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Article

Adoption of Clean Energy in Nigerian Tertiary Institutions for Sustainable Development

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Abstract: This paper discussed the adoption of clean energy in Nigerian tertiary institutions for sustainable development. Depending on secondary data obtained from recognized online and print resources. The paper concluded that the various clean energy technologies available include; solar energy, wind energy, biomass energy, hydroelectric energy and geothermal energy for deployment in the various tertiary institutions in Nigeria. The paper also noted that clean energy adoption by tertiary institutions in Nigeria will enhance environmental sustainability, cost efficiency, energy security and reliability, educational and research opportunities and contribution to national sustainable development. Based on these findings, the paper recommends that government, private institutions and tertiary institutions should jointly invest in renewable energy infrastructure, develop policy and regulatory frameworks, capacity building and training, promote research and innovation in clean energy, encourage community and stakeholder engagement, implement energy efficiency measures, explore funding and incentive mechanisms and monitor and evaluate impact

Keywords: Clean Energy, Tertiary Institutions, Sustainable Development

1. Introduction

The growing global concern over climate change, environmental degradation, and energy insecurity has placed sustainable energy solutions at the forefront of national development agendas. In Nigeria, tertiary institutions—including universities, polytechnics, and colleges of education—consume significant amounts of energy to power academic, administrative, and research activities. Traditionally, these institutions rely heavily on fossil fuels, diesel generators, and the national electricity grid, which are often unreliable, costly, and environmentally harmful. Consequently, there is an urgent need to explore and adopt clean energy alternatives such as solar, wind, biomass, and hydroelectric power to ensure energy efficiency, cost savings, and environmental sustainability (Adewuyi et al., 2020).

The adoption of clean energy in Nigerian tertiary institutions is not only a response to the challenges of energy scarcity and environmental pollution but also a strategic approach to advancing sustainable development goals (SDGs). Clean energy technologies can reduce greenhouse gas emissions, lower operational costs, and provide reliable power for teaching, research, and innovation. Moreover, integrating clean energy practices within tertiary institutions offers opportunities for research, student engagement, and community demonstration projects that promote environmental stewardship (Okafor & Nwosu, 2021).

Despite its potential, the widespread adoption of clean energy in Nigeria faces challenges including high initial investment costs, limited technical expertise, inadequate policy support, and infrastructural constraints. Understanding the feasibility, benefits, and

challenges of clean energy integration in tertiary institutions is therefore crucial for developing effective strategies that contribute to sustainable development, environmental protection, and energy security.

This study examines the adoption of clean energy in Nigerian tertiary institutions, with a focus on assessing the potential impacts on institutional sustainability, identifying barriers to implementation, and proposing actionable strategies for effective clean energy integration. By doing so, it seeks to provide a framework for energy-efficient practices that align with Nigeria's national development and environmental sustainability objectives.

2. Conceptual Terms

2.1. 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. It emphasizes a balance among economic growth, social inclusion, and environmental protection (United Nations, 2015). In the context of tertiary institutions, sustainable development 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. 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.

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.

Sustainable development has become a key focus in academic research, as scholars seek to understand and address the complex challenges facing our world today. This includes issues such as climate change, poverty, inequality, and resource depletion. Through various fields of study, such as economics, environmental science, and sociology, researchers are working to develop solutions and strategies for achieving sustainable development.

2.2. 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. Examples include solar, wind, biomass, hydroelectric, and geothermal energy. Clean energy adoption reduces environmental pollution, promotes energy security, and supports sustainable economic development (Adewuyi et al., 2020).

Clean Energy is a term that refers 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. 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, 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. By investing in clean energy, we can also reduce our reliance on foreign sources of energy and become more self-sufficient.

2.3. Concept of Tertiary Institutions

Tertiary institutions are post-secondary educational establishments that provide advanced academic, professional, and vocational training. These include universities, polytechnics, and colleges of education. They are central to national development, producing skilled manpower, promoting research and innovation, and serving as models for sustainable practices, including energy management and environmental stewardship (Okafor & Nwosu, 2021).

Tertiary Institutions 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.

3. Method

Adoption of Clean Energy in Nigerian Tertiary Institutions for Sustainable Development is a position paper that adopted a systematic literature review-based method. The method allows to collect and review the related previous literature from various online sources. With the aid of digital platform, the researcher collected secondary information to generate knowledge on this topic from 2015-2025. The position paper followed qualitative narrative design method. The researcher has visited different online sites to collect the previous literature and analyze the Nigeria-US Collaboration on Adoption of Clean Energy in Nigerian Tertiary Institutions for Sustainable Development. The previous findings are critically analyzed and presented in different themes as on the Adoption of Clean Energy in Nigerian Tertiary Institutions for Sustainable Development (Adapted from Ogunode, 2025).

