents in urban areas and nearly 26% of rural dwellers⁴ having access to electricity. According to the National Primary Health Care Development Agency (NPHCDA), 70% of Nigeria's population relies on primary health facilities, with 15 primary healthcare centres per 100,000 individuals⁵—a stark disparity between the number of PHCs and the size of Nigeria's population compared to some European nations with almost 240 PHCs per 100,000 people⁶. The Legatum Prosperity Index

¹ Galal, S. (2025, April 24). *Africa: GDP by country 2024*. Statista. Retrieved March 25, 2025, from <https://www.statista.com/statistics/1120999/gdp-of-african-countries-by-country/>

² Galal, S. (2025, February 18). *Largest populations in Africa, by country 2024*. Statista. Retrieved March 25, 2025, from <https://www.statista.com/statistics/1121246/population-in-africa-by-country/>

³ *Nigeria electricity access 1990-2025*. (n.d.). MACROTRENDS. Retrieved March 25, 2025, from <https://www.macrotrends.net/global-metrics/countries/nga/nigeria/electricity-access-statistics>

⁴ Deng, Y. (2024, August 7). *Illuminating Nigeria: Grid and off-grid electricity*. Georgetown Journal of International Affairs. <https://gjia.georgetown.edu/2024/08/07/illuminating-nigeria-blurring-the-lines-between-the-grid-and-off-grid-electricity/>

⁵ Coker, T. (2023, October 12). Charting a healthier course: The state of Nigeria's primary care — TC HEALTH. *TC HEALTH*. <https://www.tchealthng.com/thought-pieces/charting-a-healthier-course-the-state-of-nigerias-primary-care>

⁶ Coker, T. (2023b, October 12). Charting a healthier course: The state of Nigeria's primary care — TC HEALTH. *TC HEALTH*. <https://www.tchealthng.com/thought-pieces/charting-a-healthier-course-the-state-of-nigerias-primary-care>

2023 ranked Nigeria 11th of 12 countries⁷ with the worst healthcare in the world, owing to critical gaps in infrastructure and healthcare worker shortages. These factors contribute to Nigeria's high maternal mortality rate of 576 deaths per 100,000 live births and an infant mortality rate of 69 deaths per 1,000 live births⁸. With approximately 262,000 infant deaths annually, Nigeria records the second-highest total worldwide⁹.

According to the estimates of the Federal Ministry of Health, there are 40,017 healthcare facilities in Nigeria out of which 85.3% operate at the primary (community/local) healthcare delivery level¹⁰. Close to 40% of PHCs are without any access to electricity. In addition, the majority (80–83%) of PHCs are not powered by renewable sources¹¹. Unreliable power supply is common even among the PHCs with some electricity access. This indicates that being provided with electricity does not guarantee quality, as it is almost always unreliable and results in poor service delivery.

Public healthcare delivery experiences significant deterioration due to these combined power shortages. The absence of power prevents essential health services from operating reliably because vaccines lose their effectiveness. Diagnostic testing suffers from interruptions, which leads to problems with maternal and child healthcare, while emergency services become dangerously inadequate during nighttime hours. Basic healthcare functions become unpredictable due to this unreliability, which damages patient trust while driving away medical staff from such under-funded areas. The far-reaching effects in healthcare delivery present a substantial challenge to deliver equitable and effective healthcare access throughout rural and underserved regions, which exacerbates existing health disparities.

40% of PHCs in Nigeria lack electricity, and over 80% use non-renewable energy, limiting healthcare services.



Nigeria has only 15 PHCs per 100,000 people, far below global standards.



