



PROMOTING ENERGY LITERACY FOR DECARBONIZATION AND SUSTAINABLE DEVELOPMENT IN NIGERIA: CURRENT CHALLENGES AND FUTURE DIRECTIONS

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The important role of sustainable education and energy literacy as a tool for advancing decarbonisation and the United Nations Sustainable Development Goals (SDGs) has been transcribed in multiple national policy visions and guidelines in Nigeria. Despite this increasing recognition, however, the implementation and delivery of sustainable education (SE) and energy literacy programs remain stunted by a wide range of legal, policy and implementation challenges. While several studies have compiled the importance of energy literacy and SE, a comprehensive examination of the practical challenges that hinder implementation of clean energy education including SE and energy literacy in developing country contexts such as Nigeria remains sparse in the literature. This article aims to fill a gap in this regard. This article contributes to the literature on strategies to address citizens' low capabilities and skills to advance eco-entrepreneurial ventures that promote decarbonization, sustainable development which contribute to the advancement of climate action and low carbon transition plans. Policy, legal, institutional and governance challenges that arise with the design and implementation of clean energy education including SE and energy literacy in Nigeria are examined in order to identify the ways in which a comprehensive governance framework on SE and energy literacy can help close these gaps. Drawing comparative lessons from high performing countries with superior Environmental Performance Index (EPI) such as the United Kingdom with an EPI score of 77.70 while Nigeria has a low score of 28.30, this article suggests that the elaboration of coherent national strategy on clean energy education; a dedicated budgetary allocation for integrating sustainable education into the educational curriculum and research; reform of the existing laws to ensure coherent implementation of clean energy education; and the designation of focal clean energy literacy units at higher education institution are significant steps towards improving the development and implementation of energy literacy programs in Nigeria.

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1. INTRODUCTION

Education is essential to achieving the sustainability goals, it equips citizens with the skills to innovate and generate supportive infrastructure and networks which necessitates transformation of educational curriculum to reflect social context changing realities¹. Goal 4 of the United Nations Sustainable Development Goals (SDGs) therefore calls on all countries to “ensure inclusive and equitable quality education and promote lifelong learning opportunities for all” by the year 2030., while Target 4.7 of SDG4 emphasizes the need for all learners to “acquire the knowledge and skills needed to promote sustainable development, including, among others, through education for sustainable development and sustainable lifestyles” by the year 2030. Also, as elaborated in the UNESCO Education for Sustainable Development (ESD) 2030 Framework, education for sustainable development (ESD) is a key enabler of all the 17 SDGs, including SDG13 on climate action and SDG7 on access to energy for all. Energy literacy, as a key component of ESD aims to promote public awareness on the economic, social and environmental impacts across the energy value chain including generation, use, distribution and storage, and the tools for mitigating adverse impacts through informed choices and decarbonization strategies. Energy literacy programs therefore include courses that provide knowledge and skill acquisition on sustainable energy practices such as responsible consumption; decarbinzation and climate change mitigation, waste management, recycling and composting; and sustainable eco-entrepreneurship and clean energy ventures. Educational institutions, community initiatives, and campaigns are imperative for social awareness, knowledge empowerment and capacity building towards societal provocation to sustainable energy practices. Hence, energy literacy through academic curriculum and community training is imperative to reorient human practices. Furthermore, the main purpose of energy literacy is to bring an awakening of non-sustainable anthropogenic

¹ Ammar Abulidbeh and others, ‘Navigating the Confluence of Artificial Intelligence and Education For Sustainable Development in the Era of Industry 4.0: Challenges, Opportunities, and Ethical Dimensions’ (2024) 437 *Journal of Cleaner Productions* 140527.

activities and provoke societies into actions that facilitate deep decarbonizations².

The importance of energy literacy is already gaining increased recognition in a wide range of policy instruments and national strategies in Nigeria. The Nigerian National Energy Policy of 2022 specifically aims to ‘promote education, information, and public awareness campaign on energy efficiency and conservation best practices.’ It also aims to ‘promote public workshops on solar energy, biomass, biogas, wind and other renewable energy resources to ensure their adoption and market penetration.’³ The National Policy on Education of 2013 also elaborates the importance of education in advancing social, economic and environmental development in Nigeria. Similarly, the Sectorial Action Plans for Nigeria’s Nationally Determined Contribution 2017; the National Renewable Energy and Energy Efficiency Policy (NREEEP) of 2015; and Renewable Energy Master Plan (REMP) of 2014 also aim to improve energy literacy and promote sustainable energy practices in Nigeria. Given these strong policy emphases on energy literacy, a wide range of public awareness and sensitisation programs that aim to advance sustainable lifestyles and environmental awareness amongst the entire people of Nigeria are on the rise in the country. For example, virtually all higher education institutions in Nigeria have one or more forms of energy studies and environmental education programs, ranging from core or elective courses that are part of degree programs to extra-curricular initiatives that aim to stimulate energy literacy.⁴

² Wan Mohamad and others, ‘A systematic literature review on citizen awareness of energy’ (2022) 7(10) MJSSH e001803.

³ Nigerian Electrification Project
<https://www.energy.gov.ng/Energy_Policies_Plan/APPROVED_REVISIED_NEP_2022.pdf>accessed 13 August 2025

⁴ Afe Babalola and others, ‘Advancing environmental education for sustainable development in higher education in Nigeria: Current challenges and future directions’ (2021) 13(19) Sustainability 10808.

In Nigeria, the renewable energy potential is overshadowed by fossil fuel dominance⁵. Nigeria runs a resource-based economy generated from crude oil export⁶. Hence, policymakers enact pro-fossil fuel policies that promote human capacity and skill building in upstream and downstream fossil fuel activities. Also, the strategies to promote clean energy education including SE and energy literacy in Nigeria is grossly underdeveloped⁷. Furthermore, two out of ten Nigerian citizens are uneducated, leaving Nigeria with a literacy rate of 59.6%⁸. Various studies in Nigeria have highlighted the low level of sustainability awareness and adoption of energy saving measures in households. For example, a study conducted in a secondary school in three zones in Niger state revealed that 87.5% out of 23,456 students do not integrate energy efficiency measures in households⁹.

