What Is the Future of Photovoltaics in the Electrification of Africa?

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ABSTRACT

This paper examines the current state of electrification and photovoltaics in Africa, shedding light on existing challenges and opportunities for solar energy. With a focus on PV technology, we aim to contribute to the discourse on energy access in Africa and stimulate the interest of policymakers and the global solar industry. We underscore the imperative of prioritizing renewable energy investments to breach the electrification gap in Africa, where 567 million people are still living without energy access. Considering the huge potential for the application of PV technology in Africa due to solar resource availability and PV technology maturity, we therefore call on African governments to boost investments in solar PV, to subsidize PV systems and their installations, and to particularly put in place clear policies and regulations to allow both utility companies and private solar energy service providers a level playing ground.

Keywords: electricity, solar energy, photovoltaic, Africa, renewables

Introduction

The potential of solar energy, particularly through photovoltaic (PV) technology, to power the African continent is immense. In this paper, we aim to explore this potential by examining the current landscape of electrification and photovoltaics in Africa. Our goal is to contribute to the discourse on PV adoption in Africa, urging policymakers to prioritize its advancement and encouraging global solar industry intervention to enhance universal electricity access in Africa in the near future.

Despite significant progress in global electrification rates over the past decade, millions of people, particularly in the global South, still lack access to electricity. Between 2010 and 2021, the global electrification rate improved from 84% to 91%. However, a staggering 675 million people worldwide remain without electricity, with 567 million residing in sub-Saharan Africa alone (IEA, IRENA, UNSD, World Bank, & WHO, 2023). Without substantial changes, Africa is poised to continue grappling with limited electricity access, especially considering its rapidly growing population of 1.3 billion people. By 2050, Africa's population is expected to reach 2.5 billion people (IRENA & AfDB, 2022).

The International Energy Agency (IEA) emphasizes the necessity of increased investments and policy support mechanisms to bridge the electricity access gap in Africa. Without such actions, millions will still lack electricity access by 2030, the target year for achieving the Sustainable Development Goals (SDGs). SDG 7 is centered on

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ensuring universal access to modern energy that is affordable, reliable and sustainable, but Africa still has a long way to go in achieving this goal.

As the world's second most populous continent, Africa is projected by the IEA to require a total installed capacity of energy of 510 GW by 2030 to meet its rising power needs (IEA, 2022). Renewable energy sources are expected to dominate this capacity, with solar photovoltaics alone accounting for 125 GW (IEA, 2022). Previous research has already shown renewable energy is suitable for Africa's energy transformation, as it is both low-cost and climate-compatible (Oyewo et al., 2022). Despite solar energy and photovoltaic technology being proclaimed as pivotal for breaking the energy poverty cycle in Africa, PV's total installed capacity on the continent in 2021 represented only 1% of the global total (IEA, 2022). Over the past decade, Africa installed 10.4 GW of solar capacity, with the majority being PV and this total is only about 8% of the projected required capacity by 2030 (IRENA & ADB, 2022). What then needs to be done from now on to accelerate the contributions of solar energy in the electrification of Africa?

Illustrated in Figure 1 is the present electrification rate achieved in each of the 54 African countries. It ranges from 8% (lowest) to 100% (highest). While almost all North African countries have achieved universal electrification, the majority of sub-Saharan Africa still grapples with low electricity access rates. Libya is the exception, with 70% electricity access. In Sub-Saharan Africa, on the other hand, the island nations of Mauritius and Seychelles are the only two to have attained 100% electrification. Very low electricity access rates can be observed in countries like South Sudan, Burundi, and Chad, which have only managed to attain 8%,10%, and 11% respectively. In total, 21 countries in Sub-Saharan Africa have less than 50% electricity access. This is concerning and risks failing to meet the universal access target set for 2030 by the United Nations.

Disparities in electricity access levels in Sub-Saharan Africa can be attributed to various factors, including energy resource availability, economic strength, and energy planning efficacy. The present electricity system in most parts of the African continent is untenable for any meaningful development. For this reason, electrification needs to be prioritized and be made sufficient to cater for present and future needs.

