Clean Technology Hub
Energy Innovation Centre

NIGERIA ENERGY ACCESS MARKET UPDATE

(2023-2024)

Curated by Clean Technology Hub, Abuja

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List of Tables and Figures

List of Tables

List of Figures

EXECUTIVE SUMMARY

Nigeria has experienced an average growth rate of 2.64%, resulting in a current population exceeding 200 million people, with a population density of 226 per km^2.[1] Despite this substantial population increase, the necessary corresponding growth in energy supply has not occurred concurrently with this upward demographic trend (Figure 1).

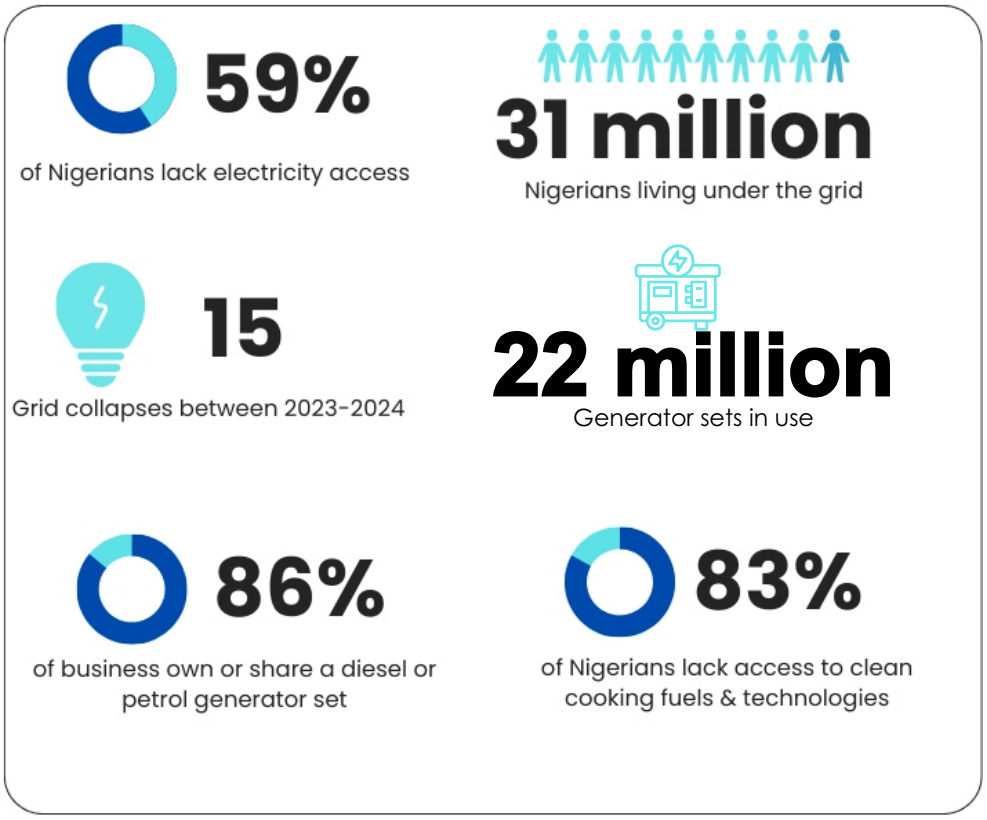


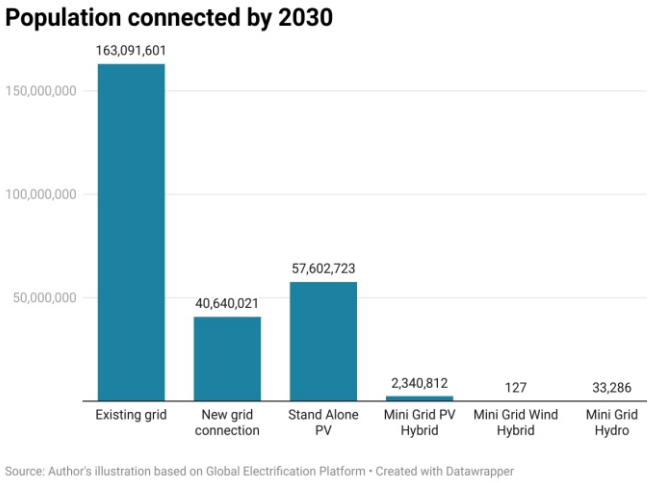
Figure 1. Summary data depicting Nigeria's energy deficits (Source: Author's illustration)

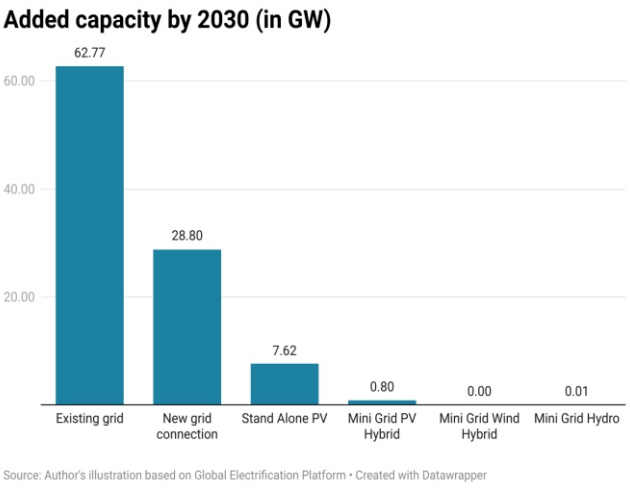
In the past decade, numerous initiatives have been undertaken to tackle this challenge. These efforts have transitioned from a nearly exclusive emphasis on national grid expansion to a diverse approach encompassing grid extension, renewable energy mini-grids, and solar home systems (SHS). The choice of energy source is typically determined by the most cost-effective solution for deployment in a specific area.[2] Based on a least-cost electrification approach, the national grid still maintains prominence in supplying power to 77% of the

[1] Worldometer (2025). "Nigeria Population". https://www.worldometers.info/world-population/nigeria-population/#:~:text=The%20current%20population%20of%20Nigeria,the%20latest%20United%20Nations%20data.

[2] REA (3 February 2022). "Nigeria's VP H.E. Prof. Yemi Osinbajo launches world-class Integrated Energy Planning Tool". https://rea.gov.ng/nigerias-vp-h-e-prof-yemi-osinbajo-launches-world-class-integrated-energy-planning-tool/#:~:text=The%20least%2Dcost%20plan%20for,USD%20847%20million%20for%20biogas.

population by 2030, with stand alone solar PV and mini-grid hybrid PV accounting for a large part of the rest.





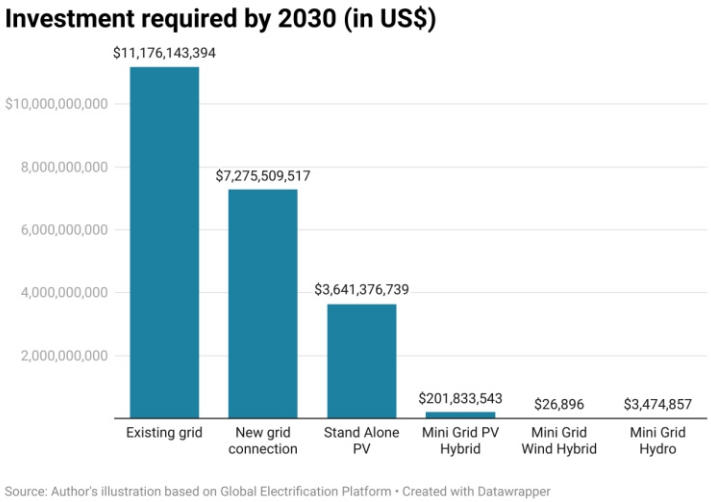


Figure 2. Least-cost electrification projections by 2030 for Nigeria by technology.

To achieve this goal, in response to the less-than-satisfactory outcomes of the Electric Power Sector Reform Act (EPSRA) of 2005, various coalitions of stakeholders have diligently worked towards enhancing energy access in Nigeria. These efforts have involved legislative, regulatory, financial, and entrepreneurial interventions. A major advancement was the enactment of the Nigerian Electricity Act of 2023, which replaced the EPSRA of 2005. In addition to these, several developments occurred between 2023 and 2024 to enable further progress in several energy subsectors, including the mini-grid and solar home systems (SHS) subsectors, electric mobility, green hydrogen and clean cooking (Figure 3).

Figure 3. Key updates in the Nigerian energy sector 2023-2024.

As a result of these developments, and as a continuation of prior trends, a significant growth in performance indicators in these subsectors was observed over the past two years.

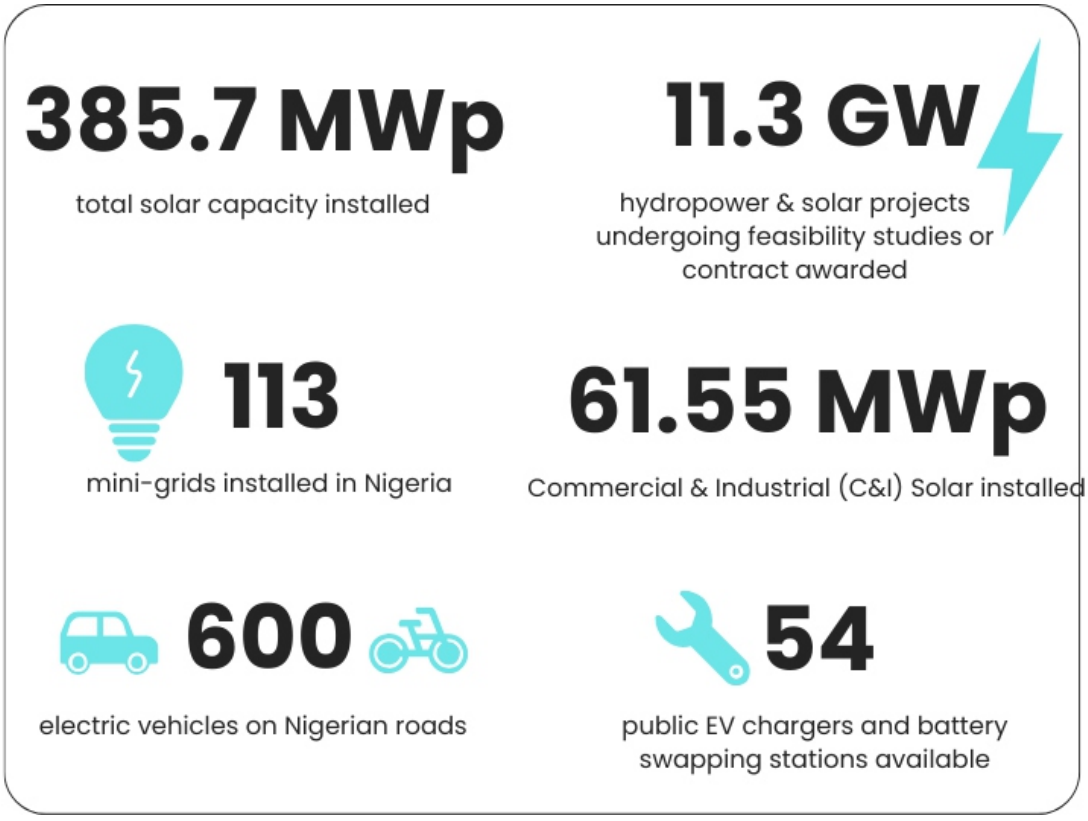


Figure 4. Selected figures depicting the size of energy subsectors (Source: Author's illustration).

