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Evaluation of Nigeria's Energy Policy on Biomass Utilization

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ABSTRACT

Biomass energy, employed for centuries as a fuel in developing nations, stands as the longest-standing energy source still actively employed by humans today. Nigeria has an abundance of different biomass energy sources, with many of them remaining untapped and undeveloped across various levels. Despite its widespread availability throughout the nation, policies aimed at enhancing its utilization have received limited attention. Several obstacles hindering Nigeria's adoption of biomass energy need to be eliminated for it to develop to reach the levels observed in some developed nations. This paper examined empirical studies to assess the factors that shape the Nigerian biomass energy adoption and policies. The study explored a total of 16 articles on biomass utilization and summative content analysis was used to analyze them. The results indicate that political, economic, and technological factors have influenced Nigeria's biomass energy adoption and policy. This calls for a need to address these multifaceted challenges to promote the sustainable use of biomass as an energy source. This aligns with the seventh goal of the United Nations (UN) Sustainable Development Goals (SDGs), emphasizing affordable and clean energy.

INTRODUCTION

Energy is an essential component of growth and a strong force behind social-economic transformation anywhere in the world. The expansion of any country's economy and quality of life depend on it. Energy is a basic need in the modern world that cannot be exaggerated; it is necessary to meet both individual and community demands (Akorede et al., 2016) including the operation of factories, the heating and lighting of homes, the keeping of hospitals open, and the supply of clean water. As such, energy consumption has a major impact on a nation's economic and social development because the aforementioned services serve as indicators of every country's development and advancement.

Renewable resources constitute a form of energy. They derive from sources such as sunlight, wind, rain, tides, and geothermal heat. In 2012, renewable energy sources accounted for about 19 percent of global energy production; these included 10% from more recent sources including geothermal, biofuel, solar, wind, and hydropower, and 9% from more traditional sources like fuelwood (International Energy Agency, 2020). By the end of 2018, about 20% of electricity generated came from renewable sources. 18.51% of this was generated by hydropower, 0.14% by wind, and 1.36% by other emerging renewable energy sources (Olanipekun & Adelakun, 2020). However, there are still obstacles to switching to renewables such as worries about the economic ramifications of moving away from conventional energy sources and political changes that affect the continuity of policies (Aidoo et al., 2023).

Nigeria, as a developing nation facing a shortage of energy to suffice the ever-increasing demand, sees over 90 percent of its rural population depending on biomass. Although Nigeria has access to a variety of renewable energy sources, the country has not effectively harnessed them to make a significant contribution to electricity production. The Energy Commission of Nigeria (ECN) formulated a long-term master plan to increase renewable energy supply and production by 36 percent by 2030 (Amulah, 2022). The ECN has

examined various sources of renewable energy including biomass, solar, wind, and hydro (Onwumelu, 2023).

This paper focuses on Biomass, which is among the renewable alternatives suitable for inclusion in Nigeria's energy mix (Haas et al., 2019). Its significance is highlighted by the fact that merely 40 percent of Nigerians are linked to the power grid, facing power outages for an average of 10 to 12 hours daily (Yusuf et al., 2019). Biomass refers to any biological material obtained from plants and animals that is used to provide energy (Regmi et al., 2021; Sánchez et al., 2019; Serag & Adil, 2021). Biomass energy has two main advantages: it is readily available and it is safe to use without endangering the environment (Sokan-Adeaga & Ana, 2015). In developing countries, especially, biofuels are by far the most crucial source of energy for rural people, agricultural output, and rural businesses (Akorede et al., 2016; Aliyu et al., 2015). This includes materials such as pressed sugarcane, rice husks, maize stovers, and wood waste, utilized as fuel in modern biomass energy systems (Akorede et al., 2016).

While biomass holds promise for delivering contemporary consumers convenient, dependable, and cost-effective services, its sustained exploitation hinges on adherence to its resource-carrying capacity. Amplified utilization of biomass may precipitate adverse consequences such as heightened greenhouse gas emissions, biodiversity depletion, disruptions to community livelihoods, and an escalation of food insecurity concerns (Kudoh et al., 2015a). Despite the readily availability of biomass, the Nigerian energy policy does not give it the same priority as other renewable energy sources prompting a critical examination of the policy framework to improve biomass integration and overall sustainability.