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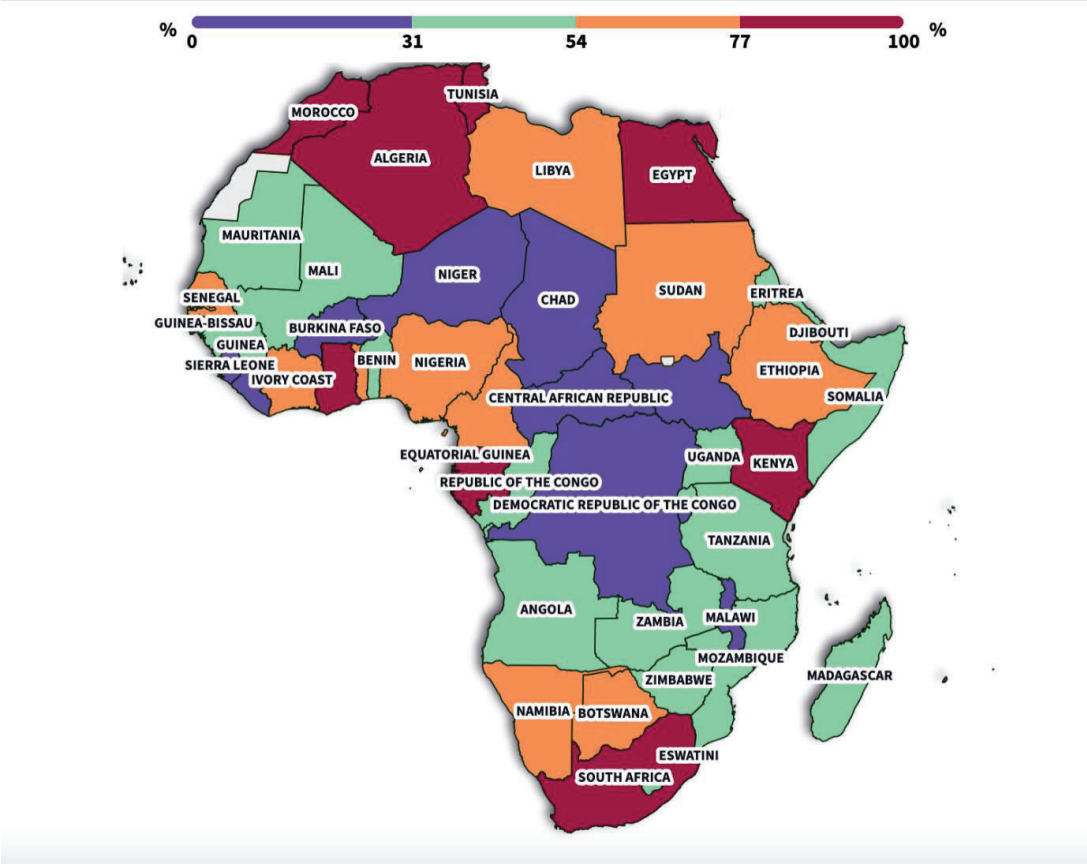

Fig. 1. Access to electricity in Africa by country in 2021.

For Africa to achieve SDG7 by 2030 and boost growth for its over one billion people through the emergence of numerous economic opportunities, more investments in renewable energy capacity will be required to break the current fossil fuel dominance in its electricity mix. Gas and coal are presently large components of the African electricity generation mix, respectively comprising 40.27% and 27.14% of electricity generation capacity in 2021 according to data from Ember. Expanding the utilization of Africa's renewable energy resources will be a game changer, especially for solar energy. The next sections provide details on the solar energy potential in the African continent and the performance of solar energy in electrification within Africa and across regions between 2017 and 2021.

Solar Energy Potential in Africa

Africa has 60% of the world's best solar resources, with an estimated average annual solar irradiation of 2,119 kilowatt-hours per square meter (kWh/m^2) (IEA, 2022; IRENA and AfDB, 2022). However, due to the continent's diverse geographical attributes,

solar irradiation levels vary across regions as shown in Figure 2. Countries in the west, north, and south typically receive an annual average irradiation of around 2,100 kWh/m^2, whereas those in the east and central regions receive less, averaging below 1,800 kWh/m^2 annually. Despite this variability, Africa's technical solar potential is estimated at a staggering 7,900 GW. What is yet utilized is approximately 1%.