⁷ *The best healthcare in the world: Country rankings*. (2020, April 30). International Citizens Insurance. <https://www.internationalinsurance.com/health/systems/>

⁸ *Situation of women and children in Nigeria*. (n.d.). UNICEF Nigeria. Retrieved March 25, 2025, from <https://www.unicef.org/nigeria/situation-women-and-children-nigeria>

⁹ *Situation of women and children in Nigeria*. (n.d.-b). UNICEF Nigeria. Retrieved March 25, 2025, from <https://www.unicef.org/nigeria/situation-women-and-children-nigeria>

¹⁰ SEforALL (2022). Deep Dive #2: Data Insights. https://www.seforall.org/system/files/2022-06/Nigeria_data_insights_0.pdf

¹¹ *Ibid.*

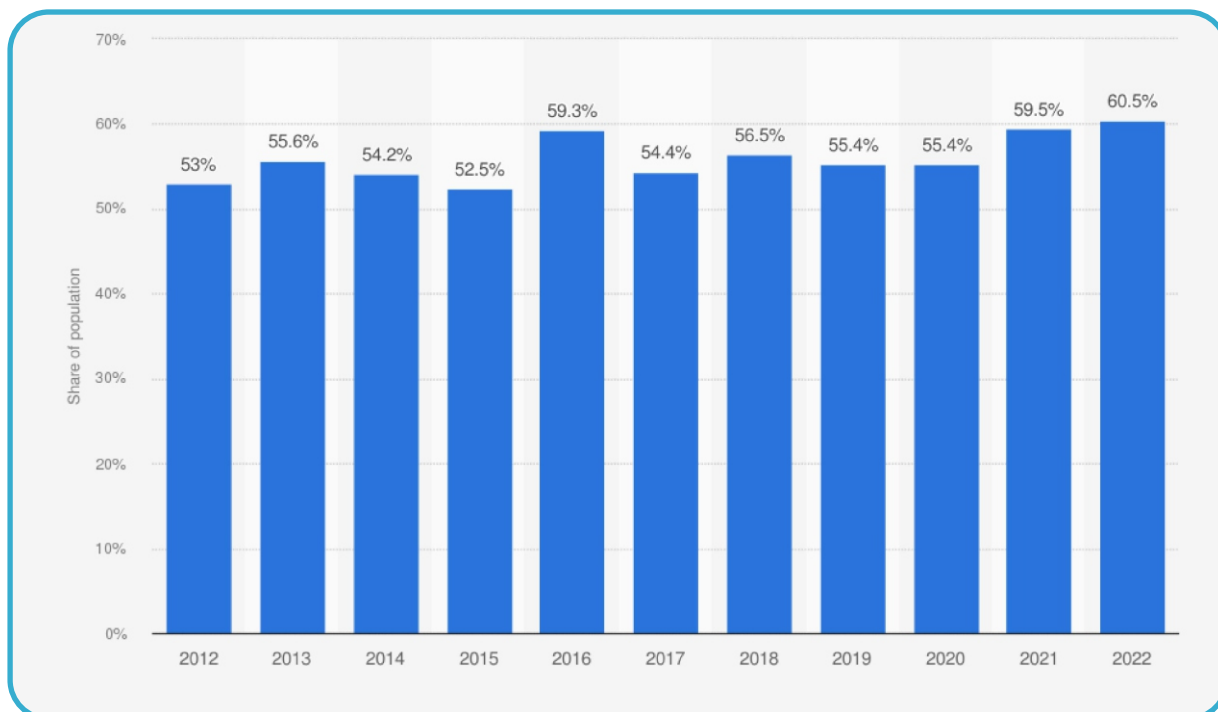


Fig. 1: Share of Population with Access to Electricity from 2012 to 2022 (World Bank; SEforALL; Statista)

2. The Role of Standalone Solar Home Systems (SHS)

A Solar Home System (SHS) is a small-scale renewable energy system. The typical components are solar panels, to harvest sunlight; batteries for energy storage; inverters that convert direct current to alternating current, and control systems to direct flow of energy. SHS offers an ideal solution to provide off-grid electricity to power homes, small businesses and standalone infrastructures especially the ones located in remote areas that are not connected or getting enough electricity supply from the national power grid. It is a cost-effective, environmentally friendly, scalable solution to affordably provide fossil-free sustainable energy for simple electrical lighting, recharging devices and operating small appliances.

