

Exploring Local Solutions to Address Energy Access Deficit for Off-grid Communities in Nigeria Through Collaborative Learning

Misbahu Ladan Mohammed^a, Aminu Bayawa Muhammad^a, Abdullahi Muhammad Sokoto^b, Muhammad Saifullahi Ladan^c and Zaharadden Muhammad Ladan^d

^aDepartment of Energy and Applied Chemistry, Usmanu Danfodiyo University, Sokoto, Nigeria

^bDepartment of Pure and Environmental Chemistry, Usmanu Danfodiyo University, Sokoto, Nigeria

^cBioresources Development Centre Jega, National Biotechnology Research and Development Agency, Nigeria.

^dBioresources Development Centre Kano, National Biotechnology Research and Development Agency, Nigeria.

Abstract

Scientific collaboration has been identified as a mutually beneficial process that yields favorable outcomes for many African countries towards achieving a number of United Nations Sustainable Development Goals (UN SDGs). In this respect, Usmanu Danfodiyo University Sokoto (UDUS) Nigeria has joined the Transforming Energy Access-Learning Partnership (TEA-LP) to develop local professionals with the skills and competencies to improve energy access for off-grid communities. In this partnership, TEA-LP is providing technical and financial support for the uptake of two new courses into the UDUS M.Sc. Renewable Energy programme. The energy access courses adapted by UDUS through the TEA-LP collaboration are: (i) Local Solutions for Energy Access, and (ii) Appliances for Off-grid Communities. The added courses aim to address the challenges of energy access and equip students with the necessary skills for sustainable energy practices. This paper will discuss the impact of the partnership to date on the UDUS M.Sc. Renewable Energy programme, the teaching methods being used for delivery of the learning outcome, the modalities employed in adapting the two new TEA-LP courses into the existing curriculum and the impact of TEA-LP on the target communities.

Keywords: energy access; off-grid communities; partnership.

How to cite: Mohammed, M. L.; Muhammad, A. B.; Sokoto, A. M.; Ladan, S. M. and Ladan, Z. M. (2024) Exploring Local Solutions to Address Energy Access Deficit for Off-grid Communities in Nigeria Through Collaborative Learning. In proceedings: Conference on Sustainable Energy Education – SEED 2024. Valencia, Spain, 3 - 5 July 2024. Pgs. 324-331. <https://doi.org/10.4995/SEED2024.2024.19007>

1. Introduction

The past few decades have seen a sharp increase in the amount of energy consumed for heating, steam and electricity due to rapid development in the transportation, industrial, agricultural, residential, and commercial sectors worldwide (Wang and Azam, 2024). As a result of the global energy shortage, coupled with increasing cost of energy, and more stringent regulations on the release of harmful substances and gases into the environment, there is growing interest on developing renewable energy options to meet the electricity demand for both urban and rural communities (Mohammed and Saha, 2022).

Nigeria has significant renewable energy resources, including solar, wind, hydro, and biomass. The development of renewable energy in Nigeria can lead to sustainable and inclusive socio-economic development, creating job opportunities and new investments and providing environmentally friendly energy options (Bugaje, 2006). However, despite abundant renewable energy resources, especially solar, which could meet the current and projected power demand in the country, the current electricity generation is heavily reliant on fossil fuels, leading to energy insecurity and a lack of access to electricity for a large portion of the population (Oyedokun et al., 2022). Solar energy, being abundant and permanent, has been extensively utilized by rural dwellers for agricultural processing (Ogunniyi et al., 2023). By developing solar energy conversion systems and implementing necessary technologies and policies, the number of people without access to electricity can be reduced, leading to an eco-friendly environment (Maduabuchi et al., 2023).

To facilitate efficient exploration and utilisation of renewable energy resources in Nigeria, there are challenges to overcome, such as inadequate governmental policy frameworks, unsustainable financial models, and low community ownership of renewable energy projects (Oubda et al., 2022). Additionally, there is a need for concerted efforts through collaborative partnership with stakeholders in the distributed renewable energy (DRE) sector to reach out to the poorest and most remote populations of the country. To date, however, this remains largely unaddressed in energy education, both in Nigeria and worldwide. Consequently, Usmanu Danfodiyo University, Sokoto (UDUS), Nigeria is among the select group of twenty three (23) universities that were competitively selected in the Transforming Energy Access-Learning Partnership (TEA-LP), an African-based organisation funded by UK Aid, supporting universities in African, South Asian and Indo-Pacific regions in delivering new and improved curricula that prepare Master of Science (M.Sc.) graduates to help achieve energy access targets in their respective countries. At the moment, UDUS had successfully adopted the two new TEA-LP developed energy access course i.e. "Local Solutions for Energy Access" and "Appliances for Off-Grid Communities" into its M.Sc. Renewable Energy programme. This paper sets out to share this experience and critically engage with sustainable energy education as a precursor for delivering the future workforce for the energy sector.

