

# TECHNOLOGY MEETS RENEWABLES

DRIVING INNOVATION IN THE  
NIGERIAN OFF-GRID ECOSYSTEM



Clean Technology Hub  
Energy Innovation Center



Clean Tech Incubation & Acceleration Foundation  
Energy Innovation Center

As investment into **renewable energy** in Nigeria increases, there will be a need to ensure **energy efficiency** and management for both renewable energy providers and consumers.



## BACKGROUND

Nigeria has potentially the biggest renewable energy market in Africa not just by virtue of its population (186 million), but also because of its low rate of power connectivity. Only about 57.3% of Nigerians are connected to the National Grid, and only 25% of those connected to the Grid receive regular power supply.

Renewable energy penetration in Nigeria is still at a nascent stage, with mostly hydropower and biomass being used. Other sources of renewable energy such as wind and solar have been deployed in relatively smaller percentages, with the latter mostly deployed for streetlights in major cities.

However, this is likely to change due to a number of policies and initiatives by the Federal Government to encourage the growth of renewable energy in the country: the government in November 2016 adopted the Vision 30:30:30 which aims at generating 30% of 30GW by the year 2030 from renewable energy. The vision is backed by a National Renewable Energy Action Plan. This action plan together with the recently released Guidelines for Mini-Grids released by the Nigerian Electricity Regulatory Commission (NERC) is expected to stimulate investment into the sector.

As investment into renewable energy in Nigeria increases, there will be a need to ensure energy efficiency and management for both renewable energy providers and consumers. This presents an opportunity for the

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Nigerian technology industry to develop tools and platforms to enable renewable energy providers and consumers effectively manage the renewable energy supply. This will also contribute to the effectiveness of the Nigeria Renewable Energy and Energy Efficiency Policy of the Federal Government, which aims to make access to and utilization of renewable energy more efficient in order to achieve lower costs for consumers and producers.

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**The chronic deficits in the power sector is caused by**



- An ageing and underfunded grid system
- Extended insurgency around gas pipelines in the Niger-Delta
- Financial liquidity issues from the sale of power assets
- Electricity thefts

# PROBLEM

Nigeria's current grid generation capacity is 12,000 megawatts, yet only 5,000 megawatts is available to meet the needs of the country's teeming population.

The chronic deficits, caused by an ageing and underfunded grid system, as well as an extended insurgency around gas pipelines in the Niger-Delta, and financial liquidity issues from the sale of power assets and electricity thefts, have left operators unable to get power to rural areas, and left 60 percent of Nigerians without electricity.

The gap between electricity demand and supply means that many Nigerian businesses and homeowners have no option but to adopt expensive self-generated diesel power for their commercial, industrial and residential uses—with electricity now estimated to be 5-10 times more expensive in Nigeria than in Europe. So how did we get here?

The privatization of the country's national power assets in 2013 was heralded by the then President, Dr. Goodluck Johnathan, as the start of better days for those who had put up with “darkness, noisy power generating sets, the related pollution and the daily disruption in their lives”, but came with its own set of challenges.

From the outset, issues on how to regulate the market, with the right checks and balances, while ensuring appropriate returns for private investors, were

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not addressed—leading to long-term, systemic issues. Today, these have culminated in a lack of liquidity in the Nigeria Electricity Supply Industry (NESI) which is affecting the ability of companies to meet payment obligations.

Without determined measures to address the issue, it could dramatically reduce energy supply. This liquidity crisis has led to cash strapped investors and stranded assets across the electricity value chain. When you add the fall of commodity prices, and its impact on the country's balance sheet, the challenges become even more multi-layered.

The knock-on-impacts are manifold. One that significantly stands out is the impact of power outages on the economy. Businesses are forced to turn to expensive diesel fuelled generators for back-up supply, reducing competitiveness, or, worse still, limiting their production or stopping operation altogether.

The high cost of doing business has contributed to skyrocketing unemployment and a dramatic slowdown in economic growth across the nation. What's more, the worsening economic recession means that, rather than the situation being addressed, there is less and less investment going into the central grid. The picture is bleak. Yet it has also provided an opportunity for the development of new ideas, technologies and solutions.