Several studies have attempted to look at the socioeconomic effects of renewable energy. Applying the ARDL method of analysis to the Nigerian context, Maji (2015) identified a positive relationship between renewable energy and economic growth. However, the author highlighted that the lack of institutional structure and policies supporting renewable energy in Nigeria could adversely affect economic growth. Similarly, Ahmed et al. (2022) discovered a substantial connection between Nigeria's economic growth and energy use. The author suggested that a diversified energy mix could enhance the country's energy security.

The reviewed studies suggest that sustainable energy may have a beneficial impact on, energy security, and economic growth. However, to achieve these advantages, they also emphasize the importance of supportive institutional frameworks and policies, emphasizing the need for a comprehensive strategy when incorporating renewable energy into national economic plans. Andre (2015) argued that industries can boost their competitiveness and economic performance through technological innovation if environmental restrictions are well-designed.

Despite the undeniable advantages of renewables, developing and emerging economies have encountered diverse challenges in the past decade when transitioning from conventional to renewable energy sources(Christian & Mihail, 2017). Some of these challenges include insufficient financial resources, weak institutional capacity, limited access to technology, and inadequate policies and regulations (Seetharaman et al., 2019). Ciarreta et al. (2017) argued that in the absence of supportive policies, renewable energy technologies currently struggle to compete with traditional energy sources. Optimal performance across the whole biomass value chain, from raw material extraction and processing to final energy production, is dependent on technological considerations (Zhou et al., 2019). The reviewed studies highlight the tangible benefits of renewable energy, including cost savings and socioeconomic advancements. However, they also highlight the persistent challenges emphasizing how crucial it is to address institutional, monetary, and legislative issues to guarantee the smooth incorporation of renewable energy sources into a variety of energy environments (Sanchez et al., 2019).

Nigeria has significant biomass resources that can be harnessed for energy production (Jekayinfa et al., 2020). Munonye et al. (2023) highlighted the possibilities of bioenergy to address energy needs and the resources available for its development. However, Nigeria is still dependent on natural gas electricity, Hydro, and solar (Akrofi, 2021). Biomass in Nigeria primarily includes agricultural residues, wood, forest residues, animal waste, and urban waste (IEA, 2020). These biomass resources

have the potential to contribute to Nigeria's renewable energy goals and reduce the country's reliance on fossil fuels (Elum et al., 2017). According to a study conducted by the International Energy Agency (2020), Nigeria's overall biomass energy resource potential is estimated to be around 17,500 megawatts (MW) for electricity generation, encompassing various sources such as agricultural residues, forest residues, and animal waste. One of Nigeria's greatest biomass resources is agricultural waste, especially crop waste. These byproducts are produced by crops like sugarcane, corn, rice, and cassava. According to (Ohimain, 2015), perennial crop residues have a potential volume of 2.35 billion kg per year with an energy potential of 28.88 PJ/year.

To encourage the development, use, and sustainability of bioenergy, the Nigerian government has developed a number of policies and initiatives (Oyefusi & Adenikinju, 2019). The Federal Ministry of Environment formally introduced The Nigerian Bioenergy Policy in 2007 to address issues with energy security, environmental sustainability, and rural development (African Development Bank, 2017). The policy advocates for the methodical advancement and application of sustainable energy sources, specifically those derived from biomass, like biofuels and biogas. Enhancing energy security through diversified energy sources, fostering rural development and poverty reduction, lowering greenhouse gas emissions and mitigating the effects of climate change, ensuring sustainable exploitation and utilization of biomass resources, and encouraging private sector investments in bioenergy projects are just a few of the main goals outlined in the Nigeria bioenergy policy (Emodi & Ebele, 2016; Oyefusi & Adenikinju, 2019). In addition, the National Bioenergy Policy acts as a road map for the creation and application of biomass energy resources in Nigeria. It seeks to promote sustainable bioenergy production, increase energy access in rural areas, and stimulate economic growth.