Hence, despite the increased awareness on energy literacy as a tool for advancing the SDGs, weaponizing education towards the advancement of energy decarbonization and sustainable development in Nigeria is still in the nascent phase¹⁰ due to a number of legal, institutional, governance and policy challenges that continue to hinder the rapid development and implementation of clean energy education at the local level¹¹. This includes broadly framed energy policies that do not specifically address the peculiar challenges of SE and energy literacy, coupled with limited budgetary

⁵ Usman Dodo and others, 'Renewable Energy Readiness in Nigeria: A Review Focusing on Power Generation' (2021) 1(1) Uniabuja Journal of Engineering and Technology 115–144.

⁶ Queendarlyn Nwabueze and others, 'Production and Economic Analysis of Enhanced Oil Recovery (EOR) by Water Flooding: A Case Study of Reservoir OD-48 in The Niger Delta' (2020) 62(1) Petroleum and Coal 103–113; Nosayaba Oka, 'Sustainable development: 2015 climate change agreement and Nigeria's commitment to its nationally determined contributions' (2020) 11(1) Management of Sustainable Development.

⁷ Felix Aberu and others, 'The relationship between education and sustainable development in Nigeria' (2022) 11(24) Journal of Public Administration Finance and Law 7–16.

⁸ Adebukola Osunyanmi, 'Prioritizing Quality Education in Nigeria: a Commitment to Sustainable Development Goals' (2018) 6 IJASEPSM 2.

⁹ Tswanya Saba and others, 'Investigating energy literacy of secondary education students in Niger state' 3, 156–170.

¹⁰ Felix Aberu and others, 'The relationship between education and sustainable development in Nigeria' (2022) 11(24) Journal of Public Administration, Finance and Law 7–16.

¹¹ Michael Agbabiaka and others, 'Institutional and Policy Barriers to Implementing Sustainable Education in Nigerian Higher Institutions' (2025) 8 Journal of Contemporary Education Research 8.

allocation for integrating sustainable education into the educational curriculum and research continue to hinder the scope and reach of clean energy education at all levels of formal education. Understanding the practical challenges to SE, energy literacy programs, green skill acquisition and citizen participation can help us plot a clear path for reforms.

This article examines the existing gaps in the design and implementation of SE & energy literacy programs in Nigeria. It provides recommendations on policy, legal, governance and institutional improvements that would increase the effective implementation of clean energy education as tools for advancing sustainable development in Nigeria. The article is divided into five sections. After this introduction, Section 2 examines the nature, scope and benefits of energy literacy. Section 3 highlights the key policy, legal, institutional and governance challenges to the effective implementation of energy literacy programs and initiatives in Nigeria. Section 4 offers recommendations on how to address the salient gaps to implementation in Nigeria. Section 5 is the concluding section.

2. ENERGY LITERACY AND SUSTAINABLE DEVELOPMENT: SCOPE, NATURE AND ELEMENTS

Current definitions of energy literacy go beyond the individual or household definitions as described by¹²; it presents a broader conceptualization which integrates finance, psychological, social and technological innovation. Energy literacy and sustainable energy education create a comprehensive awareness of the economic, social and environmental impacts through the energy lifecycle including generation, use, distribution and storage.¹³

¹² Justyna Chodkowska-Miszczuk and others, 'Local communities' literacy as a way to rural resilience -An insight from inner peripheries' (2021) 14 *Energies* 2575.

¹³ Helena Malkki and others, 'An overview of life cycle assessment (LCA) and research-based teaching in renewable and sustainable energy education' (2017) 69 *Renewable and Sustainable Energy Reviews* 218–231; Oscar Santillán and others, 'Energy literacy: A systematic review of the scientific literature' (2023) 16 *Energies* 7235.

Energy literacy is conceptualized in three domains based on the cognitive and normative influence on civil society: Knowledge/Awareness, Attitude and Behavior¹⁴.

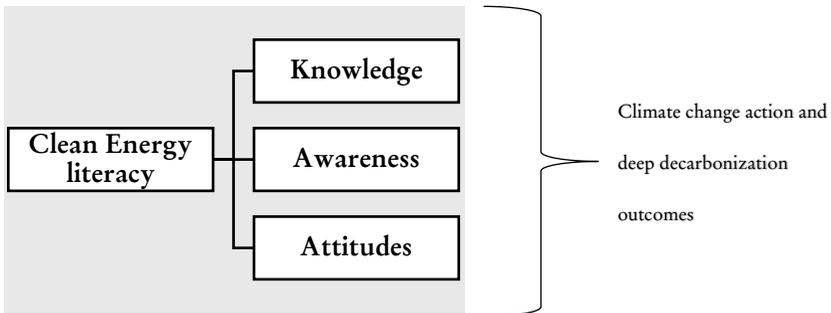


Figure 2.19: The three domains of energy literacy (Miszczuk et al. 2021: 2).

The *Knowledge domain implemented* through energy literacy initiatives captures the foundational information regarding climate change, atmospheric GHG emissions, domestic energy efficiency and conservation, and renewable resources as an alternative energy source. This generates a cognitive and conceptual understanding of energy theories, rules and life cycle processes of transformation, promoting reliability in everyday life towards a sense of *Awareness*. This should create some personal conviction towards environmental protection and the urgent need to deploy deep decarbonizations strategies and promote

¹⁴ Justyna Chodkowska-Miszczuk and others, 'Local communities literacy as a way to rural resilience -An insight from inner peripheries' (2021) 14 *Energies* 2575; Quy Van Khuc and others, 'Improving energy literacy to facilitate energy transition and nurture environmental culture in Vietnam' (2023) 7 *Urban Sci* 13.

the transition to a green economy, known as the *Attitude domain*. This level of energy literacy builds on the cognitive stimulations from knowledge and awareness towards a provoked action or collective movement into climate change action such as formulating and deploying innovative deep decarbonizations strategies through legitimized grassroots innovation projects such as establishment of eco-entrepreneurial ventures, community awareness and education campaigns, community energy consultation services, etc. The attitude domain of energy literacy education should provoke structured social movements and collective participation that innovates a space to raise awareness that energy is a social necessity subjective to collective decision-making¹⁵.