The majority of primary healthcare facilities are located in remote rural communities, with 43% of them not connected to the grid. The remaining 57% that are connected receive less than 5 hours of power supply daily¹². Adopting this renewable energy system (SHS) across primary healthcare infrastructures in the country would provide a clean off-grid solution that will significantly offset the power supply deficits and potentially improve access to electricity

¹² Ani, V. A. (2024). Proposal for the sustainable electrification of a primary healthcare centre (PHC) facility in Nigeria. *Journal of Energy and Power Technology*, 6(1), 1–12.
<https://doi.org/10.21926/jept.2401002>

in these facilities. This intervention will also enhance primary healthcare service delivery—vaccines will be preserved at optimal temperatures, mitigating wastage and maintaining their efficiency; essential medicines such as insulin and certain antibiotics will be adequately refrigerated as they are vital to improving treatment outcomes.

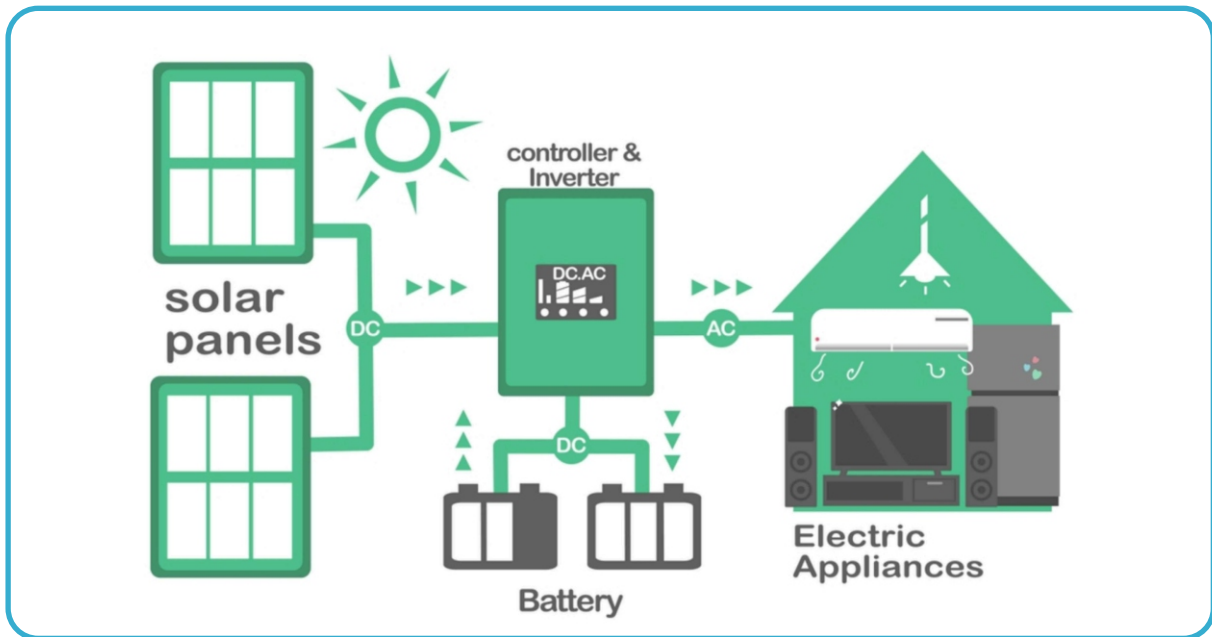


Fig. 2: Schematic Diagram of a Solar Home System Setup (Source: www.shutterstock.com)

Advantages of SHS for Healthcare Facilities

Integrating an off-grid solution such as the solar home system within Nigeria's healthcare system, especially at the primary level, has considerable environmental, economic and operational benefits:

1. Cost-effectiveness

The relatively low initial costs of diesel/petrol generators compared to the upfront costs of installing solar photovoltaic systems have encouraged many households, businesses and institutions, including PHCs, to adopt fossil-fueled alternatives to augment unreliable power supply. However, studies have shown that home solar PV option has a potential cost savings of 60-65% measured against the traditional use of diesel/petrol generators for backup power generation¹³—this is as a result of low costs of maintenance and the modularity of the system which allows for the capacity to be scaled up as energy demand increases over time.

¹³ Solar PV systems to eliminate or reduce the use of diesel generators at no additional cost: A case study of Lagos, Nigeria. (n.d.). *Renewable Energy*, 172, 209–218. <https://doi.org/10.1016/j.renene.2021.02.088>

In contrast, the significant hike in the price of fuel (over 400% increase)¹⁴ as a result of the fuel subsidy removal, coupled with the steep costs of maintaining generators, contributes to the high operational costs of PHCs and negative environmental impact in the long term.