Inclusion and exclusion criteria

Inclusion

This output of the literatures on the Adoption of Clean Energy in Nigerian Tertiary Institutions for Sustainable Development presents an in-depth study and result that can infer conclusion on the topic. The study includes: online publication; conference paper, journals sorted from reputable international journals such as CEON, Elsevier, Hindawi, JSTOR, IEEE, Learn Techlib, SAGE, Nebraska and Springer (Adapted from Ogunode, 2025v).

Exclusion

Also, the literature review excludes information from edited books, preprints, monographs, information below 2015 and book chapters (Adapted from Ogunode, 2025).

4. Result and Discussion on various clean energy options for Nigerian tertiary institutions and their importance.

1. Solar Energy

Solar energy harnesses power from the sun using photovoltaic (PV) panels or solar thermal systems. It is abundant in Nigeria due to the country's high solar irradiance levels, particularly in the northern and central regions. Solar energy can power lighting, laboratories, computer systems, and administrative buildings in tertiary institutions. Solar Energy is a renewable energy source that harnesses the power of the sun to generate electricity. It is a clean and sustainable form of energy that does not produce harmful emissions like other traditional sources. The process of solar energy generation involves the use of solar panels, which capture the sun's energy and convert it into electricity. This energy can be used to power homes, buildings, and even cars.

Benefits:

- Reduces reliance on fossil fuels and diesel generators.
- Lowers electricity costs in the long term.
- Provides a reliable source of energy in areas with frequent power outages (Adewuyi,, & Oladipo, 2020)..

2. Wind Energy

Wind energy uses turbines to convert wind flow into electricity. Certain regions of Nigeria, especially the northern savannah and coastal areas, have moderate to high wind speeds suitable for small- to medium-scale wind energy projects. Wind Energy is another renewable energy source that uses the power of the wind to generate electricity. It involves the use of wind turbines, which capture the kinetic energy of the wind and convert it into electricity. Wind energy is a clean and cost-effective alternative to traditional sources of energy and is becoming increasingly popular around the world. It is also one of the fastest-growing sources of energy, with new and more efficient turbine designs constantly being developed.

Benefits:

- Provides continuous power during sunny or non-sunny periods, complementing solar energy.
- Reduces carbon emissions and environmental pollution.
- Can be integrated with hybrid systems for more reliable energy supply (Okafo, & Nwosu, 2021). .

3. Biomass Energy

Biomass energy is derived from organic materials such as agricultural residues, wood waste, and municipal solid waste. Nigerian tertiary institutions with large campuses and cafeterias can utilize biodegradable waste to produce electricity or heat. Biomass Energy is a form of renewable energy that uses organic matter, such as wood, crops, and waste, to generate electricity. It is a carbon-neutral source of energy, meaning that it does not add to the levels of carbon dioxide in the atmosphere. Biomass energy is considered to be a sustainable and environmentally friendly alternative to fossil fuels. It is also a versatile source of energy, with applications in electricity generation, heating, and transportation.

Benefits:

- Reduces waste accumulation on campus.
- Provides a renewable and local source of energy.

- Contributes to sustainable waste management practices (Eze, Nwankwo, & Okafor, 2021).

4. Hydroelectric Energy

Small-scale hydroelectric systems can be installed in tertiary institutions located near rivers or streams. These systems convert flowing water into electricity and can provide a consistent energy supply. Hydroelectric Energy is a renewable energy source that uses the power of moving water to generate electricity. It is one of the oldest and most widely used sources of renewable energy, with hydroelectric power plants located all over the world. Hydroelectric energy is generated by converting the potential energy of water into kinetic energy, which is then used to turn turbines and produce electricity. It is a clean, reliable, and efficient source of energy that can be used on both a large and small scale.

Benefits:

- Reliable and continuous power generation.
- Low operational and maintenance costs once installed.
- Environmentally friendly and reduces dependence on fossil fuels (Okafor & Nwosu, 2021)..

5. Geothermal Energy

Geothermal energy uses heat from the Earth to generate electricity or provide heating/cooling. While geothermal potential in Nigeria is still under research, pilot projects in tertiary institutions can explore its feasibility, particularly for research and educational purposes. Geothermal Energy is a renewable energy source that harnesses the heat from the Earth to generate electricity. Geothermal power plants use the natural heat from the Earth's core to produce steam that powers turbines and generates electricity. This energy source is considered to be sustainable and environmentally friendly, as it does not produce any emissions or pollutants. It is also a reliable source of energy, with the potential to provide an uninterrupted power supply.