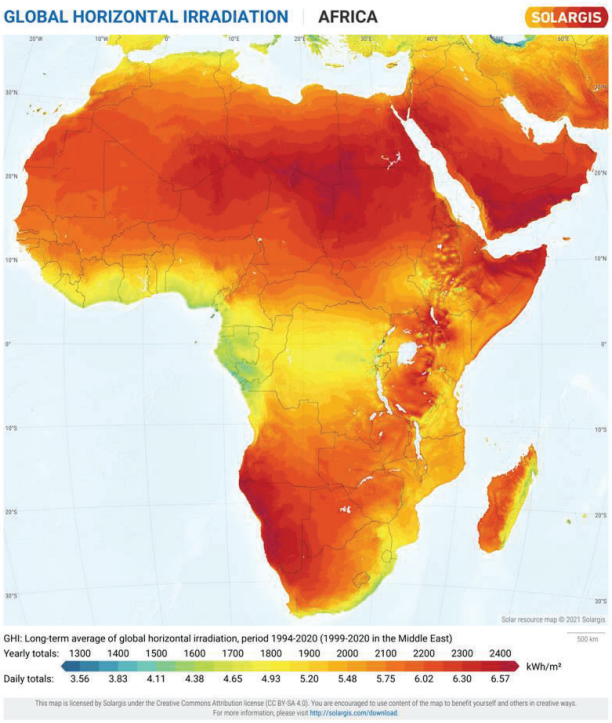

Fig. 2. Global Horizontal Solar Irradiation in Africa. (Solargis, 2021)

Despite this immense potential, the contribution of solar energy to electrification remains low in Africa when compared to other parts of the world. Figure 3 provides a comparative analysis of solar energy contributions to electricity generation globally across regions from 2017 to 2021. Only 2% of the electricity generated in Africa came from solar energy in 2021 while it was 4% in China, the United States and India respectively. The European Union (EU) had the largest share of 6% in the same year. More effort is required from Africa, since it faces the greatest electrification challenge. Africa taking advantage of its rich solar resource is a necessary step forward. Over the period from 2000 to 2021, the share of solar energy in the world's electricity mix has experienced significant growth, rising from 1.1 TWh to 1,284 TWh. Africa should

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therefore take advantage of the growing trend toward solar energy, particularly through the deployment of photovoltaics.

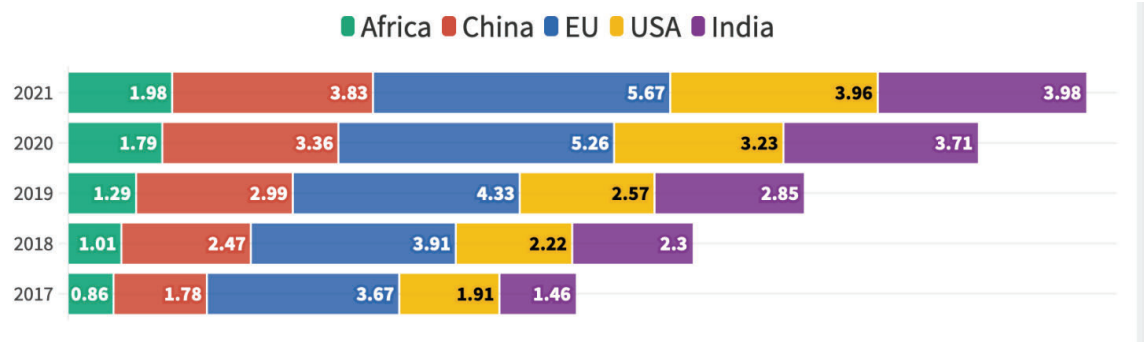

Fig. 3. Percentage share of solar energy in electricity generation across five regions (2017-2021)