This report provides an overview of the significant changes that have transpired in the Nigerian energy access landscape during 2023 to 2024. It encompasses critical sub-sectors within the Nigerian energy system, including the national grid (Nigerian Electricity Supply Industry) and various renewable energies. Additionally, it delves into key financial, legislative, regulatory, and market developments that have unfolded during this period.

1. INTRODUCTION

With about 200 million in population, Nigeria was in 2021, ranked among the top 20 countries accounting for 75% of the global deficit in energy access.[3] Though there was an annual increase in access by 2 million between 2019 and 2021, the country somewhat still accounted for the largest global energy deficit. The gap in energy access can be attributed to its failure to keep pace with the expanding population. Consequently, there is a crucial requirement to enhance the energy capacity of centralized systems while embracing decentralized approaches to bridge the energy gap effectively. Relying solely on traditional centralized energy supply is insufficient to meet the escalating demand in Nigeria.

About 60.5% of the Nigerian population has access to electricity[4] and only 17% has access to clean fuels and technologies for cooking.[5] For those connected to the national grid, despite 16,384 MW of installed generation capacity, only less than 5,000 MW gets to the final electricity users due to transmission and distribution infrastructure constraints. This is insufficient to cater to peak electricity demand of at least 8,250 MW (some estimates go up to 51,000 MW),[6] expected to grow to 15,000 MW by 2025.[7]

As a result, in addition to 91 million Nigerians lacking connection to the national grid, an estimated 31 million Nigerians live under the grid (connected to the national grid but receiving little to no electricity from it).[8] Those who have enjoyed power supply from the grid have also grappled with recurrent power failures, totalling 46 grid collapses between 2017 and 2023.[9] An estimated 22 million generators in Nigeria hold a capacity of about 42,000 MW and the country remains the largest importer of generators in Africa, requiring owners to spend $22 billion annually to fuel.[10]

About **60.5%** of the Nigerian population has access to electricity and only **17%** has access to clean fuels and technologies for cooking

[3] *Ibid*
[4] World Bank (2023). "Access to electricity (% of population) - Nigeria". https://data.worldbank.org/indicator/EG.ELC.ACCS.ZS?locations=NG.
[5] World Bank (2023). "Access to clean fuels and technologies for cooking (% of population) - Nigeria". https://data.worldbank.org/indicator/EG.CFT.ACCS.ZS?locations=NG.
[6] Precious Akanonu (2018). How big is Nigeria's power demand? Energy for Growth Hub.
[7] GET.invest (2024). "Nigeria". https://www.get-invest.eu/market-information/nigeria/energy-sector/.
[8] Ben Leo, Jared Kalow and Robert Morello (30 July 2015). "Living "Under the Grid" in Nigeria – New Estimates". Center for Global Development. https://www.cgdev.org/blog/living-under-grid-nigeria-new-estimates#:~:text=Top%2DLine%20Estimate%3A%20There%20could,%2C%20poorest%20or%20poorer%20categories).
[9] IEA (2024). *Electricity 2024*. Paris: International Energy Agency (IEA).
[10] J. Inokotong (5 December 2019), "Nigeria Spends ₦5.075trn Annually to Power Generators, Says AfDB," *Nigeria Electricity Hub*. https://www.nigeriaelectricityhub.com/2019/12/05/nigeria-spends-₦5-075trn-annually-to-power-generators-says-afdb/.

The promotion of renewable energy in Nigeria is partly to address these problems associated with the national grid, but also to decarbonize the power sector and to reach more communities using decentralized renewable energy systems. Renewable energy accounts for 2,206 MW by 2022, up by only 86 MW from 2013, largely driven by growth in solar energy supply.[11]

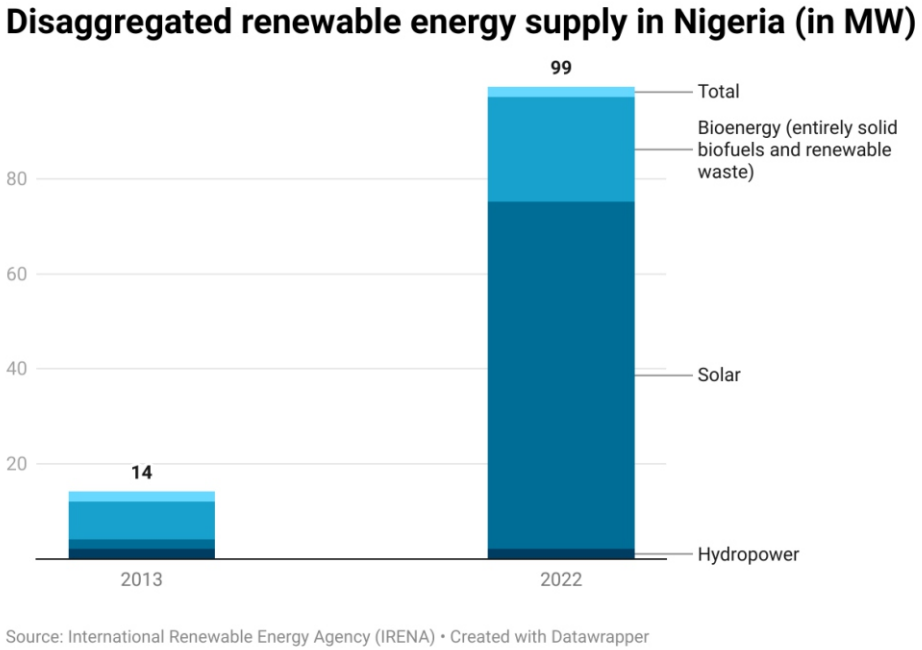


Figure 5. Disaggregated renewable energy supply in Nigeria, 2013 and 2022.[12]

To expand renewable energy supply in the grid-connected and off-grid sectors, the Nigerian government has adopted a least-cost electrification approach which involves grid expansion (and grid-connected hydropower capacity), interconnected mini-grids and off-grid systems (isolated mini-grids, solar home systems, and productive use of energy technologies). This is driven by the cost advantage of expanding decentralized systems to remote off-grid communities which are unlikely to be reached by the grid in the short-to-medium term; the inefficiencies of the national grid in certain locations where distribution infrastructure exists;[13] and the cost advantage of grid-connected utility-scale renewable energy in other areas.

This approach suggests that, based on certain assumptions, 163 million people (62% of total population) will be connected to the existing national grid as the least-cost electrification

[11] IRENA (2023). *Renewable Energy Statistics 2023*. Abu Dhabi: International Renewable Energy Agency, p. 2.
[12] Ibid.
[13] AMDA (2022). *Benchmarking Africa's Minigrids Report 2022*. Nairobi: African Minigrid Developers Association (AMDA).

approach, while standalone solar PV and new grid connection will cover 22% and 15% of the population, respectively.[14]

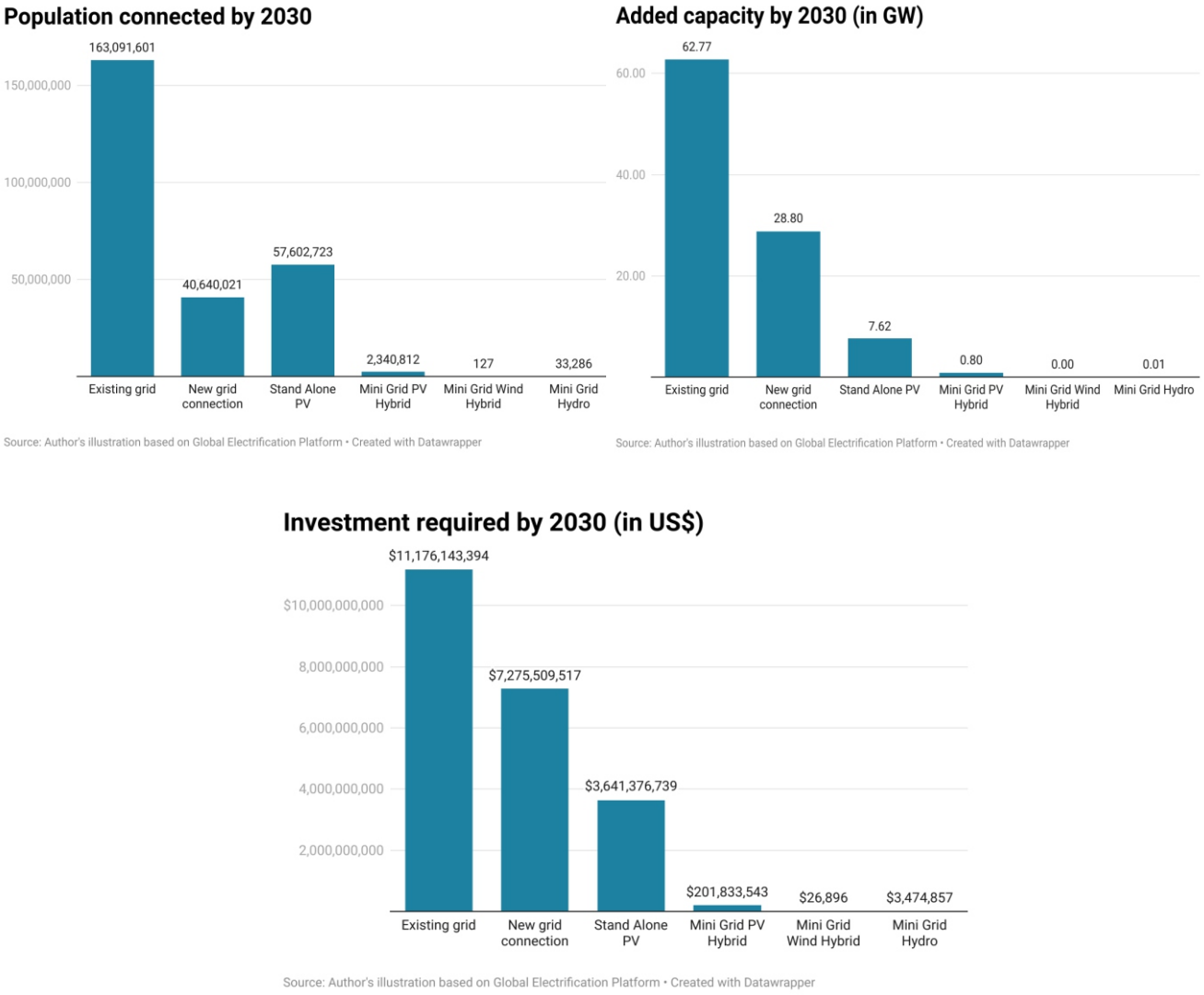


Figure 6. Least-cost electrification projections by 2030 for Nigeria by technology.

Given the well known constraints in the on-grid sector across the generation, transmission and distribution segments of the value chain, installed capacity in the off-grid renewable energy sector has grown more rapidly in percentage terms (by more than a factor of 10) than the on-grid non-renewable and renewable energy (4%) sector (Table 2). The number of people connected to off-grid renewable energy sources rose from 408,000 in 2013 to 9.5 million in 2022.