To facilitate deep decarbonization strategies to achieve climate action and low-carbon transition plans, all three domains of clean energy education must be attained to pull the magnitude of mass societal participation and inertia required to deploy deep decarbonization strategies. Successful administration of SE and energy literacy programs will equip civil society and communities with the necessary tools to participate and contribute towards energy transition and a decarbonized economy. As opposed to passed climate action strategies, described as weak and integrating few actors from a top-bottom approach¹⁶, but with the current energy transition framework, integration of SE and energy literacy programs, provokes multi-stakeholders and, most importantly, citizen participation are key as they are directly affected by climate change.

The engineering of a supportive environment through pro-sustainability policies promotes R&D, boosts innovation and social enterprise that engage in energy decentralization and decarbonization. For example, eco-entrepreneurship drives sustainable education, which is a major component for generating and disseminating energy literacy, and renewable energy information and provoking societal transformation¹⁷.

¹⁵ Nives DellaValle and others, 'Empowering energy citizenship among the energy poor' (2022) 89 *Energy Research & Social Science* 102654.

¹⁶ *ibid*

¹⁷ Valenrie Valenrie and others, 'Fostering eco-entrepreneurial intention amongst students' (2021) *Proceedings of the international conference on economics, business, social and humanities*; Wan Mohamad and others (n 2).

The role of eco-entrepreneurship from a social entrepreneurial perspective is to educate people with the objective of societal reorientation, awareness, acceptance, and skill-building. Eco-entrepreneurial actions manifest as green educators and green energy advocates can promote behavioral and societal transformation, which emerges in novel social roles and responsibilities. These objectives are strategically deployed through educational curriculums, eco- training centers, energy campaigns, accelerator, incubator training programs, and lifelong learning programs deployed by SMEEs¹⁸. Also, through effective pedagogical strategies' and learning initiatives in educational institutions, green educators can empower civil society on SE and energy literacy and enhance citizen capacity to participate in deep decarbonizations practices.

Investment in citizen and community clean energy education is imperative to achieve climate action and low-carbon transition plans while promoting a sustainable economy¹⁹. To address the scale and magnitude of climate change action requirements, society must develop high capabilities to generate required techno-innovations, eco-services, eco-products and management strategies, and create an effective green labor force while broaden green human capital pool²⁰. Various studies have assessed factors that impacts clean energy education, green skill acquisition and citizen participation to interrogate climate change impacts and generate innovative mitigation strategies. For example, empirically identified infrastructure, regulatory landscape, education and training as major determining factors on engagement of sustainability action²¹. Also, a case study assessed the impact of peer-to-peer learning (P2PL) on community

¹⁸ Katri-Liis Lepik and others, 'Towards an understanding of how a higher education institution can enhance the impact of social enterprises through incubation' (2023) 18(1) *Management & Marketing* 36–52.

¹⁹ Yaoyi Zhang, 'Promoting sustainable growth through eco-innovation, energy transition, and human capital: a comparative analysis of G-7 economies' (2024) 57 *Economic Change and Restructuring* 50.

²⁰ *ibid*

²¹ Mai Khuong and others, 'The influence of entrepreneurial ecosystems on entrepreneurs' perceptions and business success' (2022) 24 (2) *Gadjah Mada International Journal of Business*.

sustainable development and skill building²². Another analysis of the role of education discussed the emergence of sustainable education as a promoter of environmental, social and economic development²³. He takes the discussion further by defining ‘cultural sustainability education’ as an approach to social cognitive and normative re-orientation towards a sustainability awakening, a sense of responsibility and finally, the design and implementation of sustainable mitigation practices.

The benefits associated with community knowledge empowerment through SE and energy literacy boost the capabilities of citizens to generate locally sourced renewable energy, eco-ventures, promote energy autonomy and affordability, generate local green jobs, and a democratized energy transition²⁴. Furthermore, the cumulative effects of renewable energy community initiatives, energy efficiency measures, and renewable energy integration into energy mix contribute significantly towards the achievement of national climate action and low carbon transition plans. They promote a democratized bottom-top energy governance system with activities and initiatives that decentralized and decarbonize energy systems.

2.2 Contextualization in SE and Energy Literacy Administration

Researchers advise that green educators should use a multi-platform and context-based learning approach to sustainable energy and energy literacy education²⁵. This emphasizes the need for a whole Institution Approach (WIA) in all areas of sustainability education²⁶. The WIA highlights the political, socio-economic and institutional realities of a jurisdiction as the framework to administer clean energy education to citizens and

²² Joe Campbell and others, ‘Sustainable community development through peer-to-peer learning in the online and in-person classroom’ (2024) 25(8) *International Journal of Sustainability in Higher Education* 1803–1819.

²³ Yi-Chen Lai and others, ‘Effective teaching and activities of excellent teachers for the sustainable development of higher design education’ (2019) 12 *Sustainability* 28

²⁴ Jonathan Cloke and others, ‘Social energy systems approach to community renewable energy projects in the global south’ (2017) 31 *Energy Research & Social Science* 263–272.

²⁵ Wan Mohamad and others, ‘A systematic literature review on citizen awareness of energy’ (2022) 7(10) *MJSSH* e001803.

²⁶ Jorrit Holst, ‘Towards coherence on sustainability in education: a systematic review of Whole Institution Approaches’ (2023) 18 *Sustainability Science* 1015–1030

community members. This promotes coherence between what is thought and what citizens perceive within the society and eliminates contextual vacuums in sustainable energy education.²⁷

On this backdrop, strategies must be adopted based on socio-economic realities to promote SE and energy literacy including strategies that encourage fossil fuel transition, innovative strategies for RE integration into energy mix, R&D in clean technologies, and utilization of SMEEs and energy citizens to deploy legitimized energy literacy and sustainable education initiatives necessary for the cognitive and normative transition from citizen to effective human capital required to innovate eco-products, services, technologies and strategies to achieve deep decarbonizations targets. This transition is theoretically captured in a systematic analysis of Kolb's theory of experiential learning, which anatomized distinct cognitive and normative transition stages of knowledge building²⁸. This revised version captures four learning processes with contextualization at the core of learning: contextually rich concrete experience, critical reflective observation, contextual-specific abstract conceptualization and pragmatic active experimentation²⁹.

²⁷ Shuyu Qi and others, 'Co-Creation in Contextual Competences for Sustainability: Teaching for Sustainability, Student Interaction and Extracurricular Engagement' (2023) 15(21) Sustainability 15437

²⁸ Thomas Morris, 'Experiential learning – a systematic review and revision of Kolb's model' (2019) 28(8) Interactive Learning Environments 1064-1077.