Several measures have been taken to implement the Nigerian Bioenergy Policy. These include the establishment of the National Bioenergy Committee, the promotion of research and development in bioenergy technologies, and the provision of fiscal incentives for renewable energy projects(Tochukwu et al., 2018). Since the initiation of the policy, notable achievements have been recorded, such as the establishment of biofuel production facilities, increased adoption of biogas technologies, and rural electrification through bioenergy sources (African Development Bank, 2017). Despite progress, the Nigerian Bioenergy Policy faces challenges that hinder its full implementation and effectiveness. These challenges include inadequate funding, limited technology transfer, lack of coordination among relevant agencies, and the need for clearer legal frameworks and regulatory frameworks (Efurumibe et al., 2015). (Okafor et al., 2022) highlighted the need to revise government policies to optimize energy recovery while considering the economic, technological, and environmental impact on the development and sustainability of bioenergy. Norris & McCrae (2013) agreed with this and further stated that the political will to implement sustainable policies in developing countries tends to erode over time as politicians or policymakers become more focused on enacting legislation than solving implementation challenges. Without strong institutional frameworks, politicians and elites have the potential to participate in corrupt activities involving energy resources (Banerjee & Duflo, 2014). This may be showing preference towards specific parties or enterprises in energy agreements, diverting funds designated for energy infrastructure, or manipulating regulations to advance personal interests (Liedong & Frynas, 2018). Ben-Iwo et al. (2016) further pointed out that the sustainability of biorefinery facilities is influenced by technical factors, with the availability of feedstock being a key consideration while according to Falcone (2023), project developers and legislators can better navigate public opinion and resistance if they communicate openly, and involve communities in decision-making. Despite a considerable volume of bioenergy research in Nigeria, existing literature does not sufficiently address the role of processing technology in Nigeria's biomass energy policy, which has led to numerous challenges (Ohimain, 2015). Consequently, it is imperative for the Nigerian government as a regulatory body to ensure that the energy sector develops equitably and beneficially to the local economy (Gasparatos et al., 2015).

The policy further highlights the need for collaboration among stakeholders, policy

coherence, awareness campaigns, and incentives (Federal Ministry of Environment, Nigeria, 2015). The policy sets a strong foundation however, Nigeria faces significant obstacles in its attempts to promote collaboration, policy coherence, awareness campaigns, incentives, and capacity building. Policy conflicts present a significant challenge in the advancement of Nigeria's biomass energy sector (Nwozor et al., 2021). by bureaucratic obstacles and communication gaps.

A review of the literature identifies several significant gaps in the knowledge base regarding Nigeria's biomass energy policy. Notably, even though some of the literature touched upon the factors that influence biomass utilization, there aren't many in-depth discussions in the literature about the political, economic, and technological factors that may influence Nigeria's biomass energy policies. This study analyzes empirical documents on biomass utilization. It gathers evidence from the existing literature to examine factors that contribute to the formulation, of the Nigerian Energy Policies on Biomass Utilization.

METHODS

A qualitative content analysis was explored by the study, as it assessed and evaluated existing research (Creswell, 2014). The researchers deemed this technique to be appropriate for analyzing text data (Bengtsson, 2016). Given that this technique reviewed and analyzed existing studies on biomass utilization, it was deemed appropriate. In particular, the researchers used summative content analysis to measure and examine how frequently previous studies discussed the factors that influence biomass use and policy.

A thorough search of existing kinds of literature was conducted to identify relevant research papers related to biomass energy policies in Nigeria before the content analysis. To ensure credibility, a systematic and rigorous search of existing literature was done through academic platforms such as the Scopus database, Google Scholar, ResearchGate, and CrossRef metadata. Keywords such as “biomass energy” and “biomass energy policy” were searched from the academic databases. Relatively, these academic platforms contain high-quality documents, which have undergone the respective rigorous publication processes. This improved the authenticity, content representativeness, and credibility of the documents that were used (Creswell, 2014). The search results were further refined using the AND and OR Boolean operators. These scholarly repositories contain high-quality papers that have undergone stringent publication procedures. As a result, the selected documents were more credible, authentic, and had representative content. (Creswell, 2014). A total of 73 articles were identified by the authors from the database search.