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# SOLUTION

Despite these challenges—or perhaps even because of them—we have seen a significant increase in investment in distributed renewable energy (DRE) solutions; including a \$90 million investment in off-grid Nigerian solar company Nova Lumos in December.

We have also seen the launch of a National Solar Program by the Buhari/Osibanjo administration in partnership with Azuri power aimed at addressing rural and peri-urban power needs, as well as the recently announced Bank of Industry Solar Fund for Small and Medium Sized Enterprise.

The Nigerian market for decentralized renewables, which include standalone systems, mini-grids, solar irrigation and mini hydro, has been steadily expanding over the past few years, and thousands of households and businesses are now benefitting from clean, reliable power.

Almost 100 million people live without centralized grid access in Nigeria, while four in every five enterprises use diesel generators. Given the huge numbers to whom the central-grid remains a distant dream, or an unreliable millstone, there are a great many who are now considering the DRE sub-sector as a viable path to increasing electrification rates in Nigeria.

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# 2030

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It is also in recognition of this that the Federal Government of Nigeria has put in place numerous policies, plans and targets to expand access to electricity through renewable energy. It has set in place a target of generating 9000 MW from renewable energy by 2030, and this includes the deployment of 10,000 mini-grids to increase rural access to electricity and thus, eliminating national spending of \$4.4 billion annually from household energy costs through the use of solar home systems.



# INNOVATION

And Nigeria is not alone. Globally there is an increasing shift from fossil fuel electricity generation to renewables, and distributed energy products are fast becoming a part of the new energy landscape.

Take for example TESLA, which just announced that it has provided power to the whole of American Samoa using a 1.4MW mini-grid, the Australian utilities that are ditching the centralized grid in remote areas as renewably-powered captive systems become more cost effective, or the Kenyan solar home system market that is already saving families \$1 billion a year.

And these successes have led to more interest from investors' year-on-year too, with the sector raising nearly \$500 million in investment to date.

According to GSMA research in 2018, Nigeria currently has over 55 active tech hubs, surpassed only by South Africa, meanwhile, Lagos with 31 hubs, has more hubs and programmes than any other city across Africa.

The increasing importance of these new tech ecosystems is evident with the much-publicised visits of Google's Sundar Pinchai and Facebook's Mark Zuckerberg to Lagos' CcHub. The recent announcements of new hubs by Google and Facebook also denote that the upward trend is steady leading to the development of more mature markets.

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In addition, there is the argument being made that decentralized energy systems – like renewable energy are not just tech-enabled but are also a form of technology in of themselves.

This is evident in the amount of tech research and development both driving and accelerating its adoption across the board. From remote sensing and communication nodes, to smart metering, and power interfaces of distributed renewables to smart technologies (such as inverters and energy-storage devices) and storage as the preferred resource types for decentralized renewable energy systems.

As the Nigerian market continues to evolve and is quickly reaching an inflection point, some of the following trends as listed out by Clark W. Gellings are key components for achieving the future state in Nigeria:

Distribution planners will have the data, experience, and needed modeling tools to plan for different renewable-deployment scenarios.

Methods to determine feeder hosting capacities for variable distributed generation (DG) will be available.

- Distribution operators will know what distributed resources are connected to their systems, will be able to forecast and manage variability, and will be able to employ mitigation strategies when needed.
  - Distributed PV systems will include power and communication interfaces that are able to provide grid support.
  - Communication protocols and interfaces will be available for distributed management service (DMS) and will be able to take advantage of advanced functions available from electronic inverters.
  - Effective business models for utility ownership and operation of distributed
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PV will be available.