²⁹ Information Technology University of Florida, 'Kolbs four stages of learning' <<https://citt.ufl.edu/resources/the-learning-process/types-of-learners/kolbs-four-stages-of-learning/>> accessed 13 August 2025

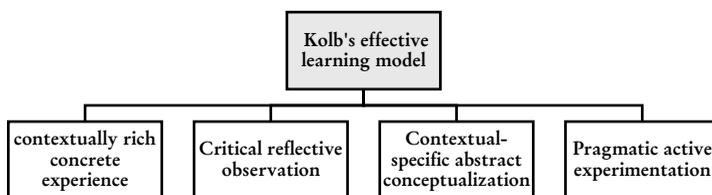


Figure 2.20: Kolb's effective learning model (Center for Instructional Technology and Training 2024)

Contextually rich concrete experience captures the initial exposure to novel information through teaching platforms such as awareness and behavior training and campaigns deployed by local green councils, green education centers; *critical reflective observation* describes observer search for meaning and relatedness (context) from exposure to novel information via discussion groups and collaborations with green institutions, *contextual-specific abstract conceptualization* captures the mind-mapping phase where synthesized knowledge is projected into real-life practical issues to seek problem-solving solutions via Incubator hubs, accelerators and blogs; and *pragmatic active experimentation* promotes the proactive implementation of contextualized problem-solving solutions to interrogate real-life challenges using real-world tools, sustainable practices and innovations such as impactful SBMIs, SMEEs and energy citizens.³⁰

Citizens can attain the level of contextualizing problem-solving solutions and contributions in the area of sustainability, energy and climate change action by undergoing a concrete experience in SE and energy literacy which includes new information exposure, active participation and relatability to current world problems³¹. A crucial aspect of achieving climate action and low-carbon transition plans is that strategies must be deployed to provoke citizens into active involvement in energy systems and transition from conventional consumers to active prosumers and

³⁰ *ibid*; see also Mehmet Biresselioglu and others, 'Empowering energy citizenship: Exploring dimensions and drivers in citizen engagement during the energy transition' (2024) 11 Energy reports 1894-1909

³¹ Thomas Morris (n 28).

active formulators of multi-objective SMEEs³². However, to administer concrete and contextual experience, a balance between social empowerment, environmental protection, and economic prosperity is required.

3. BARRIERS TO THE IMPLEMENTATION OF ENERGY LITERACY IN NIGERIA

The barriers to effective administration of SE and energy literacy are influenced by the socio-political-economic context of a geographical region or jurisdiction, which must be considered and interrogated to promote green human capacity development³³. Furthermore, though clean energy education is a prerequisite for effective individual and collective engagement in climate action, energy literacy and education alone may not be sufficient to facilitate citizen engagement³⁴. There are other factors that influence attitude and sustainability inertia, such as government willingness to allocate necessary funding, and formulate pro-sustainable education policies that support R&D, synthesis sustainable education into curriculum, provision of adequate infrastructure and a favorable environment and need of specialized governance institutions in education³⁵³⁶³⁷. In Nigeria, the barriers that limit the rapid adoption of SE and energy literacy in Nigeria include lack of clear policy provisions for sustainable education, unclear and weak implementation of relevant laws,

³² Mehmet Bireselioglu and others, 'Empowering energy citizenship: Exploring dimensions and drivers in citizen engagement during the energy transition' (2024) 11 Energy reports 1894-1909

³³ Samantha Nielsen, 'Examining the Psychology and Human Behavior of Sustainable Living: The Impact of Socioeconomic Status on Climate Change Education' (2023) University of Nebraska

³⁴ Justyna Chodkowska-Miszczuk and others (n 12).

³⁵ Abubakar Boyi, 'Education and sustainable national development in Nigeria: challenges and way forward' (2012) 14(8) International Letters of Social and Humanistic Sciences 65-72.

³⁶ Jawahitha Sarabdeen, 'The Role of Government in Driving Sustainability: A Public Policy Perspective' (2024) 8(3) Emerging Science Journal 1184-1200

³⁷ Inga Zaleniene, 'Higher Education For Sustainability: A Global Perspective' (2021) 2(2) Geography and Sustainability 99-106.

limited funding, infrastructure deficiencies and low skill and capabilities. These barriers are further discussed as below:

A. Lack of clear provisions for sustainable education in policy frameworks

The politics of education plays a major role in the development of educational practices, institutions and systems³⁸. The Nigerian government has made some progress to engineer an enabling ecosystem for clean energy education, developed and transcribed in the context of the energy industry through the *Nigerian National Energy Policy of 2022; the Sectorial Action Plans for Nigeria's Nationally Determined Contribution (SAPNNDC) 2017; the National Renewable Energy and Energy Efficiency Policy (NREEEP) of 2015; as well as the National Policy on Education of 2013*. These plans propose strategies to nationalize international sustainable development agenda including SE and energy literacy to attain localized sustainability awareness and education towards the advancement of climate change action. However, these plans lack clear and comprehensive strategies and provisions for clean energy education advancement. For example, section 3.3 of the SAPNNDC mentions five priority areas for sustainable economic advancement with no mention on the educational sectors. Yet, scholarly advocations for education to be considered as a national priority is on the rise³⁹. Although current government policies and plans have formulated some level of societal awareness and social re-orientation on energy, there is a lack of concrete learning and attainment of pragmatic active participation which provokes the proactive implementation of contextualized problem-solving solutions, sustainable practices and innovations amongst Nigerian citizens and community members⁴⁰. Scholars call for more education and

³⁸ Vitalis Ugwu, 'Politics of Education in Nigeria: Government Influence and Its Implications' (2025) 4(2) Indonesian Journal of Education and Social Science 288–305.

³⁹ Abdul-Lateef Ahmodu and others, 'Educational budget allocation and economic growth in Nigeria' (2022) 1 Fuoye Journal of Management, Innovation and Entrepreneurship 1.

⁴⁰ Edwin Umoh and others, 'A template for promoting energy conservation in Nigeria's residential sector' (2021) 32 International Journal of Sustainable Energy Planning and Management 125–137.

awareness amongst senior level ministries, departments and agencies (MDAs) to address ambiguity and formulate empirically-valid policies to advance clean energy education⁴¹.