[14] Global Electrification Platform, based on OnSSET modeling, assuming default values — i.e. Bottom-up demand target, social and productive uses demand included, estimated on-grid cost (0.052$/kWh), expected PV cost, capped annual connections, and nationwide least cost approach.

Off-Grid Renewable Energy Source	Breakdown by Sector	Installed Capacity (MW)			
		2013	No. of People Connected (thousands 2013)	2022	No. of People Connected (thousands 2022)
Hydropower		0.4	N/A	0.4	27
Solar Lights (<11 W)		0.28	382	3.56	4,806
SHS 11-50 W		N/A	N/A	10.1	2,490
SHS >50 W		0.47	26	38.18	1,987
Solar Mini-Grids		0.22	N/A	7.29	218
Solar Pumps	Total	0.98	N/A	1	N/A
	Agriculture	0.026		0.027	
	Public Water Supply	0.95		0.98	
Other Off-Grid Solar PV	Total	0.29		32.31	
	Public Lighting	N/A		0.075	
	Health	0.19		3.33	
	Education	N/A		24.54	
	Communication	0.019		0.019	
	Industry	0.084		2.63	
	Commercial/Public	N/A		1.57	
	Unspecified	N/A		0.15	
Biogas		N/A	N/A	0.14	N/A
Other Solid Biofuels		6	N/A	9	N/A
Total		**8.42**	**408**	**94.4**	**9,528**

Table 1. Off-grid renewable energy capacity and people connected in 2013 and 2022.[15]

[15] IRENA (2023). *Off-Grid Renewable Energy Statistics*. Abu Dhabi: International Renewable Energy Agency.

However, the implication of an overall small contribution of the off-grid renewable energy sector combined with the slow growth of the on-grid renewable energy sector is that, despite the Federal Government's 30:30:30 goal of a 30% renewable energy share of total energy supply by 2030, the renewable energy share of total electricity capacity has fallen from 21.2% MW in 2013 to 16.7% in 2022.[16] In addition, annual public renewable energy finance flows are erratic, with spikes in 2014 ($963 million), 2018 ($5.1 billion) and 2020 ($1.1 billion) interspersed with much lower annual flows.

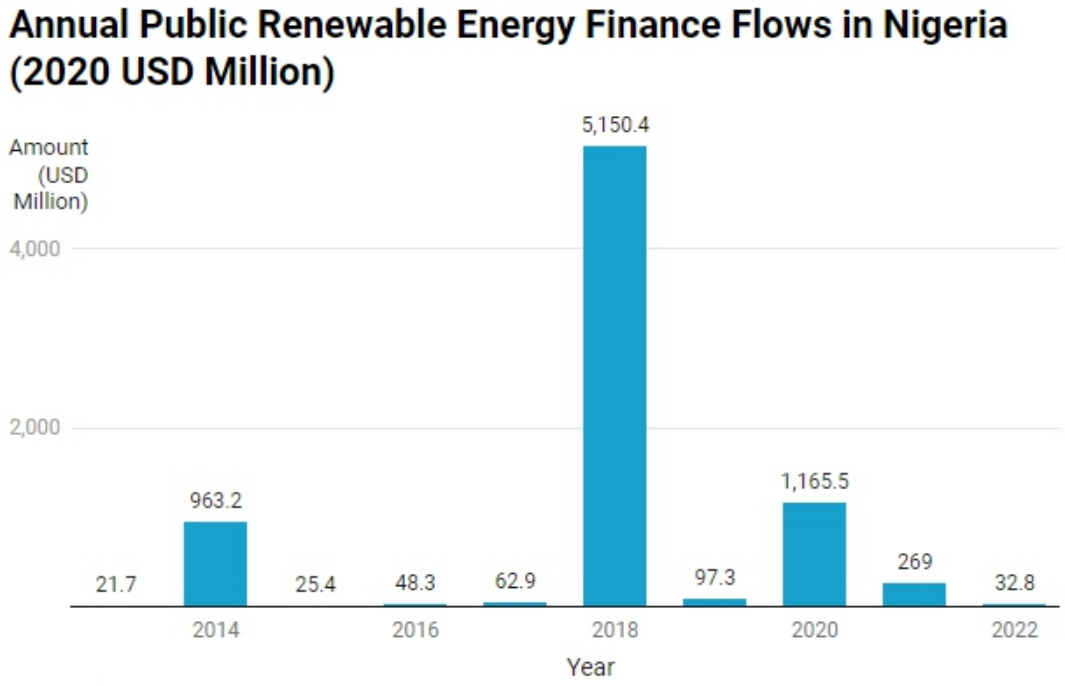


Figure 7. Annual public renewable energy finance flows in Nigeria (2020 USD million).[17]

Therefore, developments in decentralized solutions and innovations specific to certain sectors (such as electric mobility for transportation, clean cooking for household and commercial cooking and hydrogen for industrial applications) are just as important in the Nigerian context. Major progress in institutional, infrastructural and business model innovations, particularly in 2023, indicate higher future growth over the next five years. These include:

- The first interconnected solar hybrid mini-grid in Nasarawa State and the largest (10 MW) grid-connected solar plant built in Kano State (although smaller than the 50 MW Garissa Solar Plant in Kenya, which is the largest grid-connected solar power in East and Central Africa);

[16] IRENA, *Renewable Energy Statistics 2023*, p. 102.
[17] Ibid., p. 402.

- The establishment of the Nigerian Electricity Regulatory Commission (NERC) Mini-Grid Regulations 2023 in revision of the Mini-Grid Regulations 2016;
- The establishment of the Nigerian Electricity Act 2023 which repealed the Electricity Power Sector Reform Act of 2005;
- The promotion of the electric mobility sector in the National Automotive Industrial Development Plan (NAIDP) 2023 as well as the removal of federal subsidies on Petroleum Motor Spirit (PMS);
- The World Bank's commitment of $750 million for the extension of the work undertaken by the Rural Electrification Agency (REA); and
- To a lesser extent, green hydrogen pilot studies.

This market update report provides an overview of these developments across the various subsectors of the Nigerian energy sector, with a particular focus on the decentralized renewable energy sector. It draws on data published by institutions such as the International Renewable Energy Agency (IRENA) and the Rural Electrification Agency (REA), as well as information from news reports, press releases, academic papers, articles, industry reports and industry conferences.

2. NATIONAL GRID (NIGERIA ELECTRICITY SUPPLY SECTOR)

There are currently 27 grid-connected power generating plants in Nigeria, with an installed capacity of 14,000 MW. However, by Q3 2024, only 37.4% of the installed capacity across the twenty-eight (28) grid-connected plants was actually available for dispatch onto the grid.[18] The grid also experienced 3 collapses (the lowest in a decade) but rose to 12 collapses in 2024.[19]

Metric	2023	2024
Number of grid-connected plants	27	28
Installed Capacity	12672	13,625
Average plant availability factor	38.84	37.44
Grid collapses	3	12
Average hourly generation (MWh/h)	4,188.11	4,010.61

[18] NERC (2024). *Quarterly Report 2024: Third Quarter 2024*. Abuja: Nigerian Electricity Regulatory Commission (NERC), p. 4. https://nerc.gov.ng/wp-content/uploads/2024/12/2024_Q3-Report.pdf.
[19] Busola Aro (11 December 2023). "National grid collapses third time in 2023", *The Cable*. https://www.thecable.ng/national-grid-collapses-third-time-in-2023/; Tope Sunday (30 December 2024). "2024: A Year Of Grid Collapses, Transmission Tower Destructions", *The Whistler*. https://thewhistler.ng/2024-a-year-of-grid-collapses-transmission-tower-destructions/.

Total electricity generated (GWh)	36,671.98	NA
Average available generation capacity (MW)	4,531.83	4,458.27
Disco billing efficiency (%)	79.26	81.65
Disco revenue collection efficiency (%)	73.66	77.66
ATC&C Loss (%)	41.59	36.72
Meters installed	615,115	NA

Table 2. Selected metrics related to the Nigerian national grid.[20]

While by Q3 2024 renewable energy accounted for only 32.6% of total generation,[21] several large-scale renewable energy projects are, however, in the making. These include:

- The $5.8 billion Mambilla hydropower project (3,050 MW) in Taraba State, whose contract has been awarded and completion is expected in 2030;
- The $3.5 billion Makurdi hydropower plant project (1,650 MW) in Benue State, undergoing a feasibility study;
- The $1.5 billion Zungeru hydropower project (700 MW) in Niger State, completed;
- The $2 billion Egbin Phase II natural gas-fired power plant (700 MW) in Lagos State, is at the planning stage and expected completion in 2025;
- The $6 billion Kebbi Solar Independent Power Plant project (5,600 MW) in Kebbi state, at the planning stage and expected completion in 2027; and
- $1.5 billion total in five ongoing solar plant projects totalling 961 MW and expected completion in 2025.

While these utility-scale projects hold the promise of adding more than 12,000 MW to Nigeria's installed generation capacity, they are constrained by inadequacies in the transmission and distribution (T&D) value chain, as well as their limited reach to the over 91 million unelectrified population. Partly as a result of these constraints, major developments have emerged in the Nigerian Electricity Supply Industry (NESI).

2.1. Transmission and Bulk Trading Sector Developments

Grid Monitoring:

The government launched the Nigerian Electricity Transmission Access Project (NETAP) to deploy a Supervisory Control and Data Acquisition system (SCADA) for

[20] Sourced from NERC quarterly reports (Q1-Q4 2023 and Q1-Q3 2024).
[21] NERC, *Quarterly Report* 2024, p. 11.

grid monitoring (expected to be fully operational by mid-2025).[22] This project, implemented by the Transmission Company of Nigeria (TCN), will allow operators to monitor the entire electricity network from a centralized location, thereby allowing automated data collection, fault detection, and remote-controlled operations. But this requires the deployment of thousands of kilometres of fibre optic cables and the installation of SCADA equipment in transmission substations.

Unbundling of TCN

The TCN has traditionally been issued 2 (two) separate licences to operate as the transmission service provider and system operator for the national grid system by NERC. On 30 April 2024, NERC issued an order for the unbundling of TCN by creating a new company, the Nigerian Independent System Operator of Nigeria Limited ("NISO"), to be incorporated no later than 31 May 2024, to manage the market and system operation functions previously held by TCN.[23] The TCN retains its Transmission Service Provider license and is still responsible for transmission assets and liabilities and the development and maintenance of the power transmission infrastructure.

2.2. Distribution Sector Developments

Bilateral Contracting

The Electric Power Sector Reform Act 2005 had provided for the establishment of Nigeria Bulk Electricity Trading (NBET) to serve as an intermediary between the GenCos and DisCos for the procurement of energy and capacity until a time when the latter attains the required creditworthiness for the execution of Power Purchase Agreements (PPAs). NBET has had mixed success in performing its role since 2010. By 2024, the Federal Government owed GenCos NGN1.3 trillion.[24] As a result, NERC issued an Order in July 2024 that allows DisCos and GenCos to enter into bilateral contracts directly.[25]

By 2024, the Federal Government owed GenCos **NGN1.3 trillion.**

[22] Daniel Adaji (18 September 2024). "FG unveils advanced SCADA technology for national grid", *Punch*. https://punchng.com/fg-unveils-advanced-scada-technology-for-national-grid/; Soonest Nathaniel (19 September 2024). "FG Unveils $56m SCADA System To Monitor National Grid Performance", *Channels*. https://www.channelstv.com/2024/09/19/fg-unveils-56m-scada-system-to-monitor-national-grid-performance/.

