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Article

Promoting the Adoption of Clean Energy in Nigerian Tertiary Institutions for Sustainable Development and Climate Change Mitigation

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Abstract: Energy is essential for teaching, research, and administrative activities in tertiary institutions. However, many higher education institutions in Nigeria still rely heavily on fossil-fuel generators and unstable national grid electricity, which contribute to carbon emissions and environmental degradation. The continued use of diesel and petrol generators increases greenhouse gas emissions and worsens climate change. As global attention shifts toward sustainability, tertiary institutions are increasingly expected to adopt clean and renewable energy technologies such as solar, wind, and hybrid renewable systems. This paper discusses strategies for enhancing the adoption of clean energy in Nigerian tertiary institutions. The study highlights practical approaches including government policy support, renewable energy infrastructure development, institutional funding mechanisms, public–private partnerships, research and innovation initiatives, energy management systems, awareness creation, and capacity building. Evidence from renewable energy projects in Nigerian universities shows that solar installations can provide reliable electricity, reduce carbon emissions, and improve academic productivity. For instance, solar energy initiatives implemented under the Energising Education Programme have provided uninterrupted electricity to several universities, benefiting hundreds of thousands of students and staff. The paper concludes that adopting clean energy in tertiary institutions can enhance energy security, reduce operational costs, support environmental sustainability, and promote innovation in renewable energy research. Therefore, coordinated efforts by government, institutional leaders, and private sector partners are necessary to accelerate the transition to clean energy across Nigerian campuses.

Keywords: Clean Energy in Nigerian Tertiary Institutions, Sustainable Development, Climate Change Mitigation

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1. Introduction

Energy plays a fundamental role in the operation and development of tertiary institutions across the world. Universities, polytechnics, and colleges of education require large amounts of energy to power lecture halls, laboratories, offices, libraries, hostels, and other facilities. However, in many institutions in Nigeria, energy supply is still largely dependent on fossil fuels and carbon-emitting sources such as diesel and petrol generators [1]. The frequent use of these energy sources contributes significantly to carbon emissions, air pollution, and environmental degradation. The heavy reliance on fossil fuel–based

energy in tertiary institutions has become a growing environmental concern. Carbon emissions released from generators and other energy sources contribute to global environmental challenges such as climate change and global warming. Climate change has emerged as one of the most pressing environmental problems facing humanity today, affecting ecosystems, weather patterns, food production, and human health. Educational institutions, which are expected to lead societal transformation and innovation, have a responsibility to adopt sustainable practices that reduce environmental harm.

Clean energy, also known as renewable or sustainable energy, has been widely recognized as a viable alternative to carbon-based energy sources [2]. Clean energy sources such as solar, wind, hydro, and biomass generate power with minimal or no carbon emissions. The adoption of clean energy in tertiary institutions can significantly reduce their environmental footprint while promoting sustainable development. Apart from environmental benefits, the use of clean energy in tertiary institutions can improve energy reliability, reduce long-term operational costs, and serve as a practical learning platform for students and researchers studying environmental sustainability and renewable energy technologies. Universities around the world are increasingly integrating clean energy systems into their campuses as part of efforts to promote sustainability and environmental responsibility [3]. Despite these advantages, many tertiary institutions in Nigeria have been slow in adopting clean energy technologies due to financial constraints, inadequate policies, limited awareness, and infrastructural challenges. Therefore, there is a need to promote strategies that encourage the transition from carbon-emitting energy sources to clean energy systems within Nigerian tertiary institutions. Such a transition will contribute to climate change mitigation and support sustainable campus development [4].

Conceptual Terms

Concept of Tertiary Institutions

Tertiary institutions are micro section of the larger society. Tertiary institutions is an organized fraction of the whole society curved out for teaching programme, research and provision of community service. Tertiary institution can also be seen as a subset of the general society that is made of collection of different people, different culture, different life style and different value. Societies globally have been known to have some peculiar social problem and social issues. Social problems of most societies are migrated into the tertiary institutions because the societies and the tertiary institutions are inseparable to some extent. Tertiary education or higher education covers a wider range of higher learning institutions including the University [5]. These higher institutions of learning could be organized in different ways, commonly within a university and in a separate institution as university and other tertiary learning institutions. Tertiary Institutions according to Adake are institutions of higher education that offer advanced academic courses and degrees. These institutions include universities, colleges, and other educational institutions that provide students with the opportunity to pursue higher education and gain specialized knowledge in their chosen field of study. Tertiary Institutions offer degree programs such as bachelor's, master's, and doctoral degrees in a wide range of subjects, including but not limited to science, math, humanities, social sciences, and business. These institutions are known for their rigorous academic standards, experienced faculty, and cutting-edge research facilities.