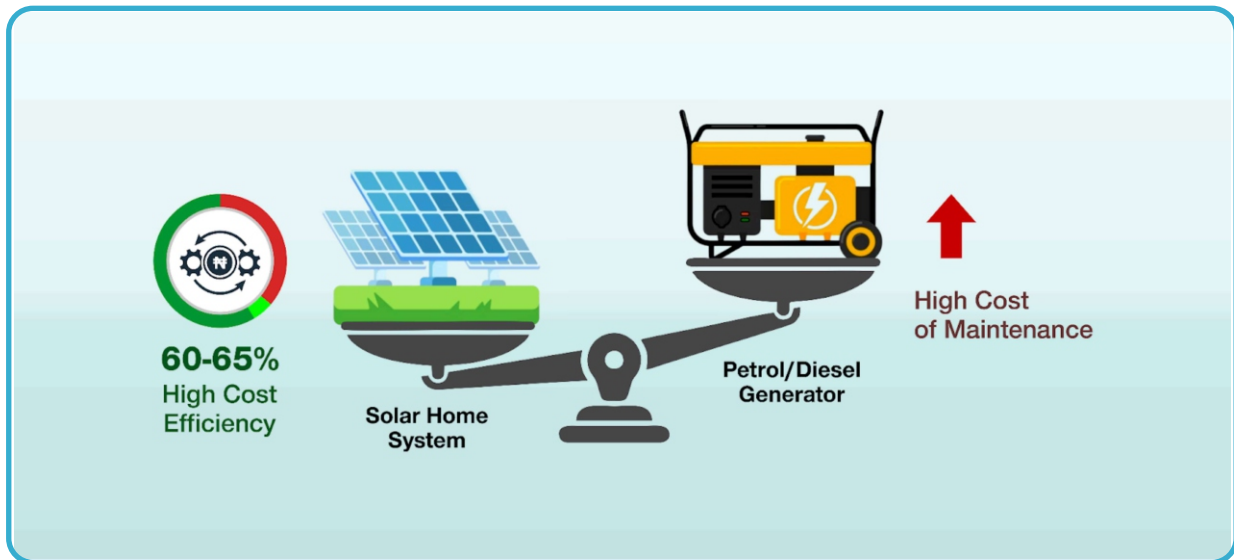


Fig. 3: Cost Efficiency Comparison: Solar Home Systems vs. Petrol/Diesel Generators (Abisoye & Miguel, 2021)

II. Reliability for Uninterrupted Healthcare Services

The SHS, being a decentralized power architecture (photovoltaic generation and integrated battery storage), bypasses vulnerabilities of the national grid. As a result, frequent grid outages contributing to operational disruptions that often compromise cold chain integrity for vaccines and pharmaceuticals, or prevent utilization of vital diagnostic equipment, are substantially reduced. Also, the reliable power supply by the SHS enables healthcare workers to provide medical services at night and in cases where there are emergencies. As opposed to diesel generators, SHS is not easily prone to mechanical vulnerabilities and fuel procurement challenges, making it the better alternative for consistent power supply in healthcare facilities.

III. Scalable System for Customized Energy Needs

The modular design of SHS makes them suitable for flexible installation that accommodates the particular requirements of primary healthcare centres based on their size and energy

¹⁴ From N198 to N1,300: The over 420% alarming surge of fuel prices in 18 months – THISDAYLIVE. (n.d.). Retrieved March 25, 2025, from <https://www.thisdaylive.com/index.php/2024/10/21/from-n198-to-n1300-the-over-420-alarming-surge-of-fuel-prices-in-18-months/>

needs. Solar panels and battery storage can be added or reduced in modules at PHCs, which enables precise power generation and storage capability matching for their existing operational demands, regardless of patient traffic changes or service portfolio adjustments. PHCs can maintain cost efficiency by avoiding excess capacity, yet can easily upgrade their energy systems because of system flexibility during service delivery expansion.

IV. Lessons from Rwanda and Ethiopia

Most African countries are grappling with energy access deficits and inadequate power infrastructure, particularly in rural regions. However, the transformative journeys of Ethiopia and Rwanda, two nations that have strategically leveraged solar home systems (SHS) to fortify their health sectors, offer a beacon of hope and practical lessons for Nigeria.