B. Unclear and weak implementation of relevant laws

The implementation barriers of the (National Environmental Standards and Regulations Enforcement Agency) NESREA Act and institutionalized agency -NESREA, limit the advancement of clean energy education. For example, the NESREA Act is the main regulatory instrument on environmental protection in Nigeria. As mentioned in section 1 & 2 of the act, the NESREA is the primary government agency responsible for enforcing guidelines, regulations, and laws related to environmental protection and preservation through compliance audits and assessments. In addition, the agency is tasked with conducting environmental awareness programs and sustainability education workshops for the community. Its enforcement powers are guided by the Constitution of the Federal Republic of Nigeria. However, gaps relating to weak regulatory enforcement due to corruption and low technical competence of regulators exists⁴². This has limited the enforcement and administration of clean energy education and environmentally-friendly practices leading to lack of societal awareness, low competence of green educators and low interest in eco- entrepreneurial activities. To address this issue, scholars call for strengthening the regulatory framework and building capacity to successfully implement the tasks of NESREA for SE and energy literacy advancement in Nigeria⁴³.

⁴¹ Adesoji Adelaja, 'Barriers to national renewable energy policy adoption: Insights from a case study of Nigeria' (2020) 30 *Energy Strategy Reviews* 100519.

⁴² Mantu Ishaku, 'NESREA and the challenge of enforcing the provisions of the environmental impact assessment Act in Nigeria' (2019) *SSRN Electronic Journal*

⁴³ Cleverline Brown, 'The legislative and institutional framework for compliance and enforcement in the petroleum sector in Nigeria: A review' (2021) 1(2) *IJAMRS* 23–33.

C. Limited funding for educational and research institutions

To address the implementation peculiarities of educational polices in developing countries like Nigeria, the United Nations Educational, Scientific and Cultural Organization (UNESCO) recommended no less than 26% of annual national financial pool to be allocated to the educational sectors⁴⁴. However, financial analysis of Nigeria from 1960-2023 indicates that allocated funds for the education sectors is approximately 5.94% which is significantly less than the UNESCO benchmark⁴⁵. Though government interventions such as the Tertiary Education Trust fund (TETFund) and Universal Basic Education Commission exist, education is under-funded in Nigeria, crippling the potential of educational systems, practices and institutions from advancing clean energy education⁴⁶. This has led to the deterioration of education standards due to lack of political will, low funding and corruption, acting as barriers to the successful integration and adoption of SE and energy literacy programs in the educational systems⁴⁷. The lack of funding and innovation in the educational system in Nigeria has limited the formulation and administration of a dynamic and robust renewable energy program⁴⁸.

D. Infrastructural deficiencies

Infrastructure and strategic infrastructure investment are essential to achieving sustainable education and social awareness of renewable energy sources⁴⁹. Generally, education system in Nigeria is pledged with poor research culture, dilapidating infrastructure, outdated facilities, inadequate

⁴⁴ Francisca Odigwe and others, 'Trend Analysis of the Nigerian Budgetary Allocation to the Education Sector from 2009 – 2018 with Reference to UNESCO'S 26% Benchmark' (2019) 14(1) IJEB.

⁴⁵ Emmanuel Ohaegbulem and others, 'On Nigeria's Budgetary Allocations to The Education Sector (1960-2023) In View of UNESCO'S Benchmarks' (2023) 11(4) International Journal of Mathematics and Statistics Studies 32–44.

⁴⁶ Michael Agbabiaka and others (n 11); Vitalis Ugwu (n 38); Vitalis Ugwu (n 38)

⁴⁷ Abdul-Lateef Ahmodu and others (n 39)

⁴⁸ Adebukola Osunyanmi (n 8).

⁴⁹ Fisayo Fagbemi and others, 'Enhancing sustainable infrastructure development: A boon to poverty reduction in Nigeria' (2022) 1 World Development Sustainability 100006.

educators and low funding⁵⁰; yet education is essential to achieving sustainable development in any jurisdiction⁵¹. Innovative pedagogies and digital tools are required to provide quality education and augment clean energy education, however, Nigerian teaching strategies rely heavily on in-person learning with limited integration of classroom technologies⁵². These deficiencies negatively impact the ability of educational and technical institutions to provide necessary resources, materials, and equipment for students to engage in experimental and experiential learning. It significantly limits the ability to administer contextual and concrete learning on clean energy education. This implies that there is a need for green infrastructure funding and upgrading facilities in education, technical and research institutions to improve performance on delivering SE, energy literacy programs and courses⁵³. Also, major curriculums in the Nigerian tertiary institutions focus on reservoir engineering and Petroleum refinery process as main courses for chemical engineering students⁵⁴. This implies that institutional funding priorities will be on the main courses leaving other courses related to SE and energy literacy with limited or no funding. Additionally, the curriculum for renewable energy is mostly limited to engineering students which limits other students from other subject areas from accessing educational and technical training in clean energy education⁵⁵.

⁵⁰ Mike Ozekhome, 'The place of education in a crisis-ridden Nigeria' (2023) 13(2) *The Journal of Sustainable Development, Law and Policy* 234–263.

⁵¹ Ammar Abulibdeh, 'Navigating the confluence of artificial intelligence and education for sustainable development in the era of industry 4.0: Challenges, opportunities, and ethical dimensions' (2024) 437 *Journal of Cleaner Production* 140527.

⁵² Thank God Nwuke and others, 'Managing Education in Nigeria and The Emerging Technologies in the 21st Century Classroom' (2025) 9(1) *World Journal of Innovation and Modern Technology*.

⁵³ Fisayo Fagbemi and others (n 49).

⁵⁴ Steve Eshiomogie and others, 'Knowledge, perception and awareness of renewable energy by engineering students in Nigeria: A need for the undergraduate engineering program adjustment' (2022) 6 *Clean Engineering and Technology* 100388.