Tertiary institution or tertiary education is conceptualized by Ogunode, Nwisagbo, and Bamson, as a planned and organized educational system designed for the total development of man/woman and for the total transformation of society through the utilization of teaching, research and provision of community service. In this paper, tertiary institutions are educational establishments that provide advanced learning and professional training after the completion of secondary education [6]. These institutions include universities, polytechnics, colleges of education, and other specialized higher education institutions. Their primary functions are teaching, research, and community

service. In Nigeria, Isife, and Nneka opined that tertiary institutions play a critical role in national development by producing skilled manpower required for economic growth and technological advancement. Universities focus on academic research and postgraduate education, while polytechnics emphasize technical and vocational training. Colleges of education primarily focus on training teachers who will serve in primary and secondary schools. Tertiary institutions are also centers of innovation and knowledge generation. Through research and academic collaboration, they contribute to solving societal problems and promoting sustainable development. Because they house large populations of students and staff and operate numerous facilities, tertiary institutions consume significant amounts of energy [7]. This makes them important institutions for implementing sustainable energy solutions such as clean energy technologies.

Concept of Clean Energy

Clean energy, also referred to as renewable energy, includes energy sources that are environmentally friendly and produce little or no greenhouse gas emissions [8]. Examples include solar, wind, biomass, hydroelectric, and geothermal energy. Clean energy adoption reduces environmental pollution, promotes energy security, and supports sustainable economic development. Clean Energy according to Adaka, refer to any type of energy that is generated from renewable sources, such as solar, wind, hydro, and geothermal power. These sources are considered "clean" because they do not emit greenhouse gases or other pollutants into the environment. Clean energy has become an increasingly important topic in recent years due to the negative impacts of traditional fossil fuels on the planet and the need for sustainable energy sources. Clean Energy is being widely adopted in various industries and sectors, from transportation and electricity generation to agriculture and manufacturing [9]. This shift towards clean energy is driven by a growing awareness of the negative effects of climate change and a desire to reduce our carbon footprint.

In terms of its impact on the environment, Adaka, noted that clean energy offers many benefits. By using renewable sources, we can decrease our dependence on fossil fuels and decrease the emission of greenhouse gases, which are major contributors to global warming. Additionally, clean energy sources have a much smaller impact on the environment, compared to traditional sources, as they do not produce harmful byproducts. Clean energy is also beneficial for the economy. The adoption of clean energy technologies has created new job opportunities and has driven economic growth in many regions [10]. By investing in clean energy, we can also reduce our reliance on foreign sources of energy and become more self-sufficient.

From the above, Clean energy in this paper refers to energy that is produced from natural resources that are renewable and environmentally friendly, generating little or no pollution or greenhouse gas emissions. Unlike fossil fuels such as coal, petrol, and diesel, clean energy sources do not significantly contribute to climate change or environmental degradation. Common forms of clean energy include solar energy, wind energy, hydroelectric power, geothermal energy, and biomass energy. Among these, solar energy is particularly suitable for many parts of Nigeria due to the country's high levels of sunlight throughout the year [11]. Solar panels installed on rooftops and open spaces can generate electricity that can power classrooms, laboratories, hostels, and administrative buildings. Clean energy technologies have become increasingly popular worldwide as governments, organizations, and institutions seek to reduce their dependence on fossil fuels and promote environmental sustainability. The adoption of clean energy systems also aligns with global environmental initiatives aimed at reducing carbon emissions and combating climate change.

Benefits of Using Clean Energy in Tertiary Institutions

Reduction of Carbon Emissions

One of the major benefits of clean energy is the reduction of carbon emissions. Fossil fuel generators used in many institutions release carbon dioxide and other greenhouse

gases into the atmosphere. These emissions contribute to global warming and climate change. By adopting renewable energy sources such as solar power, tertiary institutions can significantly reduce their carbon footprint and contribute to environmental protection.

Environmental Sustainability

Clean energy supports environmental sustainability because it reduces pollution and protects natural resources. Fossil fuels often produce harmful emissions that contaminate the air and contribute to environmental degradation [12]. Clean energy systems generate electricity without producing harmful pollutants, thereby helping to preserve the environment for future generations.

Cost Savings in the Long Term

Although the initial installation cost of renewable energy systems such as solar panels may be high, they often lead to long-term cost savings. Once installed, clean energy systems require relatively low maintenance and do not depend on continuous fuel purchases like diesel or petrol generators. This can reduce operational expenses for tertiary institutions over time.