[23] NERC (2024). Order on the Establishment of the Independent System Operator for the Nigerian Electricity Supply Industry. Abuja: NERC. https://nerc.gov.ng/wp-content/uploads/2024/05/Order-on-the-Establishment-of-the-Independent-System-Operator-for-NESI-1.pdf.

[24] Obarayese Sikuru (18 January 2025). "Electricity: We've paid 45% of GenCos' invoices – FG", Nigerian Tribune. https://tribuneonlineng.com/electricity-weve-paid-45-of-gencos-invoices-fg/.

[25] NERC (2024). *Order on the Transition to Bilateral Trading in the Nigerian Electricity Supply Industry*. Abuja: NERC. https://nerc.gov.ng/wp-content/uploads/2024/07/ORDER-ON-THE-TRANSITION-TO-BILATERAL-TRADING-IN-NESI.pdf.

Tariff Reform

The price of electricity in the sector (on-grid and off-grid) is regulated through NERC using a multi-year tariff order (MYTO) approach. Different variables are considered when reaching a MYTO, some of which include the exchange rate, gas price, the US inflation rate, Nigeria inflation rate, available generation capacity, transmission losses, and capital expenditure adjustment, amongst others. In an April 2024 Supplementary Order, NERC revised the electricity tariff for Band A customers from about N60 - N70 per kilowatt-hour to N255/KWh for all DisCos, although revised downwards to N206.80/KWh in the May 2024 Supplementary Order due to the consequent downward review of the USD to Naira exchange rate.[26] This represents a liberalization of the tariff regime for Band A customers. The allowed tariffs for Bands B to E customers remain frozen at the rates payable since December 2022.

2.3. Legislative, Policy and Regulatory Frameworks

2.3.1. Energy Transition Plan 2022

Nigeria launched its energy transition plan in August 2022, chaired by the former vice president His Excellency, Prof. Yemi Osibanjo. This plan was a follow-through action from the 2021 COP commitment made by the former president, Mohammed Buhari. The plan expressed the nation's commitment to achieving net zero and universal energy access by 2060. It covers five major sectors with the highest emissions, which are power, transport, cooking, industry and oil and gas.[27] These sectors are cumulatively responsible for 65% of Nigeria's total emissions as shown in Fig 2.[28]

The ETP specifically laid out structured plans to increase energy access in these sectors through clean and affordable energy, thereby achieving a net zero. Some of the features of the plan include[29]:

- The use of gas as a transitory fuel by 2030. This is to work with the country's available resources while putting in the right infrastructure for the incoming technologies.
- The financial budget of the plan is estimated at $1.9 Trillion, including $410 Billion above projected usual spending. This additional cost translates to about $10 billion annually till 2060.
- The plan is projected to create up to 340 thousand jobs created by 2030 and up to 840 thousand jobs created by 2060 driven mainly by the Power, Cooking and Transport sectors.

[26] Olaniwun Ajayi (2024). *Supplementary Order to the Multi Year Tariff Order 2024*. Lagos: Olaniwun Ajayi. https://www.olaniwunajayi.net/blog/wp-content/uploads/2024/06/Supplementary-Order-to-the-Multi-Year-Tariff-Order-June-2024-OALP-Power-Infrastructure-Newsletter.pdf.
[27] https://www.energytransition.gov.ng/#Plan.
[28] *Ibid.*
[29] *Ibid*

- The plan is incorporated with short and long-term action plans. The short term lays out the plan and expectations for now till 2030 and for some sectors, there is a 2030 to 2050 mid plan and eventually 2060 universal energy transition long term plan .

2.3.2. Electricity Act 2023

Subsequently, the Electricity Bill 2022 was on the 9th of June 2023 signed into law by the president of the Federal Republic of Nigeria. The Act repealed the Electric Power Reform Act 2005 that introduced privatization of gencos and discos in Nigeria. It also established the NERC, the regulatory body for electricity in Nigeria. Where the ESPRA 2005 did not fully achieve its aim in electricity stability in the country, the electricity act was enacted to address and respond to the existing gaps that have caused hindrance to a better energy access in Nigeria. Some of the identified and notable provisions in the Act include:

-  **Decentralization Of The Electricity Sector:**

  The act in response to the constitutional amendment on the 16th March 2023, also provided with the combination of sections 2(2), 63(1), 230 (2 – 9) of the EA 2023, the federating states of the Federal Republic of Nigeria are now empowered to create their electricity market, establish their state regulatory boards to oversee electricity activities within their jurisdiction. This new provision would give states power to provide electricity to their territories thereby covering more grounds especially off-grid rural areas. The Act would also give room for state electricity markets to create a smaller regulatory space that will enhance flexibility, accountability, and transparency than when a single regulator was responsible for the entire country. And it would also encourage competition among states and result in innovations and ingenuity which would, in turn, guarantee competitive prices and services

-  **Integrated National Electricity Policy And Strategic Implementation Plan:**

  Section 3 and 4 of the Act mandates the Ministry responsible for power to, within one year from the commencement of the Act, prepare and publish an Integrated National Electricity Policy in a federal gazette, and Strategic Implementation Plan to guide the overall development of the country's power sector which is subject to reviewed or revised not later than five (5) years.

-  **Renewable Energy:**

  Section 164 of the act provides for the development and utilization of renewable energy in the energy generation process for Nigeria. This provision would in its stead create an enabling environment for more clean energy investment as well as give a strong push on Nigeria's target of increasing its renewable energy share to 30% of the generation mix by 2030, vision 30:30:30 while achieving its netzero 2060 goal.

-  **Regulatory Commission:**

  The Act in section 230 (2)- (9) provides for the powers of states to make laws and regulation as it pertains to energy in the state. The NERC is however empowered to make regulations for states that do not have enacted energy regulations. The Act provides a definite framework for a symbiotic relationship between national and state regulatory commissions. The National Electricity Regulatory Commission (NERC) is saddled with the responsibility of regulating the electricity sector but is directed to transmit such powers to states that have adopted the Bill and established their own regulatory commission. As of January 2025, NERC was in the process of transferring regulatory oversight to 10 states, and had completed full transfer to 4 states (Enugu, Ekiti, Ondo, and Imo).[30]

-  **Criminalisation Of Electricity Theft, Illegal Meter Tampering/Bypass, And Willful Damage To Electricity Infrastructure:**

  A notable provision of the act is in Part XX that criminalizes the theft of electricity, electricity line, receiving stolen electricity, interference with meter, damaging electricity materials, amongst many others. The offense of electricity theft attracts between 6 months to 3 years imprisonment, and theft of electricity lines and materials attracts between 3-5 years imprisonment. Receiving stolen electricity attracts 14 years imprisonment. Interference with meters or works of licensees carries three years imprisonment. Similarly, obstruction of licensee staff from carrying out lawful activity has a 6 years jail term and at least N2M fine.

3. DISTRIBUTED RENEWABLE ENERGY (DRE) SECTOR

Nigerian households and businesses collectively expend nearly $14 billion annually to bridge the energy access gap by fuelling generator sets. This expenditure is directed towards inefficient generation methods that are not only costly (at $0.40/kWh or higher) but also yield poor-quality power, create noise pollution, and contribute to environmental pollution.[31]

[30] Damilola Aina (14 January 2025). "NERC transfers full electricity regulatory oversight to four states", *Punch*. https://punchng.com/nerc-transfers-full-electricity-regulatory-oversight-to-four-states/.
[31] REA (2017). *Nigeria Minigrid Investment Brief*. Abuja: Rural Electrification Agency (REA). https://rea.gov.ng/Nigeria_MinigridInvestmentBrief_171202-V2.pdf.

For sub-Saharan Africa in general, this reliance on diesel generators amounted to 45 GW, surpassing the entire renewables-based generating capacity in the region. Notably, Nigeria accounted for 13 GW of this total. Alarming statistics reveal that 25 terawatt-hours (TWh), equivalent to 40% of the total electricity in Nigeria, is self-generated by industrial and commercial firms as well as households using fossil fuel products.[32]

Consequently, the potential and growth of the offgrid renewable energy energy sector has been a big attraction to many countries, organizations, companies and individuals. The sector, especially solar energy, has built an established ecosystem in the last decade. This is most especially true for solar energy. Africa added 2.5 GWp of new solar power capacity in 2024 (excluding Solar Home Systems), reaching a total of 19.2 GWp across the continent.[33] Nigeria's share of this capacity is only 2.6% (63.5 MWp). While this is low compared to South Africa (1.2 GWp), and this represents only 1.6% of Nigeria's electricity mix, the country ranks fourth in Africa in terms of installed solar capacity which stands at 385.7 MWp.[34] Besides C&I Solar projects, only one utility-scale solar PV project—the 10 MW Kano Solar Project—has been completed and connected to the national grid.[35]

3.1 The Solar Mini-Grid Market

Mini-grids may be the least-cost electrification method for about 27% of population clusters across Nigeria.[36] The cost of producing electricity using this technology in Africa could fall from $0.60 per kilowatt-hour to just $0.22 by 2030, thereby increasing its attractiveness.[37]

The Nigerian mini-grid market has come a long way since the first mini-grids were installed in the 2010s.[38] In 2014, the Federal Government launched Operation Light Up Rural Nigeria

Mini-grids may be the least-cost electrification method for about **27%** clusters across Nigeria.

[32] IEA (2022). *Africa Energy Outlook 2022*. Paris: International Energy Agency (IEA), p. 43. https://iea.blob.core.windows.net/assets/220b2862-33a6-47bd-81e9-00e586f4d384/AfricaEnergyOutlook2022.pdf.
[33] AFSIA (2025). Africa Solar Outlook 2025. Kigali: Africa Solar Industry Association (AFSIA).
[34] *Ibid*.
[35] Oluwasayo Folarin (22 November 2024). "Unlocking Nigeria's solar potential: An innovative commercial structure for scaling utility-scale solar photovoltaic (PV) projects", *Businessday*. https://businessday.ng/opinion/article/unlocking-nigerias-solar-potential-an-innovative-commercial-structure-for-scaling-utility-scale-solar-photovoltaic-pv-projects/.
[36] Husein, Munir, Moner-Girona, Magda, Falchetta, Giacomo, Stevanato, Nicolo, Fahla, Fernando, Szabo, Sandor (2024). The Impacts of Incentive Policies on Improving Private Investment for Rural Electrification in Nigeria – A Geospatial Study. *Heliyon*, 10: e27440. https://portal.bazeuniversity.edu.ng/staff/assets/uploaded_publications/20240316010447588993842.pdf.
[37] Power for All (2019). Mini-grids costs can be reduced by 60% by 2030. https://www.powerforall.org/application/files/4415/6700/7650/FS__Mini-grids_costs_can_be_reduced_by_60_by_2030.pdf.
[38] Amos Abba (3 July 2020). "Durumi N228.4 million solar project broken down four years after launch, as denial trails how fund was spent". *ICIR*.

(OLRN) to provide renewable energy to 109 rural communities in 16 states but the project was abandoned after the pilot phase. Later renamed Renewable Energy (Solar) Micro Utility (REMU) in 2015, the goal was to deploy three solar mini-grid projects in six geopolitical zones. The government spent N652.4 million on the OLRN project and N465.1 million on REMU between 2014 and 2017. While the success of these two pioneer government initiatives was limited, the Nigeria Electrification Project (NEP), was launched in 2019 with $550 million funding from the World Bank and African Development Bank.