Ethiopia's approach, rooted in decentralized energy solutions, recognized the impracticality of grid extension in vast, remote regions. By forging partnerships with development organizations, they facilitated the direct distribution of SHS to health clinics and individual healthcare workers. This strategy yielded a dual advantage: firstly, it empowered frontline healthcare workers, ensuring the reliable operation of vaccine refrigerators and enabling 24/7 service delivery through solar-powered lighting and communication devices. Nigeria can emulate this by prioritizing SHS distribution to community health extension workers, who are often the lifeline for rural populations. Secondly, Ethiopia significantly strengthened its cold chain infrastructure, minimizing vaccine wastage and bolstering immunization coverage. This underscores the critical role of reliable energy in maintaining vaccine potency, a lesson Nigeria, grappling with similar challenges, must internalize.

Rwanda, in contrast, adopted a more systemic and integrated approach, embedding SHS deployment within a comprehensive healthcare improvement framework. They prioritized standardized implementation, establishing stringent guidelines and quality control measures for SHS installation and maintenance, ensuring long-term operational efficiency. This proactive approach to standardization is crucial for Nigeria, where fragmented implementation can lead to inefficiencies. Furthermore, Rwanda invested heavily in capacity building, training healthcare workers and local technicians on SHS operation and maintenance. This fostered local ownership, reducing dependence on external expertise and ensuring sustainable system upkeep. Nigeria must prioritize similar capacity-building initiatives to cultivate a skilled workforce capable of managing and maintaining solar-powered healthcare infrastructure. Finally, Rwanda's data-driven approach, characterized by robust monitoring and evaluation systems, allowed for continuous assessment of SHS impact on healthcare outcomes. Nigeria needs to adopt a similar evidence-based approach to track progress, identify bottlenecks, and refine its strategies.

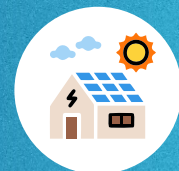
For Nigeria, the lessons are multifaceted. A paradigm shift towards decentralized, renewable energy solutions like SHS is imperative to bridge the energy access deficit in rural healthcare facilities. The development of a robust national policy and regulatory framework is crucial for ensuring standardized implementation, quality control, and long-term sustainability. Investing in comprehensive capacity-building programs for healthcare workers and local technicians is vital for fostering local ownership and ensuring the longevity of SHS initiatives. Furthermore, cultivating strategic public-private partnerships can accelerate the deployment of SHS and mobilize necessary resources. Lastly, embracing a data-driven approach, through the implementation of robust monitoring and evaluation systems, is essential for tracking progress, identifying areas for improvement, and ensuring the effective utilization of resources. By embracing these lessons, Nigeria can transform its healthcare landscape, leveraging the power of solar energy to deliver equitable and accessible healthcare services to all its citizens.

V Policy & Regulatory Landscape in Nigeria

The 2023 Electricity Act & Decentralization

With the objective to augment the energy capacity of the country, the government has developed several policies and frameworks primarily focused at integrating renewable energy into Nigeria's energy mix and bridging the energy deficits across all critical sectors of the country. According to the National Renewable and Energy Efficiency Policy (NREEEP) (2015),¹⁵ solar electricity generation is projected to contribute 3% by 2020 and 6% by 2030. The policy also encourages the adoption and installation of solar home systems for rural and off grid electrification. In a bid to achieve this projection, the Electricity Act 2023¹⁶ was enacted to decentralize the power sector. This legislation contains provisions for the NERC to transfer authority to subnational governments to generate, transmit and regulate their electricity markets.

Solar Home Systems (SHS) can reduce energy costs for primary healthcare centres in Nigeria by 60–65% compared to diesel generators, while also providing more reliable and scalable power.



¹⁵Ministry of Power (2015). *National Renewable Energy and Energy Efficiency Policy (NREEEP)*. Abuja: Ministry of Power.

<https://admin.theiguides.org/Media/Documents/NREEEP%20POLICY%202015-%20FEC%20APPROVED%20COPY.pdf>

¹⁶ National Assembly (2023). *Electricity Act, 2023*. Abuja: National Assembly.