Inclusion and exclusion criteria were developed for effective search strategies. For the inclusion criteria, research papers, articles, and reports published in English, as well as articles analyzing biomass energy policies and their influencing factors in Nigeria were considered. Included in the analysis were articles published between 2015 and 2023, that specifically addressed political factors, stakeholder perspectives, economic factors, and technological advancements within biomass energy policy (n=75). On the other hand, the review excluded papers that were not related to biomass energy policies or lacked specificity regarding biomass utilization in Nigeria. Articles published in languages other than English, those that did not address the primary factors influencing biomass energy policies in Nigeria, and those published before the year were also not considered.

Following the inclusion and exclusion criteria, the authors first independently looked through the titles and abstracts of all 73 selected publications. Because the majority of the articles did not fit the inclusion criterion, the authors further decreased the number of articles to 32. The full texts of the 32 articles were reviewed to ensure that the content was appropriately representative of the research themes. Out of the 32 articles 16 were perfectly suited for analysis. The other 16 articles were excluded because, while they discussed the use of biomass, they omitted information about the factors that influence Nigeria's biomass energy use and policy formulation process, including the political system, stakeholder perspectives, economic factors, and technological advancements. Therefore, 16 publications were chosen, analyzed, and thoroughly examined.

The preliminary screening (checking the title and abstract) and the full article screening were carried out by the first author by applying the inclusion and exclusion criteria. The second author

independently reviewed and evaluated each of the 16 articles to determine which ones should be included in the analysis to guarantee the validity and reliability of the data taken from the chosen articles. Both authors unanimously agreed for all 16 articles to be used as the final data set for the document analysis. The flow chart of the Preferred Reporting Item for Systematic Reviews and Meta-Analysis (PRISMA) is presented in Figure 1.