Benefits:

- Provides a stable and continuous energy supply.
- Reduces carbon footprint of institutional energy consumption.
- Promotes research and innovation in renewable energy technologies (Okafor & Nwosu, 2021).

B- Importance of Using Clean Energy in Nigerian Tertiary Institutions

Environmental Sustainability

Clean energy reduces greenhouse gas emissions and environmental pollution, helping institutions align with global climate change mitigation goals (United Nations, 2015). Environmental sustainability refers to the responsible and careful use of natural resources to ensure their preservation for future generations. In Nigerian tertiary institutions, the use of clean energy plays a crucial role in achieving environmental sustainability. Clean energy, which includes renewable sources such as solar, wind, and hydro power, is important for several reasons. Clean energy reduces the carbon footprint of tertiary institutions in Nigeria (Ogunode, & Olugbenga, 2023). Traditional sources of energy, such as fossil fuels, emit harmful greenhouse gases that contribute to climate change and air pollution. By transitioning to clean energy, Nigerian tertiary institutions can significantly reduce their carbon emissions and help combat the negative effects of climate change. Clean energy is more sustainable in the long run. Fossil fuels are finite resources and will eventually run out, whereas renewable sources of energy are constantly replenished by nature (Ogunode, Amos,, Bitrus, & Kauna , 2024).. By using clean energy, Nigerian tertiary institutions can become self-sufficient and reduce their dependence on imported fossil fuels. The use of clean energy can also lead to cost savings for Nigerian

tertiary institutions. While the initial investment in renewable energy infrastructure may be higher, the long-term operational costs are significantly lower compared to traditional sources of energy. This can result in cost savings for tertiary institutions, allowing them to allocate their resources towards other important areas. The adoption of clean energy in Nigerian tertiary institutions creates an opportunity for research and innovation. Students and researchers can explore and develop new technologies and systems that utilize clean energy, contributing to the growth of the green energy sector in the country (Ogunode, Audu, & Olatunde-Aiyedun, 2022)..

Cost Efficiency

Although initial installation costs can be high, clean energy systems like solar and wind reduce long-term operational costs by lowering dependence on expensive diesel generators and grid electricity (Adewuyi et al., 2020). The cost efficiency of using clean energy in Nigerian tertiary institutions is of great importance. The rising cost of traditional energy sources has made the adoption of clean energy a necessary and practical solution for tertiary institutions in Nigeria. By switching to clean energy, these institutions can greatly reduce their operating costs and save money in the long run (Omotere, 2024).. This not only benefits the institution financially, but also has a positive impact on the environment and promotes sustainable practices. Additionally, the use of clean energy in schools and universities can serve as a means of educating and inspiring future generations to prioritize clean energy and create a more sustainable future (Ogunode, Olamoyegun,& Olamoyegun 2025).

Energy Security and Reliability

Clean energy provides reliable power, especially in areas with frequent grid outages. This ensures uninterrupted academic, research, and administrative activities. Energy security and reliability are crucial aspects to consider when addressing the use of clean energy in Nigerian tertiary institutions. Clean energy plays a significant role in ensuring energy security and reliability, as it reduces dependence on non-renewable sources and mitigates the risk of unreliable energy supply (Echono, 2023). The importance of using clean energy in Nigerian tertiary institutions is two-fold. It promotes a sustainable and environmentally friendly approach to energy consumption, reducing the negative impact of traditional energy sources on the environment. It contributes to the overall energy security of the institutions, ensuring a stable and reliable supply of energy for their operations (Ariza, & Olatunde-Aiyedun, 2023). As such, the incorporation of clean energy in Nigerian tertiary institutions is essential for promoting sustainable development and ensuring the long-term viability of the institutions. By utilizing clean energy, these institutions can not only reduce their carbon footprint, but also improve their energy security and reliability for a more sustainable future (Eze et al., 2021).

Educational and Research Opportunities

Adopting renewable energy allows tertiary institutions to serve as living laboratories, providing students and researchers with hands-on experience in clean energy technologies. The importance of using clean energy in Nigerian tertiary institutions lies in the educational and research opportunities it presents. These institutions play a crucial role in shaping the minds of the country's future leaders, and by promoting the use of clean energy, they can instill these values in their students. Through the use of clean energy, Nigerian tertiary institutions can serve as a model for sustainable practices and inspire the younger generation to take action towards a greener and cleaner future. Furthermore, (Okafor & Nwosu, 2021) noted that by incorporating clean energy technologies into their curriculum, these institutions can equip their students with the necessary skills and knowledge to thrive in a world that increasingly values sustainability. The implementation of clean energy in Nigerian tertiary institutions can also create numerous research opportunities. As the country strives to transition to a more sustainable energy system, there is a growing need for innovative and cost-effective solutions. By studying and

researching, Okafor & Nwosu, (2021) noted that the use of clean energy in these institutions, students and faculty can contribute to the development of new technologies and strategies (Oloja, 2024). The use of clean energy in Nigerian tertiary institutions can have a significant impact on the environment. By reducing carbon emissions and minimizing the use of non-renewable resources, these institutions can help mitigate the effects of climate change and promote a healthier and more sustainable environment for future generations (Adams, Zubair, & Olatunde-Aiyedun, 2022).

