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Embracing Briquette Fuel in Nigeria: Challenges, Implications and Way-Out

J.A. Gidigbi[1], Z. Sani[1], A.B. Muhammad[1], A.B. Olarewaju, J. Eneche
[1] Department of Energy and Applied Chemistry, Usmanu Danfodiyo University, Sokoto, Nigeria

Email: gidigbijoshua@gmail.com

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Abstract:
Energy is crucial to critical development of any nation. It is a major determinant of economy power. Unfortunately, fossil fuel which has served as a major means of energy remain unsustainable and has detrimental effect on the environment. Renewable source of energy such as biomass promising a better replacement since it is ecofriendly and sourced from unlimited feedstock. Briquette is one of the alternative sources of energy derived from biomass. It has the potency of replacing wood fuel with good heating value and substantial heating time. It is eco-friendly and sustainable. it is majorly produced from waste residue of agricultural process and production which make it more susceptible as an alternative source of heating energy in sub-Sahara Africa, especially, Nigeria which was referred to as agricultural nation. Nigeria has many crop residues including groundnut- shells and straw; rice- straw and husk, maize-Stalk, cob and husk; cassava- stalks and peelings, soybean- straw and pods, sugar cane-bagasse and tops/leaves, cotton-stalk, millet- straw, sorghum-straw, and cowpea's shell which could serve as a good raw material for briquette production. Despite the huge availability of feedstock, manpower and technical how, briquette formulation merely exists in the nation. The commercialization of briquette in the country has failed woefully. Thus, a need for comprehensive studies on the missing links on why briquette does not thrive like other Africa nations such as Uganda and Kenya. This study reviewed; challenges; implications and way out associated with briquette technology in Nigeria.

Keywords: Briquettes, Wood fuel, Biomass, Agricultural Residue, Carbon Capture Eco-Friendly

1. Introduction

The growing demand for low-cost and alternative energy for household activities such as cooking, and heating processes is on the increase (Mahoro et al., 2022). This demand is furthered fueled by the epileptic nature and hike in electricity fee; and high cost of liquified gas in the country. Hamzat et al. (2019) reported that many households in Nigeria rely on energy to meet up with their domestic needs and activities. This includes cooking of foods for the household and processing of industrial products in order to meet up with their daily obligations. Unfortunately, the nation’s energy sector had not been able to meet up with the growing energy need of the country due to growing population and other difficulties arising from policy irregularities. Moreover, Gidigbi & Abubakar (2023); Onimisi et al. (2021) reported the unsustainability of fossil fuel has led to inconsistent supply, cumulating into huge energy demand for domestic purposes. These demands were more felt in rural communities with little/no access to fossil fuel and electricity supply. Thereby leaving them with only one choice of wood fuel to augment for the shortages.

Moreover, the high cost of non-renewable energy and low access to the fossil fuel especially in a semi-urban and rural communities, has driven majority of low-income earner and rural dwellers to rely on wood fuel, especially charcoal for domestic cooking; ironing and other business engagement such as blacksmith that required heat energy (Kpalo & Zainuddin, 2020; Obi, et al., 2014). According to Aliyu et al. (2021), wood fuel is accounted for more than 37% of total energy usage in Nigeria.

The modernized charcoal stoves, kilns and ovens are gradually gaining acceptability even in some major cities such as Lagos, Port Harcourt and Abuja, as an alternative source of cooking system. Major reasons for the wide patronage include easily accessible; affordability and quantity heat energy supply. According to Ali et al., (2019), the larger patronage of wood fuel has been linked with deforestation, as wood reserves are constantly suffering from premature cutting down. This has a severe impact on the quality of air available in the environment as the world geared towards zero-carbon society.