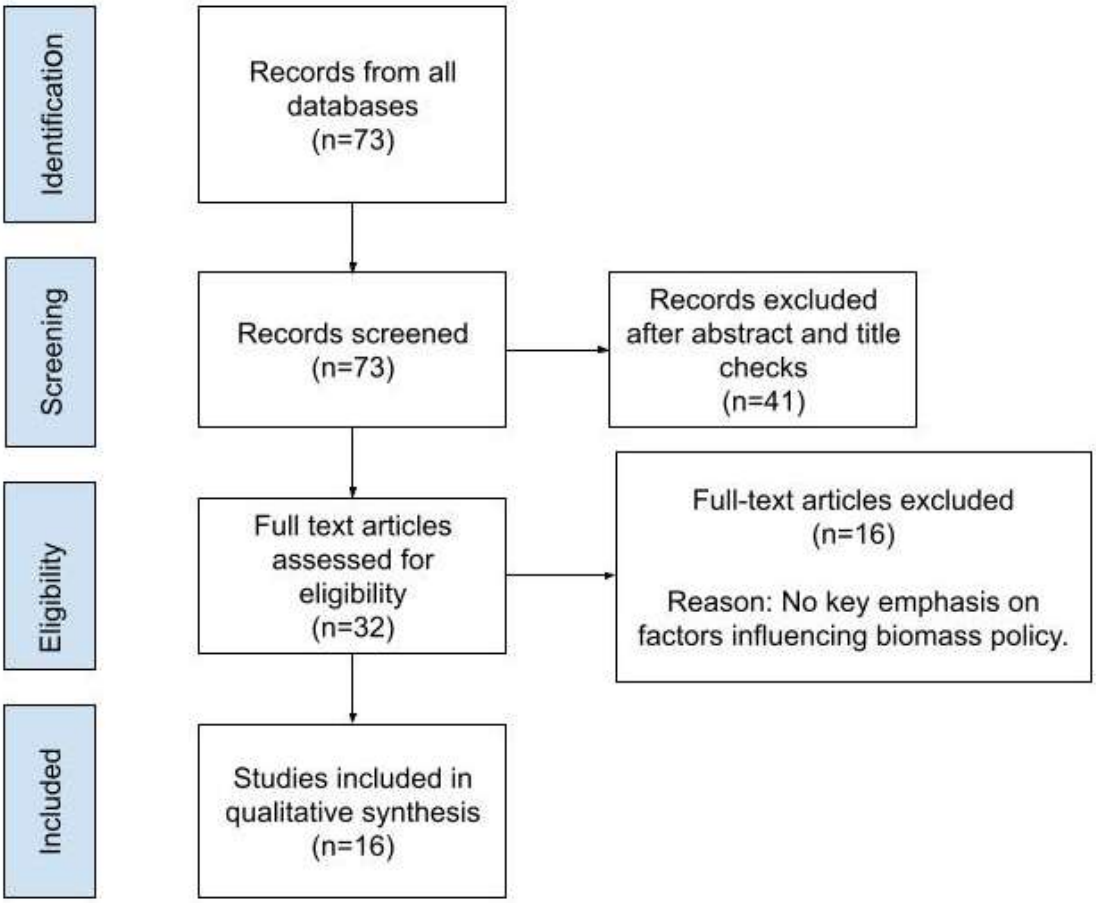

Figure 1. PRISMA Flow Chart Showing Literature Search.

Data Extraction

The information that made up the qualitative synthesis was extracted from the chosen articles by the two authors. The first author then created an extensive table (see Table 1) that contains details of the extracted data. Data extraction was based on key themes, including year and author (s), research design, region, analysis strategy, current biomass energy challenges, and factors that influence biomass policy formulation. The two authors unanimously agreed on these themes. After closely reading every article that is included, the first author imputed the data within the appropriate themes. Following that, the second author reviewed every entry within each of the themes. At this point, the first author conducted a frequency count following the summative content analysis. The number of articles that cited the current challenges to biomass use and the factors influencing biomass policy use (or both) was counted and recorded. This helped to determine the key factors influencing biomass energy policies in Nigeria.

Table 1. Selected Articles and themes

No	Author(s) and year	Country/region	Research/Study Design	Analysis strategy	Current Biomass Energy Challenges	Factors influencing biomass policy adoption and formulation
1	Maji (2015)	Nigeria	Policy Analysis	ARDL Approach to Cointegration	lack of institutional structure and policies	x
2	Falcone (2023)	Italy	Literature Review	Content Analysis and Case Study	x	Public participation
3	Gberevbie et al., (2018)	Nigeria	Conference Paper	Historical Research	x	Public participation
4	Kudoh et al. (2015)	East Asia	Literature review	Working group	Need for modern technology	x
5	Ezealigo et al. (2021)	Nigeria	Mixed Techniques	Computational and Analytical Approach	Need to revise government policies.	x
6	Aidoo et al. (2023)	South Africa	Quantitative Analysis	Empirical Analysis	x	Public participation
7	Nwozor et al. (2021)	Nigeria	Qualitative	Logical Inductive	x	Policy conflict within Institutions
8	Gasparatos et al. (2015)	Sub-Saharan Africa	Literature Review	Qualitative Synthesis	x	Absence of Technology transfer
9	Andre (2015)	Spain	Book Chapter	Review	Technology	
10	Zhou et al. (2019)	China	Quantitative Analysis	Mediating Effect Test	Technical development	Technology development in policy
11	Banerjee & Duflo (2014)	United States	Review Article	Systematic review and observation	Weak government Institutions	x
12	(Aliyu et al., 2017)	Nigeria	Qualitative Analysis		x	Weakened political system
13	Ben-Iwo et al. (2016)	Nigeria	Qualitative Analysis	Descriptive	Technology	x
14	Liedong & Frynas (2018)	Ghana	Survey	Hierarchical Regression Analyses	Weak Institutional frameworks	Weak Institutional Framework
15	Akrofi, (2021)	Iran	Quantitative Analysis	EMCI	Dependence on fossil fuel	Energy diversification
16	Okafor et al. (2022)	Nigeria	Review	Systematic Review	Need to revise government policies	Energy diversification

RESULTS AND DISCUSSION

The findings provide answers to the question of the influence of economic, political, and technological factors that influence biomass use and policy formulation. Out of the 16 articles selected that form the dataset for the study, all were published between 2015-2023., Italy (Falcone, 2023), East Asia (Kudoh et al., 2015a), South Africa (Aidoo et al., 2023), Sub-Saharan Africa (Gasparatos et al., 2015), United States (Banerjee & Duflo, 2014), Iran (Akrofi, 2021) and Ghana (Liedong & Frynas, 2018). The majority (7) were published in Nigeria. As shown in Table 1, most of more than half of the articles used qualitative systematic reviews while others used quantitative and mixed approaches. For those that adopted a qualitative approach, systematic reviews, and content analysis were mostly used. For the articles that used quantitative methods, multiple analysis methods were used.