⁵⁵ *ibid*

E. Low skill and capabilities to implement sustainable education

The advancement of SE and energy literacy towards climate change action and sustainable development is significantly linked to human capital development⁵⁶. The educationalist, through schools, universities and eco-ventures provide the trainings and skill building that promote cognitive and normative transition towards sustainability and energy efficiency practices on a local scale⁵⁷. However, the lack of skill and capabilities of institutions, educators, faculty members and ecopreneurs to integrate the sustainability framework leads to outdated curriculum, ineffective pedagogical approach to clean energy education and lack of empirical data for policy makers to formulate empirically-valid educational policies for clean energy education advancement⁵⁸. This is evident in recent investigative studies to assess the level of sustainability and energy literacy awareness amongst households and university students in Nigeria. A study in the Southern western region of Nigeria assessed the energy efficiency practice among university students and it was found that 81.4% have low awareness of energy efficiency practice and have not received any formal training on sustainable energy education⁵⁹. Another study in Katsina state, examined 192 urban and rural households to assess the preferred cooking energy, and it was found that firewood and charcoal were the prevailing sourcing of cooking energy⁶⁰. Advocates for professional development programs, technology learning, and mentorship programs for teachers are on the rise (Gloria_2025). Also, boosting technology integration, building the capacity of administrator and adopting innovative strategies to strengthen institution support⁶¹.

⁵⁶ Gloria Nwachukwu, 'Human capital development: A driver for educational improvement in Nigeria' (2024) 12(6) *British Journal of Education* 30–39.

⁵⁷ Dorah Akporehe and others, 'Innovations for Attaining Sustainable Development Goal: Persisting in Schools in Nigeria' (2021) 11(4) *Journal of Educational and Social Research*.

⁵⁸ Michael Agbabiaka and others (n 11).

⁵⁹ Emmanuel Olanipekun and others, 'A Study of Awareness and Electricity Use Behaviour of On-campus Residence Students in Nigeria' (2020) 54 *IJSBAR* 2.

⁶⁰ Mannir Sani and others, 'Cooking Energy Consumption, Preferences and Effect Among Rural and Urban Households in Katsina State, Nigeria' (2024) 7(3) *African Journal of Environment and Natural Science Research* 125–141.

⁶¹ Oghogho Akpata and others, 'Nigeria's Energy Transition Plan: A journey towards equity, fairness and inclusion' (2022) *Templars*.

As described above, the implications to education are multifaceted. These barriers have limited Nigeria's ability to capture the potential in clean energy education as a viable tool to advance climate change action and sustainable development. Scholarly, recommendations have called for a more supportive learning environment, adequate funding and clear measurable policy goals at all levels of the educational system⁶². Furthermore, scholars are advocating for government and citizen participation in promoting energy literacy and SE and its integration into all educational institutions in Nigeria⁶³. Also, Nigeria required rural infrastructure and electrification projects while equipping local dwellers with knowledge and skills to recognize and implement local energy initiatives including renewable energy initiatives to alleviate energy poverty and promote economic empowerment^{64,65}.

On this back drop, Nigeria will need to adopt superior strategies to address barriers and promote energy literacy among the Nigerian population. Therefore, it is imperative to draw lessons from jurisdictions with high Environmental Performance Index (EPI) such as the UK to capture best policy and legal strategies, recommendations and guidelines that support the broad dissemination of SE and energy literacy.

4. PRACTICAL IMPLEMENTATION OF ENERGY LITERACY: LESSONS FROM THE UK

This section unpacks the UK best practices and innovative strategies that generate a supportive environment for clean energy education, social awareness and a high sustainability context. It examines the role of comprehensive national strategies that have fostered a supportive environment for eco-entrepreneurship in the UK by “transitioning away from large-scale, centralized, fossil fuel-based energy systems” and the

⁶² Felix Aberu and others (n 7).

⁶³ Tswana Saba and others (n 9).

⁶⁴ Folorunsho Ajide and others, ‘Energy poverty and shadow economy: evidence from Africa’ (2024) 18(6) *International Journal of Energy Sector Management* 1982–2009.

⁶⁵ Mannir Sani and others (n 60).

integration of small-scale renewable off-grid solutions. The progress made by the UK in mainstreaming clean energy education as a whole system shows the importance of comprehensive policy, legal and institutional frameworks that emphasize public sensitization and awareness, and also provide resources for effective implementation. The next section evaluates the status of implementation of clean energy education in the UK.

A. Prioritization of sustainable education and clear provisions in policy design

The *Sustainability and Climate Change Strategy (2022)* formulated by the UK Department for Education (DfE) based on recommendations from institutionalized sustainability focused agencies and committee including the Committee on Climate Change and the Green Jobs Taskforce from which multiple innovative strategies and schemes are implemented⁶⁶. For example, the **Action for Climate Empowerment (ACE)** aims at building social capacity to engage in sustainability initiatives via information dissemination, trainings, public awareness and climate change education⁶⁷. This includes collaborations with the DfE and educators, students, NGOs, and community members to formulate informed and impactful decarbonization strategies through youth panels and interactive platforms and education initiatives like the *Green Home Grant Skills training* for 16-18 yrs. old, on energy efficiency strategies and green technology utilization promoting socio-technical abilities in the youth population⁶⁸. Also, the collaborations with the *Institute for Apprenticeships and Technical Education* and multiple technological institutes for remote training and apprenticeships in green technologies for the youth population. Other initiatives implemented through the UK DfE, in

⁶⁶ *Sustainability and climate change: a strategy for the education and children's services systems* (2023) <https://www.gov.uk/government/publications/sustainability-and-climate-change-strategy/sustainability-and-climate-change-a-strategy-for-the-education-and-childrens-services-systems> accessed 13 August 2025.

⁶⁷ Action for Climate Empowerment, <https://unfccc.int/topics/education-and-youth/big-picture/ACE#Education> accessed 13 August 2025.

⁶⁸ United Kingdom of Great Britain and Northern Ireland's Nationally Determined Contribution (2022) <<https://unfccc.int/sites/default/files/NDC/2022-09/UK%20NDC%20ICTU%202022.pdf>> accessed 13 August 2025

England, include *Climate Leaders Awards* which encourages knowledge and skill building in youth and young children and the establishment of *National Education Nature Park* which is a comprehensive proactive learning initiatives that integrates advanced technologies to promote skills in digital mapping and data analysis regarding innovations in climate change action⁶⁹. In Scotland, the *Learning for Sustainability (LFS) Action Plan* formulated by the *Learning for Sustainability National Implementation Group* and *One Planet Schools Working Group*; sets a 2030 target to ensure all educational experiences consist and are coordinated towards sustainability objective⁷⁰. Under the auspice of the DOE, these initiatives aggressively integrate SE and energy literacy into education institutions and curriculum.