2. The impact of TEA-LP partnership on the UDUS M.Sc. renewable energy programme

One of the cardinal objectives of the M.Sc. Renewable programme run by UDUS is to produce competent professionals capable of applying renewable energy technologies in solving the energy needs of modern society, especially for applications in rural areas and remote locations. Thus, the two TEA-LP developed energy access courses adopted into the UDUS M.Sc. programme, "Local Solutions for Energy Access" and "Appliances for Off-Grid Communities" agrees well with the main objective of the programme, as well as the mandate and vision of UDUS of providing energy experts to help drive the clean energy access transition. Moreover, UDUS is utilizing a grant of £16,700 secured from TEA-LP in the integration of the two new courses into the M.Sc. Programme, through development of programme webpage, marketing for the revised programme and payment of staff time where necessary.

Furthermore, UDUS was among the 23 new partner universities in attendance at the Transforming Energy Access-Learning Partnership (TEA-LP) sponsored course uptake workshop hosted at the Strathmore Business School, Strathmore University in Nairobi, Kenya from 5 to 9 June 2023, as a prelude to the successful take-off of the partnership. The workshop focused on the uptake of the 3 new Master's level courses developed by the TEA-LP, where participants were introduced to the latest developments in the energy access, in terms of technology solutions, energy demand, socio-economic aspects, business models, financial and policy options as well as environmental considerations. Participants were provided with a general framework to transfer knowledge and skills to contribute to the growing off-grid appliances sector. The two participants from UDUS had acknowledged the positive impact of the training towards their capacity building in the teaching and learning of TEA-LP and broader courses for the programme.

The students of M.Sc. programme in UDUS have been linked into the network that TEA-LP provides, with unique opportunities to participate in Efficiency for Access Design Challenge (EforA), a global, multi-disciplinary competition that empowers teams of university students to help accelerate clean energy access. The inter-university team of five students is working on a project titled "Design and performance evaluation of a solar-powered DC milking machine for dairy cattle". The concept note and proposed budget for the prototyping grants for the project have been approved by the Challenge team.

3. Teaching methodologies and contents of the TEA-LP developed courses

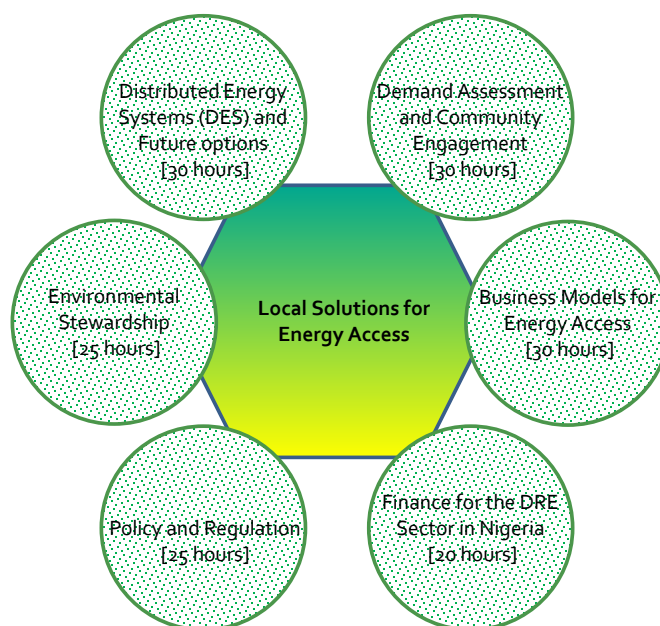
A systems thinking approach is being used in the teaching of both courses. Students are introduced to the key actors in the local and regional policies and regulations of energy access and appliances for off-grid communities in the pursuit of SDG 7 (access to affordable, reliable, sustainable and modern energy for all). Furthermore, a case study approach, including analysis of data, and highlighting best and worst case examples of global/regional solutions as well as national/local solutions for energy access are also followed. Each course consists of 6 major topics, and provides for a total of 160 student hours including in-class and out of class hours i.e. total time required for the student to complete a curriculum and achieve the course learning outcomes. Additionally, each of the major topic in the course content is further subdivided into smaller sub-topics that captures the intended learning outcome that are relevant to Nigeria.