Contribution to National Sustainable Development

By reducing carbon emissions and promoting efficient energy use, tertiary institutions contribute to Nigeria's sustainable development goals (SDGs), particularly Goal 7 (Affordable and Clean Energy) and Goal 13 (Climate Action) (United Nations, 2015). The contribution to national sustainable development is of utmost importance, especially when it comes to the use of clean energy in Nigerian tertiary institutions. Clean energy plays a crucial role in achieving sustainable development goals, as it helps reduce carbon emissions and combat climate change (Adewuyi et al., 2020). In Nigerian tertiary institutions, using clean energy is essential for a variety of reasons. It promotes environmental sustainability by reducing the institution's carbon footprint. This, in turn, helps in conserving the environment and natural resources, which are critical for sustainable development. Using clean energy also has economic benefits. It helps in reducing electricity costs, as clean energy is more affordable in the long run ((Eze et al., 2021). This can lead to financial savings for the institution, which can be utilized in other areas to improve the overall quality of education and research. Using clean energy in Nigerian tertiary institutions can also have a positive impact on public health. Traditional sources of energy, such as fossil fuels, are major contributors to air pollution and can have detrimental effects on human health. By transitioning to clean energy, the institution can help improve the air quality on campus and contribute to a healthier learning environment for students and staff. Adopting clean energy in Nigerian tertiary institutions can also have a ripple effect on the larger community. It can serve as a model for other institutions and communities to follow, promoting the use of clean energy on a national level. This, in turn, can help in achieving national sustainable development goals (Abubakar, 2017).

5. Conclusion and Recommendations

This paper discussed the adoption of clean energy in Nigerian tertiary institutions for sustainable development. The paper concluded that the various clean energy technologies available include; solar energy, wind energy, biomass energy, hydroelectric energy and geothermal energy for deployment in the various tertiary institutions in Nigeria. The paper also noted that clean energy adoption by tertiary institutions in Nigeria will enhance environmental sustainability, cost efficiency, energy security and reliability, educational and research opportunities and contribution to national sustainable development.

Based on these findings, the paper recommends that government, private institutions and tertiary institutions should jointly

1. Invest in Renewable Energy Infrastructure

Tertiary institutions should prioritize investments in renewable energy systems such as solar panels, wind turbines, biomass plants, and small-scale hydroelectric installations. Public-private partnerships and government grants can help mitigate high upfront costs and make clean energy adoption more feasible.

2. Develop Policy and Regulatory Frameworks

Universities and regulatory bodies should create institutional policies that promote the adoption of clean energy. This includes guidelines on energy efficiency, renewable

energy integration, and monitoring mechanisms to ensure compliance with environmental sustainability goals.

3. Capacity Building and Training

Staff, faculty, and students should be trained on the operation, maintenance, and management of renewable energy systems. Workshops, seminars, and certificate programs can enhance technical expertise and foster a culture of energy sustainability on campus.

4. Promote Research and Innovation in Clean Energy

Tertiary institutions should leverage their research capacity to develop innovative and cost-effective clean energy solutions suitable for local conditions. Collaboration with international institutions, energy firms, and government agencies can facilitate technology transfer and innovation.

5. Encourage Community and Stakeholder Engagement

Successful adoption of clean energy requires the participation of all stakeholders, including management, staff, students, and local communities. Awareness campaigns and participatory planning can ensure buy-in, reduce resistance, and promote sustainable energy practices across campuses.

6. Implement Energy Efficiency Measures

Alongside renewable energy adoption, institutions should adopt energy-saving practices such as efficient lighting, smart meters, automated systems, and building designs that minimize energy consumption. This reduces overall energy demand and maximizes the benefits of renewable energy systems

7. Explore Funding and Incentive Mechanisms

Governments, international agencies, and private investors should provide grants, low-interest loans, and tax incentives to support tertiary institutions in deploying clean energy technologies. Funding mechanisms can help overcome financial barriers and accelerate adoption (Adewuyi et al., 2020).

8. Monitor and Evaluate Impact

Institutions should establish monitoring systems to track energy generation, cost savings, and environmental benefits of renewable energy adoption. Regular evaluation ensures continuous improvement, accountability, and alignment with sustainability goals (Okafor & Nwosu, 2021).

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