Reliable Energy Supply

Many tertiary institutions in Nigeria experience irregular electricity supply from the national grid. Clean energy systems, particularly solar energy combined with battery storage, can provide reliable electricity for campus facilities [13]. This helps ensure that academic activities such as lectures, research, and administrative work are not interrupted by power outages.

Educational and Research Opportunities

The use of clean energy systems in tertiary institutions can serve as a practical learning laboratory for students and researchers. Students studying environmental science, engineering, and energy-related disciplines can use these systems for practical training and research projects. This can promote innovation and contribute to the development of renewable energy technologies.

Institutional Reputation and Leadership in Sustainability

Institutions that adopt clean energy demonstrate leadership in environmental responsibility and sustainability. Such institutions can serve as models for other organizations and communities. Promoting sustainable practices within campuses can also enhance the reputation of tertiary institutions both nationally and internationally.

Concept of Sustainable Development

Sustainable development refers to the development that meets the needs of the present without compromising the ability of future generations to meet their own needs [14]. It emphasizes a balance among economic growth, social inclusion, and environmental protection. In the context of tertiary institutions, sustainable development according to Adaka, involves promoting energy efficiency, responsible resource management, and environmentally friendly practices that support long-term institutional and societal growth. Sustainable Development is a practice that aims to support economic growth while also taking care of the environment and ensuring social well-being. It involves finding a balance between meeting the needs of the present generation without compromising the ability of future generations to meet their own needs. Sustainable Development considers the interconnectedness between economic, social, and environmental factors and seeks to find solutions that benefit all aspects of society [15]. This approach has gained significant attention in recent years as global issues such as climate change and inequality have become more pressing. By promoting sustainable development practices, we can work towards a more equitable and sustainable future for all [16].

Sustainable development is a concept that has gained significant attention in recent years, with a growing emphasis on balancing economic growth with social and environmental sustainability. It is defined as development that meets the needs of the

present without compromising the ability of future generations to meet their own needs. The concept incorporates principles of social justice, environmental conservation, and economic prosperity.

2. Materials and Methods

This study adopted a qualitative review model to examine strategies for promoting the adoption of clean energy in Nigerian tertiary institutions. The review approach involves the systematic collection, evaluation, and synthesis of existing literature on a given subject. Data were sourced from secondary materials, including peer-reviewed journal articles, textbooks, government publications, policy documents, and reports on renewable energy initiatives in Nigerian universities. Relevant documents on clean energy projects, such as institutional and national energy programs, were also reviewed based on their credibility, relevance, and timeliness. A thematic analysis technique was employed to analyze the collected data. Information was organized into key themes such as energy challenges in tertiary institutions, benefits of clean energy adoption, and strategies for implementation including policy support, funding mechanisms, infrastructure development, and capacity building. The review model is appropriate for this study as it enables a comprehensive understanding of clean energy adoption without primary data collection, while integrating diverse scholarly and policy perspectives to provide informed recommendations for sustainable development and climate change mitigation in Nigerian tertiary institutions.

3. Results and Discussion on strategies to Enhance Adoption of Clean Energy in Nigerian Tertiary Institutions

Strong Government Policies and Regulatory Support

Government policy plays a major role in encouraging the adoption of clean energy in tertiary institutions. When governments create supportive regulations, financial incentives, and sustainability policies, institutions become more willing to invest in renewable energy technologies. National policies that promote renewable energy development can encourage universities and colleges to transition away from fossil fuel–based electricity systems. In Nigeria, government initiatives such as renewable energy infrastructure projects have demonstrated the role of policy support in promoting clean energy adoption in universities [17]. For example, the Energising Education Programme has installed solar power systems across several universities to provide sustainable electricity for academic activities. Such policies help reduce institutional dependence on diesel generators and improve campus energy reliability.

Development of Renewable Energy Infrastructure on Campuses

One of the most effective strategies is the installation of renewable energy infrastructure such as solar photovoltaic systems, mini-grids, and hybrid renewable power systems within campuses. Renewable energy infrastructure allows universities to generate their own electricity in an environmentally friendly way. Several Nigerian universities have already begun implementing solar energy systems [18]. For example, a solar farm with thousands of photovoltaic panels installed at a university campus has been able to generate several megawatts of electricity to power academic buildings and hostels. Such infrastructure can supply electricity to laboratories, libraries, lecture halls, and hostels while reducing carbon emissions.