3.1 Local solutions for energy access

Localised energy systems are seen as a viable solution to address the challenges of unreliable and unsustainable electricity supply in Nigeria. These systems can provide jobs and investment opportunities while also improving access to electricity. However, the implementation of localised energy systems in Nigeria is facing challenges and barriers that needs to be addressed. Possible solutions include the deployment of clean and affordable off-grid mini-grid solutions to remote communities, which can unlock their economic potentials (Fasina et al., 2023). Moreover, understanding the status quo of energy access and estimating future energy requirements is crucial. Survey data collected in Nigeria provides valuable insights into demographic and socioeconomic characteristics, energy access, and preferences, which can inform the development of local solutions for access to energy (Pelz et al., 2023).

Local solutions for energy access is a multi-disciplinary course that aimed to provide the postgraduate students with a framework for understanding the off-grid or distributed renewable energy (DRE) sector, while also providing them with the necessary skills and knowledge to assess its challenges and to offer potential solutions for achieving SDG7. The 6 major topics taught in this course are shown in Figure 1.

Fig. 1 – Major topics in local solutions for energy access course



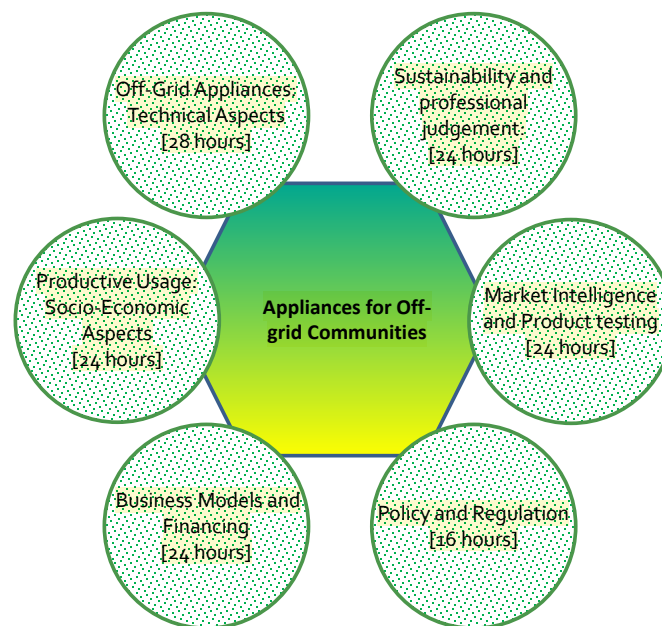
Source: Own elaboration

3.2 Appliances for off-grid communities

Off-grid hybrid energy systems with photovoltaic (PV) energy systems, inverters, deep cycle batteries, and electricity generators are commonly used in residential buildings in both rural and urban areas in Nigeria. Moreover, solar home systems (SHS) are another option for off-grid households, providing sufficient energy for their needs and potentially acting as an income source (Audu and Adamu, 2022). On a positive note, governments and international organisations have been providing substantial support to rural electrification projects in Nigeria, with the aim of expanding electricity access to remote areas by implementing off-grid solutions such as solar mini-grids and SHS (Agoundedemba et al., 2023). However, there is a need for more targeted interventions to ensure successful promotion of off-grid appliances and enhance their uptake in Nigeria's off-grid communities.

Appliances for off-grid communities course provides the Masters' level student with the knowledge and skills to map out the environmental, socio-economic, business and application aspects of off-grid appliances to accelerate their diffusion and uptake for household, health and productive uses. The course examines end-user needs such as appliance efficiency, performance, durability, affordability, financing, operation and maintenance. The course consists of 6 major topics presented in Figure 2.

Fig. 2 – Major topics in appliances for off-grid communities course



Source: Own elaboration

4. Modalities for localising the TEA-LP courses

The process of adapting the TEA-LP courses into the UDUS M.Sc. renewable energy programme started with a meeting of the Departmental Board of postgraduate studies, where the existing curriculum was reviewed and student hours were reduced by dropping two courses based on some agreed criteria to pave way for the new TEA-LP courses. After the revised curriculum was approved by the University Senate, the department embarked on an extensive marketing campaign using posters, leaflet and social media platforms to attract new students. The programme webpage was also redesigned and valuable information for prospective students were added as suggested by the TEA-LP team (<https://www.udusok.edu.ng/m-sc-renewable-energy/>). News and updates about the revised programme are being posted regularly on the webpage, and detailed information about the programme, method of application, fees and scholarship opportunities, and contact persons were all provided. As a consequence of our marketing strategy plans, the revised M.Sc. programme received unprecedented number of new intakes for the 2023/2024 academic session.

We recognized the fact that the renewable energy sector in Nigeria has traditionally been considered a male-dominated field, and the presence of women has remained very low across all levels; therefore, a number of sub-topics involving community engagement through field trips and surveys were incorporated in the course contents to allow students to relate closely with women and members of marginalised groups in the community with the

sole aim of gathering valuable data that will be used to address the issues of gender and social inclusion in the capacity-building activities and access to job opportunities in the DRE sector.