The NEP enabled the REA to become the largest single actor in the Nigerian mini-grid space. Through the NEP and other programmes (such as Energising Education Programme, Africa Mini Grid Programme, Energising Agriculture Programme, Energizing Economies Initiatives, and the IMAS Interconnected Mini-grid Acceleration Scheme). The

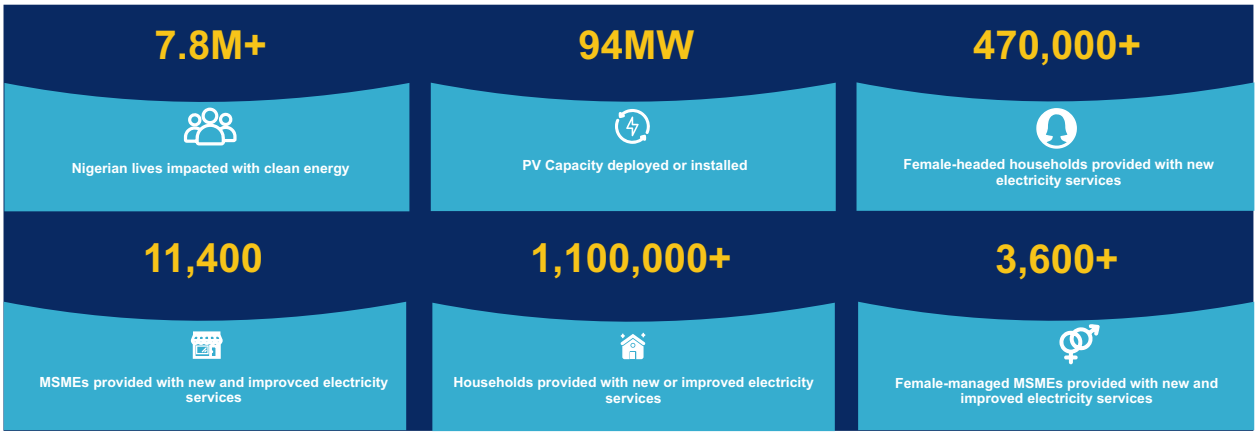


Figure 8. NEP achievements 2018-2023.[39]

There are now an estimated 113 mini-grids in Nigeria with a total installed capacity of about 12MW and 171,635 connections across 135 communities.[40] While this is a major milestone, there is a long way to go before the 3,600 to over 5,000 mini-grids (at least) required by the unelectrified population are deployed.[41]

While most mini-grids in Nigeria are isolated systems, there has been a growth in the number of interconnected mini-grids. From the first under-grid mini-grid which came online in 2020 (the Mokoloki mini-grid in Ogun State which is being connected to the national grid),

https://www.icirnigeria.org/durumi-n228-4-million-solar-project-broken-down-four-years-after-launch-as-denial-trails-how-fund-was-spent/.

[39] Nigeria Electrification Project (2023). https://nep.rea.gov.ng/.

[40] Nigeria SEforAll tool (2023). Mini-grids. https://nigeriase4all.gov.ng/mini-grids.

[41] Estimates based on the combination of Nigeria SE4ALL Data Manager and the Nigeria Integrated Energy Planning Tool. https://nigeriase4all.gov.ng/mini-grids.

there are now four more either being installed (the Wuse Market mini-grid in Abuja, the Toto mini-grid in Nasarawa and the Zarawici mini-grid in Kano) or under construction (the Robiyan mini-grid in Ogun).[42] It has been estimated that 35% of the under-served rural areas could be better served by more than 4,000 commercially viable interconnected mini-grids.[43] Approximately $1 billion annual potential revenue and $200 million annual profit could be

Figure 9. Existing and planned mini-grid sites in Nigeria by 2022.

Almost all mini-grids in Nigeria are solar PV or solar hybrid mini-grids. GVE is the largest indigenous mini-grid developer in Nigeria, with other major developers including ACOB

[42] Laurie Stone (14 October 2024). "Powering a Brighter Future for Nigeria", *RMI*. https://rmi.org/powering-a-brighter-future-for-nigeria/.
[43] NIPC (n.d.). Interconnected Mini-grids. Abuja: Nigeria Investment Promotion Commission (NIPC). https://www.greenenergyinvestment.nipc.gov.ng/sites/default/files/documents/greenenergyinvestment_interconnected-mini-grids%20%282%29.pdf.
[44] *Ibid*.
[45] Nigeria SEforALL Data Manager (2025). https://data.nigeriase4all.gov.ng/maps/new?layer=se4allWS:minigrids&view=True.

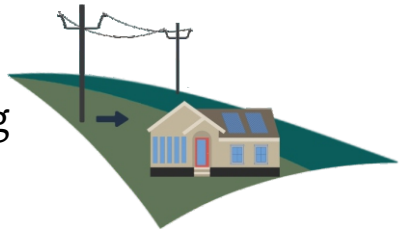
Lighting, A4&T Power Solutions, Nayo Tropical Technologies, Havenhill, Powergen, Husk Power, New Moon Nigeria Limited and Renewvia Energy Cooperation.

Project partners and funders typically include the Rural Electrification Agency (REA) and the Rural Electrification Fund (REF), World Bank, United Nations Development Programme, Bank of Industry (BoI), All On, ElectriFi, European Union, ECOWAS Center for Renewable Energy and Efficiency (ECREE), United States African Development Foundation (USADF), Global Environment Facility (GEF), Institute of Electrical and Electronics Engineers (IEEE), General Electric (GE) Africa, US NGO Solar Electric Light Fund (SELF), Foundation for Partnership Initiatives in the Niger Delta (PIND), Bettervest, and GIZ.

Following up with the impressive deployment of mini-grids through NEP, the World Bank has expanded its support for the industry by providing a $750 million funding programme named Distributed Access to Renewable Energy Scale-Up (DARES) project.[46] While this increased level of grant funding is laudable, there is substantial need for greater private financing, particularly long-term patient capital.

The solar mini-grid sector requires greater innovation in project financing in order to attract a greater share of private financing and achieve scale. The difficulties in scaling arise from the nature of off-grid electrification, which involves a large number of small projects, in comparison to the national grid which typically involves a small number of large projects. Additionally, much like infrastructure financing, each mini-grid deployed requires a large capital investment, low but steady returns and a long payback period (of at least eight years). Therefore, long-term but low interest capital is required. Therefore, innovations in bundling multiple mini-grid sites into saleable portfolios is also necessary, and firms such as Crossboundary Energy Access[47] are at the forefront of refining and testing this concept. These regulatory and financing innovations are expected to attract greater private long-term financing into the Nigerian mini-grid sector and enable it to move above the deployment of only 10-50 mini-grids annually when at least 100 annually are needed.

The World Bank has expanded its support for the industry by providing a **$750 million** funding programme named **Distributed Access to Renewable Energy Scale-Up (DARES) project.**



[46] Obas Esiedesa (27 June 2023). "World Bank plans additional $750m grant to support Nigeria Electrification Project", *Vanguard*. https://www.vanguardngr.com/2023/06/world-bank-plans-additional-750m-grant-to-support-nigeria-electrification-project/.

[47] CBEA (2023). *Open Sourcing Infrastructure Finance for Mini-Grids*. Nairobi: Crossboundary Energy Access (CBEA). https://crossboundary.com/wp-content/uploads/2023/10/Open-Sourcing-Infrastructure-Finance-for-Mini-Grids-FINAL.pdf.

To spread fixed transaction costs over a greater number of investments, it is also necessary to go beyond regulatory approval per site and instead enable regulatory approval for a bundle of sites. This was now made possible under the NERC Mini Grid Regulations 2023.

The largest single actor in the Nigerian mini-grid space is the Rural Electrification Agency (REA). The REA serves as the implementing Agency of the Federal Government of Nigeria, entrusted with the electrification of rural and underserved communities, as mandated by Section 88 of the Electric Power Sector Reform Act 2005. The Board and Management of the Agency were inaugurated on March 16, 2006. Notably, the agency's establishment was reaffirmed in Section 127 of the Electricity Act 2023, which superseded the EPSRA 2005. Since its inception, the REA has played a pivotal role in enabling and overseeing the implementation of major electrification projects initiated by the Federal Government. These initiatives include:

1.  **Nigeria Electrification Project (NEP):**

NEP is a Federal Government (FG) initiative that is private sector driven and seeks to bridge the energy access deficit by providing electricity to households, Micro, Small & Medium Enterprises (MSMEs), educational and healthcare facilities in unserved and underserved rural communities through the deployment of mini grid, Solar Home Systems (SHS), captive power plants and productive use appliances to ensure sustainability of these off-grid solutions.[48] The project which is currently implemented by the Federal Government of Nigeria through the REA is funded through the World Bank to a sum of $350 million and the African Development Bank to a sum of $200 million.[49] This project was subdivided into five components focusing on economic development through energy, health sector advancement, educational and technical assistance through capacity building. In the last five years since the commencement of the project, a commendable number of mini grid and SHS companies have emerged and taken advantage of the grant and there have been tremendous recorded achievements. The NEP ended in August 2023. In its 2020-2023 impact report, the REA states that As of July 2023, a recorded 32,826 and 1,439,623 electrification had been achieved through mini grids and SHS respectively, 7,359kw and 45,893kw of PV capacity was installed through mini grid and SHS respectively, 2, 973 households headed by women were connected and, 6,182 MSMEs were connected through SHS.[50]

[48] https://nep.rea.gov.ng/about-nep/
[49] *Ibid.*
[50] https://nep.rea.gov.ng/achievements/

3.2. Productive Use of Energy

Off Grid Technologies such as mini grids, mesh grids, solar home systems and stand alone systems are available alternatives to achieve better energy access and reach underserved and unserved areas. Applying these offgrid technologies, however, comes with its own enigma, the commonest of which is the ability to anchor these technologies with an enabling required power load. This has posed a threat to profitability for off grid technology developers and economic and social development for the underserved communities.

A complement to off grid deployment would be to encourage the Productive Use of the Energy. "Productive Use of Energy" is the use of energy enabling technologies, infrastructures and equipment in commercial, industrial and agricultural activities that results in the direct or indirect production of goods and provision of services. This cuts across household appliances, agricultural activities, health, small and medium scale enterprises, amongst others. In the concept of PUE it is not just enough to provide electricity to underserved and unserved communities, but to also stimulate the use of these energy sources by growing demand through energy enabling tools. This would in turn increase profitability on the part of the developer as well as promote socioeconomic development for the community.

Some productive energy equipment according to their services in different sectors include: Agriculture such as cold storage, solar refrigerators, irrigation, milling, drying and oil press; Commercial Activities such as transport, entertainment, phone charging stations, sewing

machines, hair styling equipment and water pumping system; and Service-related activities such as ICT, street lights and health services.

While Standalone Solar (SAS) systems have experienced rapid rates of penetration across Nigeria, traders in urban and peri-urban areas stock (PUE) solar products, with the exception of solar batteries and streetlights, at much lower penetration than SAS.[51] However, sub-Saharan Africa requires about $120 billion per annum between 2020 and 2030 which would provide 210-million off-grid enterprises with the PUE equipment required to capitalise on the rural electrification.[52]

One of the components of the NEP, as outlined by the REA, is the Results Based Financing for Productive Appliances & Equipment. PUE is the main focus of this component. The PUE Component is designed to make it easier for PUEs to be deployed in micro grid communities because its primary goal is to stimulate demand for mini grids.Electric motor for retrofitting onto existing machine, solar irrigation, solar cold storage, oven, processing machine, water pumping machine amongst others.