<https://nems.gov.ng/wp-content/uploads/2024/05/ELECTRICITY-ACT-2023.pdf>

Existing Government & Private Sector Initiatives

The Nigerian Rural Electrification Agency (REA) has been instrumental in enhancing energy access for primary healthcare centres through the deployment of solar home systems and mini-grid solutions. With initiatives focusing on renewable energy, particularly the Energizing Healthcare Programmes (EHP), the REA aims to strengthen healthcare delivery by ensuring that medical facilities have reliable electricity, crucial for maintaining effective healthcare services.

As part of its commitment to improving healthcare infrastructure under the first phase of the EHP initiative, the REA has deployed 100 containerized solar hybrid systems, each with a capacity of 50kW, across various healthcare centers in Nigeria, while the second phase will focus on deploying similar systems to 400 PHCs¹⁷. These systems are designed to power critical healthcare needs, significantly reducing reliance on diesel generators that contribute to high operational costs and environmental concerns. Also, with support from the World Bank and the African Development Bank (AfDB), REA designed the Energizing Education Programme (EEP)¹⁸ to provide sustainable and reliable power to federal universities and teaching hospitals using solar hybrid systems, thereby improving educational and healthcare outcomes.

Gaps and Challenges in Implementation

The scaling of the adoption of SHS to improve the operations and service delivery of various PHCs across the country faces major challenges. These include:

- i. **High initial investment costs and financing constraints** — Due to their small sizes, many government and private sector interventions focused on providing reliable power from renewable sources to primary healthcare centres are not yielding the significant impact required to rejuvenate the health sector, especially at the community level. Scaling these initiatives — the purchase and installation of these solar technologies requires high upfront costs and investments, which reduce the volume of purchase and installation of significant units of solar technologies at PHCs.
- ii. **Lack of technical expertise for maintenance and sustainability** — In contrast to fossil-fueled power generation alternatives, the number of technical experts trained to carry out repairs and routine maintenance of solar technologies and other

¹⁷ REA boosts healthcare sector with clean energy solutions for 100 health centres nationwide — Rural Electrification Agency. Rural Electrification Agency. <https://rea.gov.ng/rea-boosts-healthcare-sector-clean-energy-solutions-100-health-centres-nationwide/>

¹⁸ REA (n.d.). "About EEP — Energizing Education Programme. <https://eep.rea.gov.ng/about-eep/>

installation components is quite low. This has limited the widespread adoption of renewable energy alternatives.

- iii. **Policy inconsistencies and slow adoption by state governments** — The advent of the Electricity Act 2023 which provides the subnationals the authority to generate, transmit and regulate their electricity markets created a progressive opportunity for the integration of renewable energy to power critical sectors especially primary healthcare centres. While most states have passed domestic electricity laws, the implementation is quite slow, posing a major hindrance to the adoption of renewable technologies in these states. Also, most of the energy specific policies are not harmonized thereby resulting in the fragmentation of policy objectives, provisions and projections. This leads to poor implementation and discourages private developers and investors which stifles the adoption of clean energy alternatives.

Recommendations

In light of the dynamics of electrifying healthcare facilities, and the challenges and gaps which remain, the following recommendations are made for policymakers and development partners to adopt:

- Regulatory frameworks developed by the government that are energy/power specific should have provisions for tax incentives and subsidies to private developers and investors who are interested in or already implementing capital projects in the renewable energy sector. This will potentially attract more investments and encourage the contribution of the private sector, consequently promoting SHS adoption in healthcare.
- A national framework for integrating SHS into health sector electrification strategies should be developed. This will ensure the establishment of new PHC facilities are installed with SHS while the existing infrastructures will be funded to operate on SHS.
- Public-private partnerships (PPPs) should be established between relevant government entities and private developers to attract funding and investments locally and internationally.
- These partnerships can be leveraged to develop results-based financing models that reward successful SHS deployment in Nigeria.
- Consolidated upskill programs should be conducted to train or improve the technical expertise of healthcare workers and facility managers on SHS operation and maintenance. This can be effectively administered through joint capacity-building initiatives by the government, civil society, and industry experts.