Photovoltaics (PV) Technology

Among the various technologies for converting solar energy into electricity, photovoltaics (PV) stand out as one of the most economically and technically viable options. Years of research and development have led to significant improvements in PV efficiency and cost reduction, contributing to the rapid increase in PV installations worldwide. Over 90% of the global PV market consists of crystalline silicon (c-Si) (Heath et al., 2020, p. 1). The capacity of PV has experienced remarkable growth, rising from 1.4 gigawatts (GW) in the year 2000 to 512 GW by 2018 (Heath et al., 2020, p. 1). As of 2022, the global installed capacity of solar energy has further surged to 1,185 GW, underscoring the increasing importance and adoption of PV technology in meeting global energy needs (REN21, 2023).

Despite the global rise in PV adoption rates, Africa lags behind in installed capacity, accounting for just 1% of the global total. Recent data indicates that the continent currently has 261 operational solar farms, with capacities ranging from 1 megawatt, 95 under construction, and a further 195 announced (Global Energy Monitor., 2024). PV technology has helped bridge the electrification gap in Africa and has the potential to do more if action from policymakers and industry practitioners intensifies. Several African countries have expanded electricity access through mini-grids and solar home systems. According to the International Energy Agency, more than half of the electricity expansion in sub-Saharan Africa in 2022 was due to solar home systems. Moving forward in the race to achieve universal electricity access by 2030 and beyond, there is still more to be done. Figure 4 compares the renewable electricity (RE) targets by 2030 to the electricity generated from solar in 2021 in nine countries in sub-Saharan Africa.

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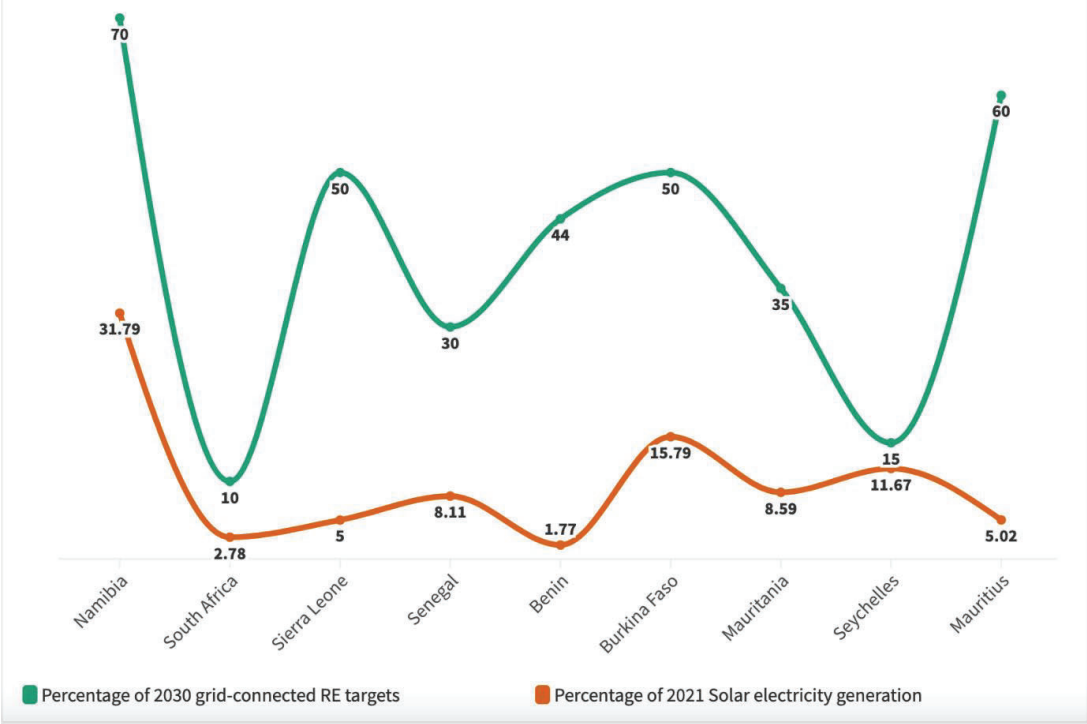

Fig. 4. Renewable electricity targets and solar electricity generation in Africa.