A significant action REA has engaged in for PUE enhancement is signing grant agreements on the 2nd June, 2023 with 14 Energy Access Companies (EACs) under the Results-Based Financing for Productive Use Appliances & Equipment (PUE) component of the NEP. These steps have shown the government's commitment to this activity.[53]

3.3. Commercial and Industrial (C&I) Solar

Current power demand for C&I customers in Nigeria is estimated to be between 8,000 and 14,000 MW.[54] It is estimated that Nigeria has 61.55 MWp of C&I Solar installed in 2024.[55] The country's C&I Solar sector is estimated to be worth at least $15 billion per year.[56] This growth and the prospects for profitability are largely driven by the fact 86 % of companies operating in the country owns or share a generator, which covers nearly half (48 %) of their total

Nigeria's C&I Solar sector is estimated to be worth at least **$15 billion** per year.

[53] https://nep.rea.gov.ng/productive-use-equipment-pue-grant-signing-2/
[54] NIPC (n.d.). Commercial and Industrial Systems. https://www.greenenergyinvestment.nipc.gov.ng/sites/default/files/documents/greenenergyinvestment_ee-commercial-and-industrial_systems.pdf.
[55] AFSIA, *Africa Solar Outlook 2025*.
[56] Jasper Graf von Hardenberg (1 November 2022). "Tipping point for African C&I solar", *PV Magazine*. https://www.pv-magazine.com/2022/11/01/tipping-point-for-african-ci-solar/.

[51] ACE-TAF and IPSOS (2021). *Stand-Alone Off-Grid Solar Market Research Nigeria*. Nairobi: Africa Clean Energy Technical Assistance Facility (ACE-TAF) and IPSOS, p. 8.
[52] PREO (2021). The Power of the Productive Use of Energy, p. 8. https://www.preo.org/wp-content/uploads/2023/11/PREO_PURE-Opportunity-Report_Oct-2021.pdf.

electricity needs.[57] With the spike in the price of fuels in 2023, by replacing diesel generators with solar for daytime power, businesses could save up to 40% on their energy costs.[58] The cost of electricity for petrol gensets is about 83% higher than the cost of electricity from the grid.[59] It is therefore not surprising that, unlike the mini-grid sector where government subsidies have been prominent, most of the solar installations done for C&I customers are primarily driven by economics and private investment.[60]

With the spike in the price of fuels in **2023,** by replacing diesel generators with solar for daytime power, businesses could save up to **40%** on their energy costs.

2023 saw the growth of several financing facilities for C&I Solar. In June 2023, The Facility for Energy Inclusion (FEI) signed a facility agreement to provide $30 million of senior debt to CrossBoundary Energy (CBE) and is in the process of arranging an additional $20 million in Q3 2023. This transaction, structured by FEI as an innovative construction loan facility, allows CBE to further scale its investments in C&I renewable energy solutions across Africa.

In July 2023, Rensource Energy announced the closing of a $15 Million facility with Afrigreen Debt Impact Fund SLP (Afrigreen).[61] The debt finance provided by Afrigreen will be a mix of US dollars and Naira financing to fund the construction of over 30MW of Rensource C&I portfolio in the next 3 years.

In 2023, Daystar Power and Rocky Mountain Institute (RMI) were funded by the United States Trade and Development Agency (USTDA) to run a comprehensive feasibility study of trilateral cooperation between C&I Solar providers, DisCos and C&I customers. The goal was to create a pipeline of hybrid solar and grid-connected power systems for twenty businesses in Lagos and Abuja working in close cooperation with three DisCos, Abuja Electricity Distribution Company (AEDC), Eko Electricity Distribution Company (EKEDC), and Ikeja Electric (IE).[62] The model tested was one where trilateral collaboration between the three actors would reduce overall energy costs for the C&I customer because the C&I Solar provider could install the solar system without diesel generator backup, in order to provide electricity during the day, while the DisCo provides electricity outside daylight hours. The study, which looked at 20 different businesses (from schools to churches to supermarkets to furniture manufacturers), found a positive impact in 17 cases, with an average savings of 26%

[57] NIPC (n.d.), Commercial and Industrial Systems.
[58] *Ibid.*
[59] SEforALL (2024). *Beyond Gensets: Advancing the Energy Transition in Lagos State*. Vienna: Sustainable Energy for All (SEforALL), p. 16.
[60] NIPC (n.d.), Commercial and Industrial Systems, p. 2.

[61] AFSIA (13 July 2023). "Rensource announces a $15 million deal with Afrigreen Debt Impact Fund SLP". https://www.afsiasolar.com/rensource-announces-a-15-million-deal-with-afrigreen-debt-impact-fund-slp/.
[62] Daystar Power (12 March 2024). "Solar meets the grid in new power generation model for Nigeria". https://www.daystar-power.com/blog-post/solar-meets-the-grid-in-new-power-generation-model-for-nigeria.

and DisCo profitability increasing from 8% to up to a whopping 1,000% in some cases.[63] At scale, it is estimated that the business model can potentially apply to 170,000 businesses and eventually unlock 3.3GW of solar capacity and $6.5 billion investment opportunity across Nigeria.[64]

3.4. The Solar Home Systems (SHS) Market

It is estimated that 6.2 million Nigerians (6% of the non-electrified population) are best served by SHS.[65] With about 324,000 quality verified Stand Alone Solar units (including solar lanterns, Solar Home Systems (SHS) and solar panels) sold in 2019, Nigeria ranks as the fifth largest market globally for key off-grid solar (OGS) markets.[66] The OGS market opportunity is estimated at $9.2 billion annually.[67] By 2040, the Nigerian government aims to achieve 100 per cent rural electrification with a target of 5 per cent coming from SAS solutions.

The most ambitious programme for the deployment of SHS in Nigeria was the Solar Naija Naija programme. This was a NGN140 billion Central Bank of Nigeria (CBN) intervention facility intended to expand energy access to 25 million Nigerians, by enabling 5 million new, solar-based electricity connections in communities that are not connected to the grid.[68] The program is a mechanism to support the economic recovery in response to the COVID-19 pandemic as part of key components of the Nigeria Economic Sustainability Plan (NESP) initiative.[69]

One of the challenges faced by most offgrid deployers in Nigeria is the importation of major components of the technologies such as panels, inverters and batteries. Most locally manufactured components have been identified by deployers as sub standard. Two major schemes in the solar value chain market include:

1. **National Agency for Science and Engineering infrastructure (NASENI):**

   NASENI built a solar photovoltaic cell production plant in Gora, Nasarawa state.[70] On the 24th of March, the Federal Government commissioned the solar photovoltaic cell production plant in Gora following through on a signed agreement in July 2013. It built on the already existing 7.5-megawatt Solar Panel Production Plant in Karshi,

[63] *Ibid.* [64] *Ibid.*

[65] SE4ALL Africa Hub and African Development Bank (2018). Mini-Grid Market Opportunity Assessment: Nigeria. https://greenminigrid.afdb.org/sites/default/files/minigrid_market_opportunity_assessment_nigeria_june_2018.pdf.

[66] ACE-TAF and IPSOS, *Stand-Alone Off-Grid Solar Market Research Nigeria*.

[67] *Ibid.*

[68] REA (n.d.). "FG launches Solar Power Naija Programme". https://nep.rea.gov.ng/posts/fg-launches-solar-power-naija-programme.html.

[69] *Ibid.*

[70] Uchechukwu Okoro (18 April 2023). "Nigeria now building solar module production plant", *Energy & Utilities*. https://energy-utilities.com/nigeria-now-building-solar-module-production-plant-news120633.html#:~:text=Nigeria's%20National%20Agency%20for%20Science,west%20of%20the%20capital%20Abuja; Innocent Odoh (2023). "Nigeria To Begin Local Production Of Solar Cell", *Leadership*. https://leadership.ng/nigeria-to-begin-local-production-of-solar-cell/#google_vignette.

Abuja FCT which does not produce solar cells. This solar PV plant when completed will comprise four main production sections: a polysilicon production section, a 1,000-tonnes per annum ingot production section, a 50MW annual solar wafers section, and a 50MW solar cells section. An estimated $172 million will go toward funding the plant project; 85% of this would come from The China-Africa Development Fund through the Bank of China, with the remaining 15% coming from the Nigerian government through local partners. The plant is expected to generate about 19,800 jobs when completed.

2. **Auxano Solar LTD:**

Auxano Solar was the first privately owned solar PV manufacturing company in Nigeria. In 2016, Auxano Solar started with a 10MW solar panel factory and their products have been identified by developers as dependable panels. The company however took up a notch in 2018 with a $50,000 seed capital in convertible debt from All-on and United States African Development Foundation (USADF). Auxano Solar won this capital through the 2018 Nigeria Off-Grid Energy Challenge.[71] In 2020, a $1.5 million investment in equity and debt was signed between All On and Auxano Solar.[72] The investment was projected to contribute immensely to the expansion of the Auxano Solar's panel assembly plant.

4. EMERGING RENEWABLE ENERGY SECTORS

4.1. Clean Cooking

Sub-Saharan Africa has in the last two decades experienced a continual increase in the clean cooking deficit in the midst of a 41% in global deficit in 2021[73]. This is due to its inability to keep pace with the growing population. According to the World Bank data in 2020, only 17% (or 180 million people) of the Nigerian population has access to clean cooking.[74] According to the National Bureau of Statistics, 62% of households in Nigeria use wood for cooking, 20% use kerosene, 10.5% use LPG, 4% use charcoal, 3% use other improved biomass forms, and only 1% use electricity for cooking.

According to the World Bank data in 2020, only **17%** **(or 180 million people)** of the Nigerian population has access to clean cooking

[71] USADF (16 October 2018). "USADF and All On Announce Winners of the 2018 Nigeria Off-Grid Energy Challenge". https://www.usadf.gov/press-release/207.
[72] All On (21 September 2020). "All On and Auxano Solar Nigeria Sign $1.5m Investment Deal for Solar Panel Assembly Plant Expansion". https://www.all-on.com/media/media-releases/all-on-and-auxano-solar-nigeria-sign-dollar-1-point-5m-investment-deal-for-solar-panel-assembly-plant-expansion.html.
[73] IEA (n.d.). "A Vision for Clean Cooking Access for All". https://www.iea.org/reports/a-vision-for-clean-cooking-access-for-all/executive-summary.
[74] World Bank (2025). "Access to clean fuels and technologies for cooking (% of population) - Nigeria". https://data.worldbank.org/indicator/EG.CFT.ACCS.ZS?locations=NG.

The effects of a lack of clean cooking is beyond the impact on climate change, as it has been linked to affect the general well being and health status of inhabitants. According to the World Health Organisation (WHO), 3.2 million people die every year from illness caused by use of polluting fuels and technologies, which increases exposure to toxic levels of air pollution.[75] Not only has cooking pollution been tagged as causing emission, it has also been recorded as the next biggest cause of death in Nigeria after malaria and HIV/AIDS.