Biomass Energy Adoption

Table 1 reveals that biomass energy faces challenges in terms of its adoption. This is because 10 of the reviewed articles mentioned these challenges related to the adoption of biomass energy. (eg Akrofi, 2021; Andre 2015; Banerjee & Duflo 2014; Ben-Iwo et al. 2016; Ezealigo et al., 2021; Kudoh et al., 2015; Liedong & Frynas 2018; Maji 2015; Okafor et al. 2022; Zhou et al., 2019). From Table 1, the reviewed articles mentioned the challenges to biomass energy adoption however, weak institutional frameworks and policies remain dominant. For example, weak institutional frameworks and the need to revise policy were mentioned in (Banerjee & Duflo, 2014; Ezealigo et al., 2021; Liedong & Frynas, 2018; Maji, 2015; Okafor et al., 2022). From the reviewed articles, in the Nigerian context, the challenges associated with weak institutional frameworks are evident in the lack of coordinated efforts among relevant government bodies. Administrative inefficiencies and inadequate structures hinder the effective implementation of biomass energy projects. Addressing these weaknesses requires substantial reforms in organizational setups, ensuring that institutions responsible for energy policies work collaboratively and efficiently.

Other challenges mentioned in the reviewed articles included technology (Andre, 2015; Ben-Iwo et al., 2016; Kudoh et al., 2015; Zhou et al., 2019). Nigeria faces specific technological challenges, including outdated infrastructure and a lack of innovation in the biomass energy sector. Advancements in technology tailored to the Nigerian context are essential for overcoming these challenges. Investment in research and development, along with collaboration with the private sector, can drive technological innovations that make biomass energy more accessible and efficient.

Lastly, the reviewed articles mentioned dependence on fossil fuels as another challenge to biomass adoption (Akrofi, 2021). The prevalent dependence on fossil fuels in Nigeria, particularly in the form of oil and gas, poses a significant hindrance to the transition to biomass energy. Policies and strategies that encourage a gradual shift away from fossil fuel dependency are essential. The Nigerian government should incentivize the use of biomass, emphasizing its role in diversifying the energy mix and reducing environmental impacts.

Biomass Energy Policy

Table 1 reveals that biomass energy policies are significantly influenced by political, economic, and technological factors. This is because 10 of the articles mention these factors. For example, (Aidoo et al., 2023; Akrofi, 2021; Aliyu et al., 2017; Falcone, 2023; Gasparatos et al., 2015; Gberevbie et al., 2018; Liedong & Frynas, 2018; Nwozor et al., 2021; Okafor et al., 2022; Zhou et al., 2019). From Table 1, even though all 10 reviewed articles mentioned the factors that influence biomass policy formulation, public participation, and weak institutional frameworks remain dominant. 3 of the reviewed articles mentioned weak institutional frameworks (Aliyu et al., 2017; Liedong & Frynas, 2018; Nwozor et al., 2021). The reviewed studies mentioned that the policy lacks comprehensiveness due to a weakened political system. This weakness has led to conflicting interests among governments and policymakers, with the government prioritizing its interests over those of the citizens (Aliyu et al., 2017). Government officials in Nigeria often make decisions on policy implementation, showing preference towards their interests or aligning with their ethnic or religious identity (Tochukwu et al., 2018). Policymaking in Nigeria is likened to a "learning process" or "trial and error", where inadequately designed policies or programs are frequently discarded because their initial

justifications lacked sufficient factual support or did not align with the demands of the general public.