- Utilities that own and operate distributed PV systems will have established practices to minimize operation costs and avoid downtime.
  - Communication, metering, and power interfaces of distributed renewables to provide grid support, including the required communication protocols for integration.
  - Smart technologies (such as inverters and energy-storage devices) and advanced measurements and controls (such as self-diagnosis and self-healing).
  - Existing and emerging intelligent technologies and techniques to provide for proactive maintenance, optimal levels of asset utilization, and greater efficiencies.
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# THE DRE OPPORTUNITY IN NIGERIA

The Nigerian Electricity Supply Industry (NESI) is currently grappling with challenges that can be resolved through strategic partnerships with these tech hubs and furthermore, closing these Research and Development gaps will require that the industry invests resources in developing and implementing new processes, tools, techniques, and technologies. An increasing questioning and urge to rethink flawed business models have led several tech hubs and programs to narrow down their offering and target specific niches. However, through strategic partnerships, businesses opportunities for both the Tech ecosystems and the Decentralized Renewables ecosystems can be harnessed in the following areas;

- Data Analytics and Smart Database Management (electric customer/product enumeration/inventory)
  - Supervisory Control and Data Acquisition (SCADA) systems (for remote monitoring of power systems and electricity consumption patterns)
  - Geographic Information Systems (GIS) and mapping of energy resources, infrastructure and capacities
  - Core engineering including smart meters; payment platforms; smart cards; charge controllers, remote monitoring systems, etc
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- Mobile Money payment platforms
- Backward integrated IT tech support for RE companies

The Federal Ministry of Science and Technology (FMS&T) is mandated and committed to ensuring that science, technology and innovation drives the engine of growth for Nigeria's economic development.

The Energy Commission of Nigeria (ECN) under the direct supervision of the FMS&T Renewable Energy Division is responsible for performing functions such as supporting development of technologies relating to the energy sector.

Furthermore, in a bid to energize the local electricity market – the government of Nigeria recently activated a local content regulation for the electricity sector- aimed at ensuring that high level technical jobs and opportunities are taken advantage of by Nigeria labor market.

Similarly, President Buhari in March 2019, just assented to a legislation that allows Engineers to be exempt from posting to non-engineering firms for the National Youth Service Scheme. This provides a great opportunity for both the local tech ecosystem and the decentralized renewable energy ecosystem to take advantage of the budding opportunities, investments, jobs, and innovation taking place in the Nigerian Electricity Supply Industry (NESI).

From standalone home systems, to hybrid solar and hydro technologies powering manufacturing and agro businesses, the DRE sector has been growing rapidly in Nigeria. The 2016 Global Off-Grid Solar Market Report shows that the Nigerian decentralized solar market grew 73 percent in the first six months of the year 2016, and is still growing at an accelerated rate.

Despite facing serious macro-economic challenges since 2016 most

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Nigerian renewable energy companies are witnessing increased sales—a testament to the innovation and drive through which they have adopted new business models.

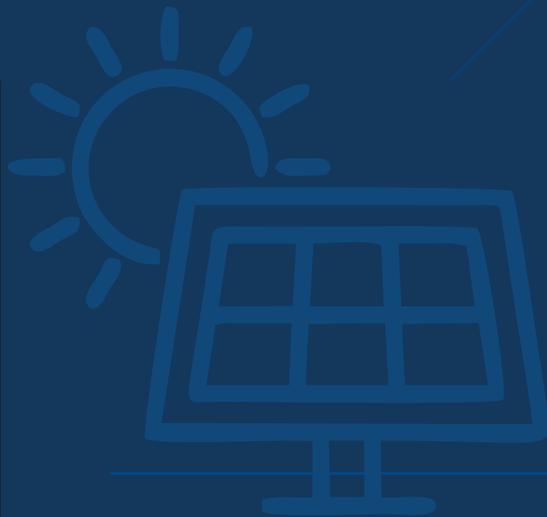
The growing prominence of DRE technology, and increasing awareness of its impact and potential, also led to the earlier mentioned launch of the National Solar Program by the Nigerian government in early February 2016 – with the program aimed at providing electricity to 20,000 households. The program focuses on powering rural homes that cannot be serviced by the national grid

**20,000**

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# FINANCING/INVESTMENTS

There is a notable growth trajectory in the off-grid solar market: 1.7 million solar products sold between 2015 and 2017, and an annual growth rate of 36% between 2014 and 2016. Yet, the current level of finance and investment in the DRE market falls significantly short of what is required to commercially unlock the market.

The lack of investment flows is evident as many technology providers and companies acknowledge challenges in raising patient capital from local finance institutions and remain increasingly dependent on donor funds in the Nigerian market.