B. Supportive legal framework for citizens access to sustainable education

Multiple UK legislation infer to clean energy education through mandates for generating strategies to boost climate change action and practices on a local scale. This includes the UK Climate Change Act (CCA) 2008 and Well-being of Future Generations (WFG) Act 2015. In pursuit of Part 1, Section 10(2) of the CCA 2008, mandates generation of innovative strategies implicated with carbon budget, including the need for ‘scientific knowledge’, relevant technologies, economic and policy. Furthermore, Part 1, Section 15(1-2), mandates strategies that target local sustainability and climate change action. Secondly, under Part 1, section 3 of the WFG Act 2015, public bodies which includes educational institutions are mandated to implement strategies that advance the sustainability and well-being objective of the Welsh jurisdictions. Furthermore, a comprehensive monitoring and assessment framework to ensure compliance to integration and quality of clean energy education via periodic school

⁶⁹ NASUWT, the Teachers’ Union, ‘Sustainability and climate change strategy (England)’ <https://www.nasuwt.org.uk/advice/in-the-classroom/assessment-curriculum-and-qualifications/sustainability-and-climate-change-strategy-england.html#:~:text=The%20Climate%20Leaders%20Award%20has,with%20colleges%2C%20schools%20and%20nurseries> accessed 13 August 2025.

⁷⁰ *Learning for sustainability action plan* <<https://education.gov.scot/media/cx1lwhvu/learningforsustainability-vision2030actionplan.pdf>> accessed 13 August

inspections under the LfS policy exists. Also, Estyn inspections are carried out to ensure proper pedagogy delivered through curriculum design and initiatives for schools located in Wales. Additionally, the Education and Training Inspectorate (ETI), provides monitoring and evaluation of sustainable education for all school levels in Northern Ireland, UK.

Finally, the recently updated UK Code for Higher Education integrates sustainability as a key indicator of quality education⁷¹. This provides a framework for the rapid integration of SE and energy literacy programs across the UK educational curriculum. Through these legislation, public bodies, educational institutions, schools, and education providers have a legal duty to transform pedagogical approaches towards clean energy education.

C. Multiple funding allocations for sustainable education advancement

In the UK, broad financial channels through government-approved funds boost infrastructure development, R&D, generation and integration of advanced green technologies and initiatives that encourage contextualized, experimental and experiential learning. Such funds include the UK Infrastructure Development Plan (UKIDP) 2025 and UK Research and Innovation priority funds. Under the UKIDP, with an investment of more than £481 millions, aims to advance infrastructure developing relating to research and innovation in areas that include climate change action such as the ‘Floods and Droughts Research Infrastructure’ (FDRI), the ‘John Innes Centre and The Sainsbury Laboratory Next Generation Infrastructure’ to catalyzed capabilities in Net Zero via an interdisciplinary approach; ‘Smart Data Research UK’ aimed to transform data storage and analytics integrating by generating advanced

⁷¹ Sustainability exchange, ‘Sustainability included in revised higher education Quality code for the first time’ https://www.sustainabilityexchange.ac.uk/news/sustainability_included_in_revised_higher_educat#:~:text=the%20first%20time-,Sustainability%20included%20in%20revised%20higher%20education%20Quality%20Code%20for%20the,the%20Code%2C%20sustainability%20was%20absent accessed 13 August 2025.

technologies⁷². Secondly, the UK Research and Innovation priority fund, with allocated funds of about £ 202.62 million, facilitate an enabling environment for clean energy education through strategic ‘themed initiatives and programs’ that advance clean energy education, sustainability and climate change action. These themes include, ‘Landscape Decisions’ which implicates actor from multiple disciplines to design land use and development based on sustainability objective across the UK; ‘Constructing a Digital Environment’ funds pilot studies that integrate advanced technologies such as sensors and monitoring tools to capture data on long-term environmental changes for further empirical studies; ‘UK Climate Resilience’ which funds solution projects on flooding and other environmental risks⁷³. These strategic infrastructure development and advanced research initiatives will provide an enabling environment for the rapid administration of clean energy education in the UK.

D. Institutionalization of strategic incubator and accelerator hubs

Through knowledge hubs such as the **Sustainability Support for Education**, an online resource tool established by the UK DfE which provides useful information for educators to advance sustainability initiatives in England- based schools⁷⁴. Also, under the auspice of the DfE, the **Education and Training Inspectorate** provides independent policy recommendations and school inspections conducting trainings, ensuring standards for youth organizations, work-based learning organizations, preschool through to college and further education⁷⁵. In Scotland, the *Learning for Sustainability (Lfs) in Initial Teacher Education (ITE)* integrates sustainability objectives into training teachers via workshop, conferences and skill building initiatives for university teachers to advance

⁷² UK Research and Innovation, ‘Infrastructure Fund Project’ <<https://www.ukri.org/what-we-do/creating-world-class-research-and-innovation-infrastructure/funded-infrastructure-projects/>>accessed 12 August

⁷³ UK Research and Innovation, ‘Strategic Priorities Fund’ <<https://www.ukri.org/what-we-do/strategic-priorities-fund/>>accessed 13 August

⁷⁴ TPX impact <<https://www.tpxicompany.com/about/news-hub/news/df-digital-support-hub-education>>accessed 13 August

⁷⁵ Education and Training Inspectorate Empowering Improvement <<https://www.etini.gov.uk/about-us>>accessed 12 August 2025

clean energy education⁷⁶. Lastly, the Scotland-based *Regional Centre of Expertise on Education for Sustainable Development* provides training, conferences and publish policy reviews to support sustainability learning through strategic collaborations with key actors, educators, private sector practitioners to implement national and local events that boost sustainability awareness and teaching⁷⁷.