The Clean cooking ecosystem in Nigeria is quite a diverse sector depending on certain factors such as fuel types and regional conditions. For instance, while there is widespread use of wood for cooking across the country, there is significant regional disparity in this practice. States in northern Nigeria are more likely to use wood fuel than southern ones. States like Lagos and Ogun have very low numbers of households that predominantly use wood for cooking. Liquefied Petroleum Gas (LPG) is the most commonly used cooking fuel in the South South and South West geopolitical zones and in major cities where incomes are higher and LPG distribution networks are accessible. Kerosene is the predominant fuel type in South East geopolitical zones.

Biomass stoves of all varieties are most common in the heavily rural South East, North East, and North West regions. Most households use more than one type of fuel. Rural households primarily depend on charcoal and wood as their primary cooking methods, while some use locally made kerosene cookstoves. On the other hand, urban households use both traditional and modern stoves with a diverse array of fuels including purchased wood, charcoal, LPG, and, to a small extent, electricity.

The clean cooking sector in Nigeria is still in the early stages of development relative to leading African countries like Kenya. Regulatory support is low and levels of both energy access and clean cooking access also remain low. Some of the delay in progress can be attributed to uneven support from the government, and the resulting discouragement of donor support. However, in recent times, there has been evidence that the government has begun to take the issue of clean cooking more seriously in order to change this situation.

These efforts are expressed in provisions in the Economic Sustainability Plan (2020), the Nationally Determined Contributions (NDC), the Energy Transition Plan (2022) and the National Clean cooking policy 2024. The National LPG Expansion Plan (2020) aims to have 30 million homes switch to LPG by 2025 and reach a total consumption volume of 5 million metric tons. The LPG plan is built on the 2017 National Gas Policy that introduced other measures such as the removal of 5% value added tax (VAT) on LPG. The National LPG Expansion Initiative was also established as well as a Presidential Inter-Ministerial Committee on LPG with its secretariat in the Office of the Vice President.

[75] *Ibid.*

As part of the updated Nationally Determined Contributions (NDCss), Nigeria has committed to two targets:

- **Enhanced Ambition Scenario:** 44% of the population in 2030 using clean fuels (unconditional).
- **Maximum Ambition Scenario:** 65% of the population in 2030 using clean fuels (conditional on international support).

The NDC's Maximum Ambition scenario assumes that just under half of the country's population shifts to LPG by 2030, and kerosene is fully phased out. The scenario projects that there would be a sharp rise in the sales of improved biomass stoves, with over 8 million units, or an average of 750,000 per year, added by 2030 and with these improved stoves being used by 13% of the population.[76] Furthermore, the Energy Transition Plan for Nigeria envisages a switch to LPG-based cooking first, followed by a longer-term switch to electricity based cooking. Consistent with these, the National Clean Cooking Policy was launched in 2024 with 2030 targets for cooking solutions (Figure 8).

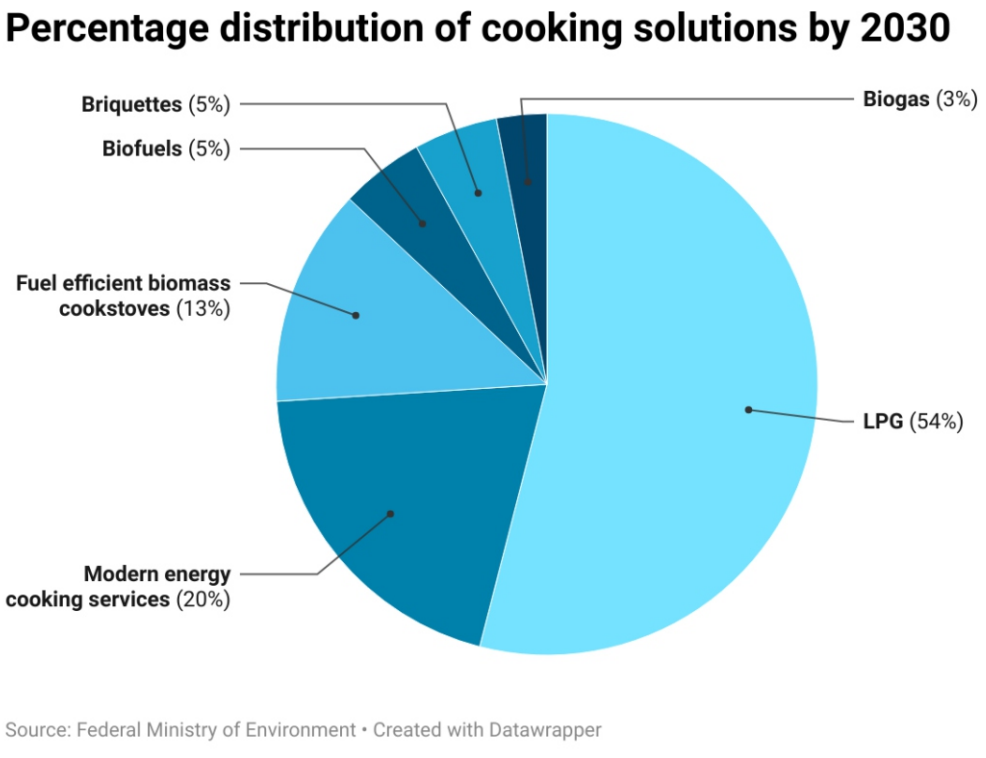


Figure 10. National Clean Cooking Policy cooking solutions targets 2030.[77]

[76] María Y. Roche (2021). *Strengthening the Nigerian Clean-Cooking Business Ecosystem*. Abuja: : International Centre for Energy, Environment and Development (ICEED). https://ng.boell.org/sites/default/files/2021-05/FINAL_Strengthening%20the%20Nigerian%20Clean-Cooking%20Bus.pdf.

Additionally, the Federal Government seeks to increase the supply of LPG by supplying 5 million tonnes per annum and by 2030 and ensuring that 10 million cylinders are injected into Nigerian homes and institutions.[78] To implement these listed policies, The Federal government aims to employ a wide range of policy and regulatory instruments. These include fiscal instruments (such as import duty waivers for imported biofuels for a period of not more than 10 years), the establishment ofresearchanddevelopmentprogrammes, public education programmes, establishing standards, and provision of annual budgetary allocations to promote the expansion of the access to the clean cooking solutions and through multilateral sponsorship from other countries.

A growing number of non-state actors operate in Nigeria's clean cooking space. The Nigerian LPG Association is currently working with the Federal Government on the LPG Implementation Plan. The Nigerian Alliance for Clean Cookstoves, which brings together most of the improved cookstove (ICS) businesses. More local and international ICS companies, like Burn Manufacturing Limited, Envirofit, Nenu Engineering Ltd have entered into the clean cooking market. LPG, improved biomass cookstoves (ICS) and renewable-fuel value chains are also emerging nationwide.

4.2. Electric Mobility

The e-mobility ecosystem, however nascent in the nigeria space, has in recent times created a buzzing effect and has attracted government, private and international stakeholders. In 2021, Stallions Motors launched Nigeria's first electric car in Abuja. Before this launch however, Nigeria already had a two wheeler industry with the participation of companies like MAX, ThinkBikes and Siltech.[79] The country has since then formed a solid ecospace embracing two and three wheelers, passenger vehicles, public minibuses and mass bus transits.

There are already at least 30 companies in the Nigerian e-mobility space providing solutions ranging from EVs to charging stations. MAX, for example, announced plans in 2022 to raise $100 million by 2023 in order to expand green mobility solutions in ten African countries and

[77] Federal Ministry of Environment (2023). *National Clean Cooking Policy*. Abuja: Federal Ministry of Environment, p. 8. .https://naccnigeria.org/wp-content/uploads/2024/05/National-Clean-Cooking-Policy-v2.pdf.
[78] *Ibid.*, p. 11.
[79] Olawale Ajimotokan (30 January 2025). "Stallion Motor Unveils Nigeria's First Electric Car in Abuja", *THISDAY*. https://www.thisdaylive.com/index.php/2021/02/06/stallion-motor-unveils-nigerias-first-electric-car-in-abuja/.

to increase the share of electric vehicles in the company's fleet from 5% to 70% by 2026.[80] Some other outstanding recent events the sector has built on are presented in the table below.

Date	Event
August 2022	Launch of the Nigeria Energy Transition Plan capturing a transition plan from ICE to electric vehicles by 2060.
May 2023	Oando Clean Energy Limited (OCEL), in partnership with the Lagos Metropolitan Area Transport Authority (LAMATA), commenced operations of its electric mass transit with two buses at Lagos Bus Services Limited (LBSL) for a pilot phase.[81]
	Removal of federal subsidies on petroleum motor spirit (PMS), which raised the relative Total Cost of Ownership (TCO) of ICE vehicles relative to electric vehicles, thereby making the latter more commercially competitive.[82]
June 2023	Sterling Bank's Qore launched Nigeria's first public commercial EV charging station in Lagos. The Qore project created a value chain in the EV market space such as: EV financing, battery switching and battery swapping.
July 2023	A validation workshop on a draft of the National Action Plan for E-mobility in Nigeria was hosted by the National Automotive Design and Development Council in Abuja. This addressed the issues related to policy and regulation, financial mechanisms, market development, and manpower enhancement in the EV ecospace.
December 2023	Launch of the National Automotive Industrial Development Plan (NAIDP, 2023-2033) which contains provisions for EV producers.
October 2024	Launch of the Electric Mobility Promoters Association of Nigeria (EMPAN).
November 2024	Launch of Connect Volt app to locate, navigate to and connect with EV charging stations across Nigeria.
December 2024	Nigerian Consumer Credit Corporation (CrediCorp) and the National Automotive Design and Development Council (NADDC) unveil a N20 billion consumer credit fund

[80] Mike Ochonma (8 December 2022). "Startup MAX targets 100m EVs in rollout 10 countries by 2023", *BusinessAMLive*. https://www.businessamlive.com/start-up-max-targets-100m-evs-roll-out-in-10-countries-by-2023/.

[81] Mary Izuaka (24 May 2023). "Oando, LAMATA launch electric mass transit buses in Lagos", *Premium Times*. https://www.premiumtimesng.com/regional/ssouth-west/600202-oando-lamata-launch-electric-mass-transit-buses-in-lagos.html?tztc=1.

[82] CTH and AfEMA (2023). Nigeria Fuel Subsidy Removal: Time for Electric Mobility? Technical Brief. Abuja & Nairobi: Clean Technology Hub and African E-Mobility Alliance. https://cleantechnologyhub.com/wp-content/uploads/2023/07/Nigeria-Fuel-Subsidy-Removal-Time-for-E-Mobility.pdf.

	to enable Nigerians to purchase locally-assembled vehicles.
	FGN exempts VAT for Liquefied Natural Gas (LNG), Compressed Natural Gas (CNG), and Electric vehicles.

Table 3. Major events in the Nigerian e-mobility sector (2023-2024).

The ETP envisions EVs making up only 1% of the passenger vehicle mix by 2030 and 60% by 2050. Furthermore, the NAIDP aims to increase local production of vehicles and achieve 40% local content. The plan also targets 30% locally produced EVs by 2033. It specifies a range of fiscal incentives geared towards achieving these goals.