5. The impact of TEA-LP on the target communities

Exploring local solutions in Addressing energy access often means leveraging renewable energy sources such as solar, wind, or biomass. This can lead to reduced dependence on fossil fuels, lowering greenhouse gas emissions, and mitigating the community's environmental impact. For instance, our students had recently developed a high-performing biomass stove for local communities as a transitional or interim solution that can provide some health benefits and significantly reduce environmental pollution. Furthermore, we offer our students opportunities for fieldwork, where they can work directly with communities to understand their unique energy access needs and challenges.

6. Conclusion

In the Nigerian context, where energy access remains a significant barrier to development and quality of life for millions of people, adopting collaborative and locally-driven solutions is not just beneficial, but it is essential. TEA-LP could play a crucial role in addressing the problem by fostering knowledge exchange, capacity building, and innovative problem-solving among stakeholders. The exploration of local solutions not only ensures that interventions are contextually relevant but also promotes community ownership and sustainability.

Acknowledgements

The authors graciously acknowledged the financial support provided to Usmanu Danfodiyo University Sokoto by The University of Cape Town (UCT) (funded by UK Aid through the Carbon Trust) for the Transforming Energy Access–Learning Partnership (TEA-LP) to support the uptake of the two TEA-LP courses.

Conflicts of interest

The authors declare that they have no known competing financial interests or personal relationships that could have influenced the work reported in this paper.

References

- Agoundedemba, M., Kim, C., & Kim, H.-G. (2023). Energy Status in Africa: Challenges, Progress and Sustainable Pathways. *Energies*, 16, 7708. <https://doi.org/10.3390/en16237708>.
- Audu, H., & Adamu, A. (2022). Expanding energy access in rural off-grid communities: a study on household adoption and affordability of solar home systems in Kwara State, Nigeria.

- Journal of Global Economics and Business*, 3(11), 181-201.
<https://doi.org/10.58934/jgeb.v3i11.166>.
- Bugaje, I. M. (2006). Renewable energy for sustainable development in Africa: a review. *Renewable and Sustainable Energy Reviews*, 10(6), 603-612.
<https://doi.org/https://doi.org/10.1016/j.rser.2004.11.002>.
- Fasina, E. T., Adebajji, B., & Adewale, A. (2023). Integrating localised energy systems into the Nigerian power network. *Global Journal of Engineering and Technology Advances*, 15, 001-007. <https://doi.org/10.30574/gjeta.2023.15.1.0061>.
- Maduabuchi, C., Nsude, C., Eneh, C., Emmanuel, E., Okoli, K., Emmanuel, I., Idogho, C., Waya, B., & Harsito, C. (2023). Renewable Energy Potential Estimation Using Climatic-Weather-Forecasting Machine Learning Algorithms. *Energies*, 16, 1603.
<https://doi.org/10.3390/en16041603>.
- Mohammed, M. L., & Saha, B. (2022). Recent Advances in Greener and Energy Efficient Alkene Epoxidation Processes. *Energies*, 15(8). <https://doi.org/10.3390/en15082858>.
- Ogunniyi, O., Oni, T., Ikubanni, P., Aliyu, S., Ajisegiri, E., Ibikunle, R., . . . Elewa, R. (2023). Prospects for Nigerian Electricity Production from Renewable Energy. *2023 International Conference on Science, Engineering and Business for Sustainable Development Goals (SEB-SDG)*. <https://doi.org/10.1109/SEB-SDG57117.2023.10124504>.
- Oubda, D., Ouedraogo, S., Diasso, A., Marcel, K., Zougmore, F., Koalga, Z., & Frédéric, O. (2022). Renewable Energies in Africa, Context and Socio-Economic Challenge. *Open Journal of Applied Sciences*, 12, 1856-1872. <https://doi.org/10.4236/ojapps.2022.1211128>.
- Oyedokun, J., Fasina, E. T., Adebajji, B., & Adewale, A. (2022). Electricity challenges in Nigeria: Renewable energy a way forward. *Global Journal of Engineering and Technology Advances*, 11(03), 016-023. <https://doi.org/10.30574/gjeta.2022.11.3.0085>.
- Pelz, S., Chinichian, N., Neyrand, C., & Blechinger, P. (2023). Electricity supply quality and use among rural and peri-urban households and small firms in Nigeria. *Scientific Data*, 10(1), 273. <https://doi.org/10.1038/s41597-023-02185-0>.
- Wang, J., & Azam, W. (2024). Natural resource scarcity, fossil fuel energy consumption, and total greenhouse gas emissions in top emitting countries. *Geoscience Frontiers*, 15(2), 101757. <https://doi.org/https://doi.org/10.1016/j.gsf.2023.101757>.