4. ADVANCING ENERGY LITERACY IN NIGERIA: RECOMMENDATIONS.

Advancing energy literacy requires the formulation of supportive fiscal and policy instruments, strategic infrastructure and technology generation, and international collaborations. To address barriers to energy literacy in Nigeria, strategies that transition the energy context of Nigeria towards an alternative to fossil-fuel-based energy generation, energy conservation contributes to a paradigm shifts in social attitudes regarding harnessing energy resources and consumption. Based on the UK best practices, recommendations are as follows:

A. Formulation of national strategies and priorities on sustainable education advancement

To formulate national strategies that advance sustainable education and energy literacy programs in Nigeria, it is recommended that the Ministry of Education of Nigeria in collaboration with strategic institutionalized agencies such as *Inter-Ministerial Committee on Renewable Energy and Energy Efficiency and The Council, National Environmental Standards and Regulations Enforcement Agency* (NESREA), and the Rural Electrification Agency (REA) to formulate a national plan similar to the UK Sustainability and Climate Change Strategy (2022) such as the *Climate Change and Sustainable Education Strategy*. This national

⁷⁶ Scottish Council of Deans of Education <<https://www.scde.ac.uk/learning-for-sustainability-in-ite#:~:text=The%20Lfs%20in%20ITE%20network%20meets%20regularly%20in%20Dperson%20and,Education%20Institutions%20which%20provide%20ITE>>accessed 13 August 2025

⁷⁷ Regional Centre of Expertise on Education <<https://learningforsustainabilityscotland.org/about-us/>>accessed 13 August 2025

strategy initiatives to promote sustainable education and awareness through Green Learning Awards, and the establishment of *Green learning Parks* to engage youth and Nigerian citizens in active to engage in contextualized, **experimental and experiential learning as well as** skill building for empowerment. To ensure the successful implementation of the *Climate Change and Sustainable Education Strategy* and programs, the institution of a specialized agency similar to the UK Learning for Sustainability National Implementation Group, such as the *Sustainable Education Implementation committee*, tasked with monitoring and periodic progress reports. Furthermore, the provisions of the CCSES should be codified into all relevant policy documents such as the *Nigerian National Energy Policy of 2022; the Sectorial Action Plans for Nigeria's Nationally Determined Contribution (SAPNNDC) 2017; the National Renewable Energy and Energy Efficiency Policy (NREEEP) of 2015; as well as the National Policy on Education of 2013.*

Also, the proposed *Sustainable Education Implementation committee* should be tasked with identifying innovative collaborations with relevant agencies such as the (National Environmental Standards and Regulations Enforcement Agency) NESREA and the Rural Electrification Agency (REA) to formulate strategies that advance clean energy education on a local scale.

B. Supportive legal framework for legitimization of sustainable education programs

The two relevant legislations that can be leveraged to mandate the integration of clean energy education from pre-school, primary, secondary, tertiary education systems, public trainings and workshops include the Nigeria *Climate Change Act (CCA) No. 11 of 2021* and the *NESREA Act No.25 of 2007*. Through the provisions of these Act, regulatory wisdom can be formulated to ensure compliance and quality control of clean energy education pedagogical approach. Taking lessons from the UK, the Nigerian government should integrate sustainability as an additional indicator of quality education which should be coded into the *National Policy on Education of 2013* and the proposed *Climate Change and Sustainable Education Strategy*. Also, the institutionalization of specialized of an inspectorate agency to conduct period school

inspections similar to Wales, the UK Estyn Inspections and the Northern Ireland Education and Training Inspectorate (ETI) as an effective monitoring and evaluation strategy to ensure proper curriculum design and programs to ensure quality pedagogical approach to SE and energy literacy programs.

C. Establishment of sustainable education funds

Nigeria will need to improve its allocation of funds for educational development. In the UK, strategic funds such as the UK Infrastructure Development Plan 2025 and the UK Research and Innovation priority funds exist with clear objectives outlined as ‘themes’. It is therefore recommended that Nigeria develop a *National Sustainable Education Fund* to target strategic infrastructure, research and technology innovation that engineer an enabling environment for clean energy education and climate change action. These strategies should be ‘themed’ to reflect current socio-economic realities including: a fossil-fuel decoupling theme like ‘Decoupling to net zero’. Other recommended themes include ‘Building Next-Gen Educators’, ‘Green technology development programs’, ‘Green building advancement scheme’, ‘Building a digital environment’ and ‘Nigeria Climate Change Resilience’. Allocated funds for these strategic programs and initiatives will eliminate fossil-fuel dominance, boost green development and infrastructure, build educator competence and generate data required for empirical studies and impactful policy formulation.

D. Institutionalization of strategic capacity development hubs

To ensure local capacity building and educator competence in clean energy education, Nigeria needs to leverage on existing agencies such as NESREA and also institutionalize specialized Inspectorates, constellations of knowledge hubs and create open source online platforms similar to the UK **Education and Training Inspectorate**, Learning for Sustainability (Lfs) in Initial Teacher Education (ITE), Scotland-based Regional Centre of Expertise on Education for Sustainable Development, and the **Sustainability Support for Education** online resource tool, under the auspice of the DfE. It is therefore recommended that the Nigerian Federal Ministry of Education institutionalize a *Center for Sustainable*

Development and Education. Furthermore, the Federal Ministry of Education can collaborate with the REA and NESREA to establish clusters of Green Education Hubs to deploy trainings, workshops, resources, free conferences, sustainable education curriculum development and assessment reviews for local, state and federal government schools in Nigeria.

CONCLUSION

Energy decarbonization and climate change action is an interplay between effective clean energy education, political and socio-economic instruments. It requires a high level of awareness on SE and energy literacy amongst Nigerian citizens, educators, community members, ecopreneurs, students and policy makers. To achieve rapid energy decarbonization towards Nigeria climate action and low carbon transition plans, contextual educational programs must be designed and administered effectively. This requires infrastructure, facilities and technologies, social enterprises, education and research institutions to leverage on for effective pedagogy delivery of SE and energy literacy programs, teachings, trainings, workshops and seminars. This article adds to the knowledge on clean energy education including SE and energy literacy as a tool for energy decarbonization. It sheds light on several aspects that must be considered to design and deliver clean energy education, create awareness and provoke citizens to increase their knowledge and participation in climate action and sustainability initiatives. Additionally, Nigeria should adopt strategies that reduce cost of green infrastructure and transform the energy context, promote rapid information dissemination on the domestic level via national and international collaborations to rapidly advance energy decentralization towards national climate action and low-carbon transition targets.