For the ETP goals to be achieved, more public commercial charging stations need to be installed across the country. The Energy Transition Plan (ETP) projects that there would be 60 public charging stations across Nigeria by 2030. By the end of 2024, there were an estimated 54 public charging stations across Nigeria.[83] However, there are still no dedicated regulations for EV charging infrastructure that standardizes plug types and communication protocols.

The commercial case for EVs in terms of comparative cost of ownership significantly improved in 2023. On the 29th of May, 2023, a major shift for the energy sector in Nigeria was the removal of fuel subsidy. Nigeria being an oil based economy with the energy market heavily reliant on fossil fuel generation for different energy activities like driving, cooking, electricity amongst others.

4.3. Green Hydrogen

There are only two operating green hydrogen installations in Africa (in Egypt and Kenya). The rest are still under development. However, there has been a lull in new green hydrogen project announcements. The figure dropped from 100 GW worth of new project announcements in 2022 and 2023 to only 1,180 MW in 2024.[84]

Nigeria is a major oil producer, the largest economy in West Africa, a key player in West African transition geopolitics, and, unlike Mali and Niger (which account for 84% of the subregional potential), it is a Gulf of Guinea country with access to shipping and ocean transportation, which would be valuable for participating in global hydrogen markets and for lowering hydrogen costs, even though it has the third-largest aggregate green hydrogen

[83] These are listed on the Connect Volt app. https://connectvolt.com/.
[84] AFSIA, *Africa Solar Outlook 2025*, p. 54.

potential among ECOWAS member countries. This cost reduction could occur by encouraging demand from refining and chemical production already using hydrogen based on fossil fuels and are concentrated in coastal industrial zones.[85] Hydrogen as a source of energy has been infused into the Energy Transition Plan (ETP) for various purposes such as power generation capacity and Industry usage.

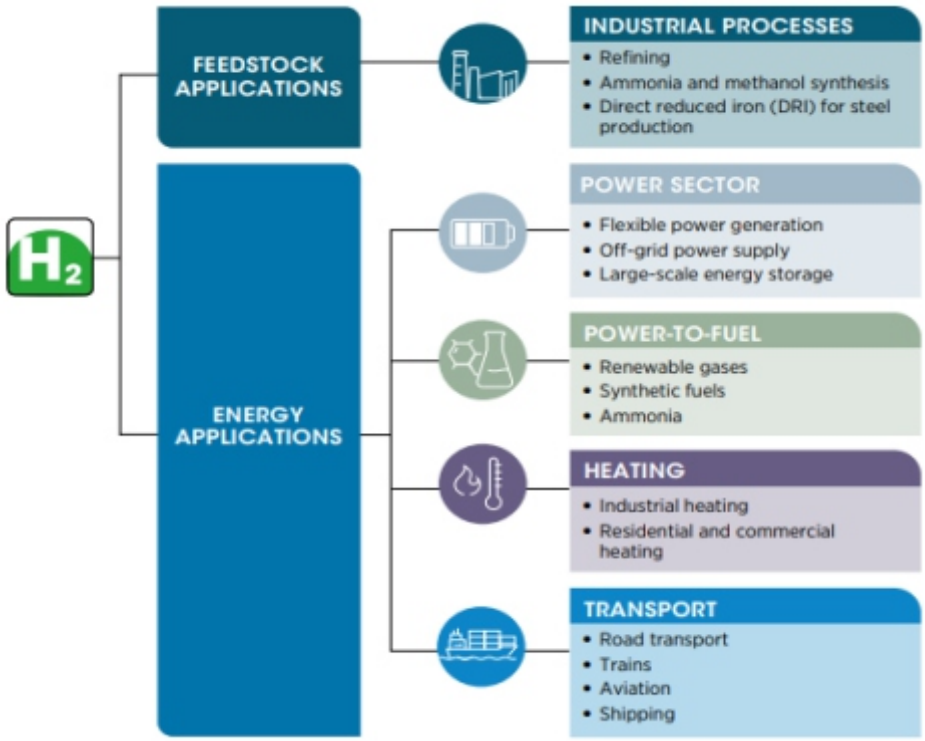


Figure 11. Hydrogen Applications (Source: IRENA).

However, although the ETP includes hydrogen as an option for the decarbonization of Nigeria's industry, specifically for ammonia production, it does not envisage hydrogen making up a significant share of Nigeria's final energy consumption by 2030, while by 2015 it could make up a small share and enjoy a Compound Annual Growth Rate (CAGR) of 21% between 2030 and 2050.[86] In other words, the plan sees hydrogen production ramp-up only post-2030 due to "market uncertainty". It argues that existing and new facilities built pre-2030 could use Steam Methane Reforming (SMR) to produce hydrogen with Carbon Capture and Storage (CCS) (blue hydrogen), while facilities constructed post-2030 could use green (or blue) hydrogen as the hydrogen market develops.

[85] IEA, *The Future of Hydrogen*, p. 15.
[86] Abigail Adaramola and Abel B.S. Gaiya (2023). *Nigeria Green Hydrogen Market Update 2023*. Abuja: Clean Tech Hub. https://cleantechintell.com/nigeria-hydrogen-market-update-report/.

Various actors have made efforts to reduce this market uncertainty that limits government support and investor participation in the Nigerian green hydrogen space. In 2023, an inter-ministerial committee was formed to draft a Nigerian hydrogen policy. In the same year, the German-Nigerian Hydrogen Office unveiled a Study on the Policy and Regulation Frameworks for the Build-up of a Hydrogen Market in Nigeria, aimed at informing policymakers and pressure groups seeking to develop a Nigerian hydrogen market. In addition, the Accra-based West African Science Service Centre on Climate Change and Adapted Land Use (WASCAL), funded by the German government, created West Africa's first open-access geospatial resource for green hydrogen, the H2 Atlas-Africa.

Several feasibility studies are being conducted, including in decentralized applications of green hydrogen. One key feasibility study conducted by the Delegation of German Industry and Commerce in Nigeria is the integration of a green hydrogen production unit to an existing solar PV mini-grid in Gbamu Gbamu, Ogun State. This project focused on energy system design and deployment of excess electricity generated from solar PV for green hydrogen production based on optimized solar PV, electrolyzer, fuel cell, H2 storage, and compressor components. The analysis shows that the levelized cost of energy (LCOE) is 77 NGN/kWh with 18% excess renewable energy generation and an option for hydrogen sales to heavy-duty vehicles to promote net-zero emissions.[87] The sensitivity analysis result showed that, over time, the cost of hydrogen produced from the mini-grid becomes cheaper than diesel. Additionally, a green hydrogen pilot project is being undertaken in Ondo State.

5. DATA AND TOOLS FOR ENERGY PLANNING

The mass deployment of renewable energy technologies requires a range of data, tools and toolkits to inform planners, policymakers, investors, developers and researchers. The absence of such tools have hindered public and private investment particularly in the off-grid sector, forcing project developers to incur losses from deploying personnel to potential sites based on inaccurate or incomplete data available online during pre-feasibility assessments.

In response to these challenges, several innovative open-access tools, datasets and toolkits have been created to provide developers and planners with better information to improve planning effectiveness and reduce costs associated with imperfect information. While these are listed on platforms such as the Nigeria Off-Grid Solar Knowledge Hub,[88] those developed between 2023 and 2024 are listed below:

[87] AHK (2022). *Green Hydrogen Production for Use in Off-Grid Applications, Nigeria*. Lagos: AHK. https://www.now-gmbh.de/wp-content/uploads/2022/12/H2-in-der-dezentralen-Energieversorgung_Green-Hydrogen-Production-Nigeria_AHK.pdf.

[88] Nigeria Off-Grid Solar Knowledge Hub (2025). "Estimate and Stimulate Demand", *Energypedia*. https://energypedia.info/wiki/Estimate_and_Stimulate_Demand.

S/N	Tool Name	Developer	Year Launched	Description
		Finance Tools		
2	AFUR Mini-Grid Tariff Tool	African Forum for Utility Regulators	2023	The tool enhances the process of determining cost-reflective tariffs for mini-grid projects to ensure fair and efficient pricing.
3	Mini-Grid Project Finance Term Sheets	Crossboundary Group	2023	The project financing term sheets can be used to structure and finance mini-grid projects in Africa.
4	Mini-Grid Finance Model	Crossboundary Group	2023	A spreadsheet-based modeling tool for mini-grid project finance projects.
5	Financial Assessment Tool for Electrification	PeopleSUN	2023	Designed to establish the financial viability of mini grid and solar home system (SHS) projects according to different criteria including: revenues, expenses, and company's financial situation.
		Planning & Modeling Tools		
6	Off Grid Planning Tool	PeopleSUN	2023	The tool aims to perform a spatial optimization of the distribution grid as well as the design of the energy converters and energy storage.
7	Community Minigrid Tool	Reiner Lemoine Institute (RLI), the greenwerk (tgw) and Clean Technology Hub (CTH)	2024	A simple web-based tool designed for communities in Nigeria to take the first steps toward electricity access. Model electricity demand, size a suitable mini-grid, conduct financial analyses and more. The tool will provide the user with a comprehensive document with which to approach stakeholders.
		Datasets		
8	Global E2&3W Catalog	United Nations Environment Programme	2023	A catalog of vehicle models, prices
		(UNEP)		
9	E-Mobility Data Africa	Africa Electric Mobility Alliance (AfEMA)	2024	A data dashboard with estimates for 23 African countries of EV fleets, number of market players, number of chargers and battery swapping stations, and other key data.

Table 4. Open tools developed for the energy sector (2023-2024).

6. CONCLUSION

The Nigerian Electricity Supply Industry (NESI) continues to face persistent challenges such as inadequate infrastructure, regulatory inefficiencies, and financial constraints. The existing infrastructure is insufficient to meet the growing demand for reliable electricity, and the lack of consistent regulatory policies has stifled progress in the sector. To overcome these challenges, there is a pressing need for substantial infrastructural development and a firm financial commitment from both the government and private investors. Recent political initiatives, including the Nigeria Energy Transition Plan and the Nigerian Electricity Act 2023, have created a foundation for positive change. The removal of fuel subsidies and the proposed electricity tariff increases are steps in the right direction, but these measures must be complemented by well-crafted, transparent, and supportive policies that attract investment and ensure long-term sustainability.

Decentralized energy solutions, such as solar mini-grids and solar home systems, offer an immediate and effective means to bridge the energy access gap, especially in rural and off-grid areas. These solutions require a conducive environment for investment, and the government's role in creating an enabling investment climate is critical. Programs like the Energizing Education Programme (EEP) and the Nigeria Electrification Project (NEP) emphasize the importance of public-private partnerships, which are necessary to accelerate infrastructure development. Additionally, human capacity development, including training a skilled workforce to install and maintain solar systems, will play a vital role in ensuring the sustainability of these initiatives. Technological transfer from global partners can also help enhance local expertise and enable the adoption of innovative energy solutions.

To fully realize Nigeria's energy potential, the government must streamline regulatory frameworks, implement effective policies, and ensure that these policies are consistently applied. A favorable in-country value proposition—one that offers clear incentives for investors and businesses—is essential to attracting both local and international investment in the renewable energy sector. Encouraging investment in renewable technologies like green hydrogen, alongside the integration of advanced data tools for energy planning, will further support the nation's transition to a low-carbon economy. By focusing on infrastructural development, financial commitment, and the creation of an enabling environment for investment, Nigeria can move closer to achieving energy security and sustainable economic growth.

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