The negative impact of the 2016 economic recession, which saw the naira equivalent of foreign loans go up by almost 250% gives credence to the need for local financing. This situation not surprisingly led several local DRE enterprises to become adverse to long-term foreign finance. Likewise the instability in the country's foreign exchange market led to significant capital flight and investor hesitancy as well.

It is important, however, to note that the tide in investment flow for the Nigerian off-grid DRE market is evolving, even though it is barely matching the growing energy demand. As Africa's largest electricity market, Nigeria has accrued a significant number of electricity financing commitments. Between 2013 and 2014, Nigeria and Ethiopia received the highest

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electricity commitments in Africa of \$2.4 billion per year for both the grid and booming off-grid market. Nigeria's off-grid market for mini-grids and solar home systems is estimated to yield \$10 billion annually in revenue and savings of \$6 billion for Nigerian homes and businesses.

This momentum has led to innovative new funding making its way to the DRE space. This is evident in the recent successful raising of Series A – round of fund-raising by Arnergy, a local Nigerian DRE company to the tune of \$9 million USD – the first of its kind ever raised in the sector.

As earlier mentioned, the Nigerian Bank of Industry launched a Solar Fund aimed at reducing the cost of doing business in Nigeria by enabling enterprises to purchase decentralized energy solutions to meet their energy needs. While, the Green Climate Fund committed \$80 million to the Universal Green Energy Access Programme (UGEAP) to support the expansion of solar home systems, solar mini-grid systems and solar for small and medium enterprises, with Nigeria being one of five initial focus countries.

This funding hints at a looming boom for the DRE sector in the country, and the Nigerian industry players will be working hard to ensure that funding opportunities are used to develop greater knowledge about the sector by investors, as well as a strong track record—ultimately unlocking government guarantees, innovative funds, commercial lending and capital market financing.

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# TECH MEETS RENEWABLE

In improving the DRE market and creating more opportunities for investment in the sector, the role of information and communication technology (ICT) cannot be overemphasized. ICT already provides a bedrock for the sector through remote sensory and monitoring systems of decentralized systems, as well as block-chain technology which connects consumers with distributors.

For example, Mobisol, a company that has helped thousands of households and businesses benefit from solar electricity in Tanzania and Rwanda, has created a software that enables them to monitor the quality and energy usage of decentralized systems using a mobile application.

At any given moment, the company can see if any of their systems are providing a lower than expected amount of power output—for example when something is obstructing the direct sunlight onto a PV panel—and directly provide customers with advice to resolve the situation. As noted by Anne Schanz, Mobisol's Software Developer, "Remote monitoring technologies allow for better customer service." And good customer service is the bedrock of strong sales.

For mini-grids too, data enables companies to understand the load profile of their customers to better match power output to customer needs, and has led to some developers working proactively with local enterprises to support

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them in boosting their own productivity. A move that not only enables enterprises to increase their growth, but increases demands for mini-grid power, whilst laying the foundations for strong, sustainable returns.

In Bangladesh, home to the world's largest solar home system programme, new software breakthroughs have even gone one stage further, and are enabling customers to create their own 'mini-utilities'. The high prevalence of solar home systems and renewable energy literacy have led to the creation of technology which allows neighbours to share the excess solar power from their rooftop systems—enabling them to build their own decentralized energy networks.

Yet it is the use of mobile phones and mobile money—matched with Pay-As-You-Go (PAYGO) financing—that has been the biggest game-changer to date. PAYGO allows solar home system customers who were previously unable to afford clean energy to purchase their systems in installments, until they ultimately own their own products.

While there are a few different technology models, ranging from chip and pin, to the latest in GSM enabled connectivity including digital voice (VIOP) and data connectivity that have made organizations and businesses more efficient and nimble - all provide a mechanism for millions of households and businesses to get energy access for the first time.

Moreover, the ability for investors to better understand the energy profile of customers through data gathered by PAYGO systems, and for them to see first-hand that customers previously considered 'unbankable' are able, and willing, to pay for clean safe power, is set to unlock even more financial support for the sector. It is also creating a part for ICT enabled job growth where developers are able to create new methods of integrating financial technology with distributed energy technologies.