Public–Private Partnerships in Renewable Energy Development

Public–private partnerships (PPPs) can significantly enhance clean energy adoption in tertiary institutions. Renewable energy companies often possess the technical expertise and financial capacity required to design, install, and maintain large-scale renewable energy systems [19]. For instance, private energy companies have collaborated with universities in Nigeria to install solar energy systems that provide reliable electricity for campus operations while reducing operational costs. Through PPP arrangements,

institutions can access renewable energy technologies without bearing the entire financial burden of installation and maintenance.

Investment in Research and Innovation on Renewable Energy

Tertiary institutions are centers of knowledge creation and innovation. By investing in renewable energy research, universities can develop locally relevant technologies that support clean energy adoption. Establishing renewable energy research centers, laboratories, and innovation hubs can promote experimentation with solar, biomass, wind, and hybrid energy systems (Abubakar, 2017). Research initiatives can also help institutions design efficient campus energy systems tailored to their specific electricity demand. Studies on hybrid renewable energy systems show that integrating solar power with other renewable sources can meet campus energy needs sustainably. Such research initiatives not only promote energy sustainability but also provide practical learning opportunities for students.

Institutional Funding and Green Financing Mechanisms

Financial constraints according to Federal Government of Nigeria remain a major barrier to clean energy adoption in many tertiary institutions. Establishing dedicated sustainability funds or green financing mechanisms can help institutions invest in renewable energy technologies. Universities can allocate part of their infrastructure budgets to renewable energy projects or seek funding from international climate finance institutions and development agencies. Renewable energy investments often provide long-term economic benefits by reducing fuel costs and maintenance expenses associated with diesel generators. Cost savings from reduced fuel consumption can help institutions recover their investment in renewable energy systems.

Capacity Building and Technical Training

The adoption of clean energy technologies requires skilled personnel who can design, operate, and maintain renewable energy systems. Tertiary institutions should therefore invest in training programs for engineers, technicians, and energy managers. Training initiatives can equip staff and students with practical knowledge about renewable energy technologies. Some universities have already established training centers where students receive practical instruction on solar energy installation and maintenance. Capacity building ensures that renewable energy systems installed on campuses are effectively maintained and utilized.

Energy Efficiency and Smart Energy Management Systems

Another strategy is the implementation of energy management systems that monitor and optimize energy consumption on campuses. Smart energy management technologies can track electricity use across buildings and reduce energy waste.Research on campus energy systems shows that data-driven energy management models can help universities distribute electricity efficiently and reduce overall energy consumption. Combining energy efficiency measures with renewable energy systems can significantly reduce institutional carbon emissions.

Awareness Creation and Sustainability Education

Promoting awareness about environmental sustainability among students and staff can also encourage clean energy adoption. When campus communities understand the environmental and economic benefits of renewable energy, they are more likely to support sustainability initiatives. Educational campaigns, seminars, workshops, and sustainability programs can help build a culture of environmental responsibility within tertiary institutions. Students exposed to sustainability education often become advocates for renewable energy and environmental protection.

4. Conclusion

The increasing demand for electricity in tertiary institutions and the environmental impact of fossil fuel–based energy systems have made the adoption of clean energy an urgent necessity. In many universities across Nigeria, heavy dependence on diesel

generators contributes to carbon emissions, environmental pollution, and high operational costs. Clean energy technologies such as solar power offer a sustainable solution to these challenges.

Strategies such as supportive government policies, renewable energy infrastructure development, public–private partnerships, research and innovation, financial investment, capacity building, energy management systems, and awareness programs can significantly enhance clean energy adoption in tertiary institutions. Evidence from renewable energy projects implemented in Nigerian universities demonstrates that clean energy systems can provide reliable electricity while reducing environmental impact. Based on the findings, the study recommends the following:

1)The government should expand renewable energy programs for universities by providing grants and policy support for clean energy infrastructure.

2) Tertiary institutions should integrate renewable energy systems into campus development plans to reduce dependence on fossil fuels.

3) Universities should establish renewable energy research centers to promote innovation in sustainable energy technologies.

4) Public–private partnerships should be encouraged to support renewable energy investments in higher education institutions.

5) Institutional leaders should allocate funding for renewable energy projects as part of campus sustainability initiatives.

6) Training programs on renewable energy technologies should be provided for staff and students to enhance technical capacity.

7) Energy efficiency measures and smart energy management systems should be implemented to reduce energy waste and optimize renewable energy use.

8) Awareness campaigns on environmental sustainability should be promoted within campuses to encourage support for clean energy adoption.

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