A great disparity exists between the RE targets and the electricity generated from solar in the nine countries compared. An exception is Seychelles, which is close to achieving its target. Solar electricity is quite minimal in Africa, and this is evident even in South Africa, which has the largest solar capacity installed in Africa, yet produces just about 3% of its electricity from solar. Namibia is commendable for generating the largest share of solar electricity in Africa in 2021. For clarity, almost all the African countries not included in Figure 4 produce about 1% or less of electricity from solar. Given this unfortunate situation, urgent action is therefore needed in tackling the electrification challenge in Africa with photovoltaics. We provide the following recommendations toward that goal.

Policy Recommendations

1. African governments should boost investments in solar PV to upscale its role in electricity generation. This can be done by providing prevailing policy instruments that have worked in countries or regions with thriving solar markets, especially China and the European Union.

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2. The total cost of installing a solar system need to be subsidized within African countries to encourage widespread adoption of PV technology. While there is evidence of the falling prices of PV panels, the cost remains a challenge and therefore requires curtailment to reduce the burden on the customers.

3. Establish clear policies and regulations to provide a level playing field for both utility companies and private solar investors to avoid conflicts and uncertainties in electricity service provisions. This can prevent conflicts over customers and create room for coordinated electricity service provision.

4. Local manufacturing of solar photovoltaics should be focused on the first- and second-generation PV technologies (Si-based and thin film, respectively), given their maturity. Third-generation technologies are yet to be commercialized and may not be appropriate for the African context.

5. African countries should initiate discussions around PV recycling, adopting favorable policies that will enhance the development of PV recycling companies to avert a PV waste challenge soon.

Conclusion

Africa has a huge solar potential for various PV applications including floating, off-grid, and utility-scale installations. To achieve the various African RE targets by 2030 and accomplish 100% electrification, African countries must enhance their commitment to the development and installation of RE projects over the continent in the next few years. Furthermore, efforts need to be intensified by all stakeholders within and outside Africa. Just as put forward by (Oyewo et al., 2022), a renewable future for Africa will require strong institutional support, regional cooperation as well as the strengthening of systematic innovation.

Conflict of Interest

This research did not receive any specific funding, and the authors declare no conflict of interest.

Acknowledgments

This work utilized data from Ember and employed Flourish for visualizing electrification in Africa and the percentage share of solar energy, specifically in Figures 1, 3, and 4.

REFERENCES

Heath, G. A., Silverman, T. J., Kempe, M., Deceglie, M., Ravikumar, D., Remo, T., Cui, H., Sinha, P., Libby, C., Shaw, S., Komoto, K., Wambach, K., Butler, E., Barnes, T., & Wade, A. (2020). Research and development priorities for silicon photovoltaic module recycling to support a circular economy. *Nature Energy*, 5(7)10.1038/s41560-020-0645-2

IEA. (2022). *AfricaEnergyOutlook2022*. https://www.iea.org/reports/africa-energy-outlook-2022

IEA, IRENA, UNSD, World Bank, & WHO. (2023). *Tracking SDG7: The energy progress report*. Washington DC: World Bank. https://trackingsdg7.esmap.org/data/files/download-documents/sdg7-report2023-full_report.pdf

IRENA and ADB. (2022). *Renewable energy market analysis: Africa and its regions*. International Renewable Energy Agency and African Development Bank.

Oyewo, A. S., Bogdanov, D., Aghahosseini, A., Mensah, T. N. O., & Breyer, C. (2022). *Contextualizing the scope, scale, and speed of energy pathways toward sustainable development in Africa*.

REN21. (2023). *Renewables 2023 global status report collection, global overview*. REN21 Secretariat.

Global Energy Monitor. (2024). *Solar Farm Phase Count by Region.* https://globalenergymonitor.org/projects/global-solar-power-tracker/

Solargis. (2021). *Global Horizontal Solar Irradiation in Africa.* [Map]. Solargis. https://solargis.com

 https://doi.org/10.52202/077496-0025