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Each of these leaps occurred through an enabling ICT backbone across Africa and its ability to enable new business models and streams of economic activities. We have also seen how a number of remote sensing and monitoring systems for DRE technologies in hard to reach communities are dependent on ICT technology.

It is clear, that these technologies can be adapted and used in scaling up DRE businesses and its penetration via reaching hard to get customer targets, by encouraging more PAYG usage of DRE technologies and via support for several other industries that are powered through DRE technologies especially in the off-grid space.

In Nigeria, we are already seeing this happen. The Lumos financing—as well as their partnership with mobile operator MTN—along with the emergence of several other nimble, innovative companies maximising the use of software and ICT solutions. This has already changed the narrative around DRE solutions and the opportunities they present, and it shows that technology will remain at the heart of the energy access push across the country.

This is why Clean Technology Hub launched its Tech Meets Renewables project – a three pronged project focused on ideation and connector as a first phase, towards giving highlights and trends in the sector in a bid to getting both ecosystems connected and begin the process of practical integration.

The other fulcrum of the project is the need to build synergized platforms that can enable scale for access to energy which is where the second phase comes in – by way of Pitch/Hackathon where Clean Technology Hub (CTH) along with other core partners seek solutions that the Tech ecosystem can provide for the Renewable Energy ecosystem.

The third phase involves putting successful pitchers are put through an incubation program and matched with successful companies in the Renewable Energy ecosystem to develop their ideas for scale.

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# WHAT WILL THE FUTURE HOLD?

Nigeria's declining electricity output poses both a challenge and an opportunity for the renewable energy sector to bridge the gap in helping the country meet its energy access goals. Solving Nigeria's power deficit is an achievable goal, but continued technological advances and application will play a key role in making it happen.

To do this there is need to innovate and accelerate the deployment of off-grid renewable energy technologies to meet the increasing demands for stable electricity across the country. From smart meters and payback systems, PAYGO systems to block-chain technologies, engaging the country's communications and ICT entrepreneurs, and capabilities with the challenges and opportunities of the DRE sector has very real potential to unlock new innovations, and to keep Nigeria at the forefront of the clean energy revolution.

While there are many factors that will need to be addressed to resolve the energy crisis in the country—from finance to policy, awareness to capacity building—engaging pioneers from the technology sector with the challenge of energy access may prove an invaluable step towards ending energy poverty.

Nigeria's robust tech ecosystem can provide platforms already deployed in other sectors by partnering with the robust and youthful human capital and young innovators already existing in the ICT and Technology sector to use

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new technologies to drive improvement in access to electricity within the country.

It is clear – and this is evident by the Technology meets Renewable Energy project undertaken by Clean Technology Hub – that technology can and will be a huge driver for decentralise renewable energy in a way that deepens connections and energy access penetration to grow access more rapidly.

Clean Tech Hub in collaboration with partners organized this project to encourage discourse and collaborations between Renewable Energy and Technology experts to explore the existing gaps in Renewable Energy technologies, and business opportunities that can be harnessed in the short and long run.

With all of these innovation and changes, Nigeria cannot afford to lag behind in the global energy revolution. While there is a huge amount to be done, what is encouraging is that in Nigeria we are witnessing for the first time concerted efforts to prioritize renewable sources in the country's energy mix, as well as an uptick in renewable energy investment.

We still have to align our policy, regulatory and fiscal measures to ensure that Nigeria gets ahead of the curve, but we have a huge opportunity to become a key player in the decentralized renewable energy space, and an even greater opportunity to end energy poverty in Nigeria–fast.

Clean Technology Hub (CTH) is a pioneering hybrid hub for the research, development, demonstration and incubation of clean energy technologies in Africa, and their validation for commercial stage development. It is an early start-up incubator for inventions and innovations in clean energy, a consultancy for sustainability and energy efficiency solutions for organizations, and a driver of clean energy investment into Africa.

CTH is focused on addressing Africa's energy poverty, increasing energy access through clean, renewable energy and sustainability.



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