Another factor mentioned in the reviewed articles was public participation (Aidoo et al., 2023; Falcone, 2023; Gberevbie et al., 2018). Policy formulation related to biomass energy entails various stakeholder groups, each playing a crucial role in influencing decision-making processes. The lack of an inclusive and consultative policy-making process in the development of the biomass energy policy presents a significant challenge as it may not fully address the needs of affected stakeholders (Aliyu et al., 2017). This shortcoming could lead to a policy that does not fairly represent the various viewpoints and interests that exist within the biomass energy industry. As a result, the policy's implementation might unfairly affect different groups, giving preference to some stakeholders or industries while ignoring the concerns of others. Furthermore, a top-down strategy might ignore the specific needs and challenges of different regions or communities, leading to a lack of consideration for local variations in resource availability, infrastructure, and socio-economic conditions. If important stakeholders are not consulted, the policy may encounter resistance and opposition, which could lead to non-compliance, legal issues, or implementation challenges (Gberevbie et al., 2018). Ultimately, creating effective, equitable, and sustainable policies requires a consultative and inclusive policy-making process; if this is not the case, the Biomass Energy Policy may not meet its objectives. This is because different stakeholders have different needs and viewpoints.

Next, the reviewed articles mentioned technology as a factor that influences biomass energy policy (Gasparatos et al., 2015; Zhou et al., 2019) and energy diversification (Akrofi, 2021; Okafor et al., 2022). Technology transfer is essential to the development of the biofuel industry because it makes it possible to implement innovative and effective production techniques. The oversight of this aspect in the policy framework, as noted by Ndukwu et al. (2021) presents a missed opportunity for Nigeria to benefit from international know-how and developments in biofuel technology. A more thorough and globally conscious approach would actively seek out and incorporate global best practices, encourage cooperation with technology suppliers, and remove barriers to technology transfer. To address these deficiencies, Policymakers should take a more globally informed approach by incorporating technology transfer mechanisms, learning from successful global biofuel initiatives, and adjusting the policy to reflect changing market dynamics and international standards.

Lastly, the reviewed article mentioned energy diversification as one of the factors that influence biomass energy policy (Akrofi, 2021; Okafor et al., 2022). The current energy policy in Nigeria exhibits a notable gap in addressing the imperative of energy diversification, particularly in the context of biomass. The existing policy framework tends to be skewed towards conventional energy sources, neglecting the vast potential and benefits that biomass can offer in fostering diversification. There is a lack of specific provisions or incentives within the policy that encourage the integration of biomass into the energy mix. The absence of targeted measures, such as subsidies or financial incentives for biomass projects, reflects a limited recognition of the role biomass can play in diversifying the energy landscape. Additionally, the policy inadequately addresses regulatory barriers and challenges associated with the incorporation of biomass into the national grid, hindering its seamless integration. To effectively leverage the benefits of energy diversification through biomass, there is a pressing need for policy revisions that explicitly acknowledge and support the role of biomass in achieving a more diversified, sustainable, and resilient energy portfolio for Nigeria.

CONCLUSION

The culmination of the interpretation of findings and the ensuing discussion sheds light on pivotal insights into the intricacies of biomass energy utilization and policy formulation in Nigeria. The research successfully navigated through a myriad of articles, highlighting the multifaceted challenges faced by biomass adoption, particularly in the Nigerian context. The challenges encompass institutional shortcomings, the need for policy revision, technological constraints, dependence on fossil fuels, and funding inadequacies.

While the findings underscore the pervasive challenges, they also reveal a common thread- the profound influence of political, economic, and

technological factors in shaping biomass policies. The literature consistently emphasizes the critical role these factors play in both policy formulation and adoption, emphasizing the need for a nuanced and context-specific approach. Weak institutional frameworks emerge as a dominant challenge, demanding urgent attention and reform to provide a robust foundation for biomass integration.

The importance of a comprehensive national bioenergy policy tailored to Nigeria's unique political, economic, and technological landscape becomes evident. This policy should intricately address the identified challenges, incorporating flexibility, resilience, and inclusivity. Foremost, urgent attention is warranted for the strengthening of institutional frameworks governing biomass policies. Weaknesses identified in the current system must be addressed to provide a solid foundation for effective biomass integration. A comprehensive review of existing policies is imperative, aligning them with contemporary challenges and opportunities in the biomass sector. Concurrently, initiatives fostering the integration of advanced technologies into biomass energy production should be prioritized to enhance efficiency and sustainability. Public participation in policy formulation processes is crucial to ensure alignment with citizens' needs and priorities. Moreover, the implementation of policies that encourage and support research and development projects in the biomass sector is essential, fostering innovation and continuous improvement.

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