According to the conscious (The Conscious Challenge, 2018), the continuous cutting down of wood for other uses including wood fuel has been linked to severe drought. Also, Africa Union Development Agency (AUPED, 2022) reported that burning of wood fuel has been associated with lungs diseases as an emission of carbon monoxide (CO) usually accompanied burning wood fuel, thereby causing damage to both health and environment. (Weinhold, 2011) reported that exposure to harmful pollutants such as Carbon monoxide and Nitrogen dioxide could lead to elevated blood pressure which resulted into increased risk of cardiovascular diseases, such as stroke and renal failure. Also, Barnes (Barnes, 2014) reported that exposure to harmful gasses is mostly responsible for cases of pneumonia amongst children of less than five years of age and in many severe cases could lead to premature deaths (Ritchie & Roser, 2019). Globally, deaths from indoor air pollution including wood fuel burning are estimated to be about 3.8 million annually. Also, Africa Union Development Agency (AUPED, 2022) attributed the lung diseases such as lung cancer to burning of wood processes in which harmful gasses are being emitted into the lungs, which cases damages in the lungs. In 2002, The World Health Organization (World Health Organization (WHO), 2007) argued that polluted air was associated with 79,000 deaths recorded in the year 2002, a number which has been increase between 106,900 to 605,100 fatalities annually (Balmes, 2019). Unfortunately, the most victims of polluted air are those who cannot afford quality healthcare services, thereby, contributing to the national diseases burden. Therefore, to minimize the health and environmental challenges arising from utilization of wood fuel for domestic cooking and heating process, it is imperative to devise alternative means of generating fuel energy that is affordable and ecofriendly for domestic and small medium enterprise purposes.

2. Briquette

Agricultural activities such as farming generates a lot waste inform of plant residue. This agricultural waste is enormous especially in some rural areas where farming is their major occupation. The burning of this waste is a common practice among the rural dwellers' farmers; as they cleared the land for new season of farming. This practice has been identified as a major contributor to greenhouse effect to the environment, especially in Sahara Africa (Akpenpuun, et al., 2020; Olaoye & Kudabo, 2017). The eco-friendly and economical mode of disposing this waste is by converting them to useful feedstock for such as briquette for fuel energy (UNEP, 2011). Briquettes, which also known as a green charcoal has come up as an alternative fuel for domestic cooking and heating process. According to International Water Management Institute (IWNI, 2017), briquette is a carbon neutral cooking fuel that is made from renewable biomass waste such as sugarcane waste, coffee husks and rice husks etc. which can be sold as a fuel for cooking and heating. It a renewable organic resource that contains energy in form of chemical that can be transformed to fuel energy (USAID, 2010).

Briquette fuel has the competitive advantage over wood fuel as they reduce health challenges associated with wood fuel due to inhaling of carbon monoxide and are also beneficial to the environment as they reduce greenhouse effect. The world health organization revealed that almost 52% of the global population still rely on wood fuel, coal and solid biomass as a means of energy for domestic purposes such as heating and cooking process in which larger population resides in Africa and Asia. For instance, United State Agency for International development (USAID, 2010) reported that apart from Bangladesh and Thailand, the use of biomass briquettes as domestic cooking fuel is rather limited in Asia due to cheap wood fuel, which make larger population depends on wood fuel for their domestic cooking and heating process. In Malawi, Food and Agricultural Organization (FAO, 2020) reported that the average annual wood fuel removal from forests ranged from 4.8 to 5.7 million m3 (under bark) in the period from 1991 to 2011, and since 1996, has been continuously increasing reaching 5.7 million m3 in 2011. While the forest area in the nation from 1990 to 2015 decreased from 3.9 million to 3.1 million hectares, with an annual rate of change of -0.9 percent and an overall reduction in this period of 0.8 million hectares. In Darfur, Sudan (USAID, 2010) reported that over two million rural inhabitants heavily rely on fuel wood due to its low cost which is responsible for rapid depletion of forest reserve. While in Ghana, 60% of the population depend on the wood fuel to meet their domestic energy need (Chaney, 2010). The Global Village Energy Partnership International (GVEP, 2013) in 2013 reported that approximately 82% of the Kenya's population relied on wood fuel for their cooking and heating.

Similarly, in 2011, Nigeria was rank among the countries that produce wood fuel in the world, meaning that majority of the rural dwellers still depend on the wood fuel to meet their daily domestic energy need in the country (Ichu et al., 2020). This attested to the fact of high rates of deforestation, desertification and lack of sustainable forest management that is facing the country. Also, Considering the effect of these negative trends on the environment and climatic condition, briquette fuel seems to be the perfect alternative energy fuel.

The implication of this data is that much relief will be experience by climate if an eco-friendly source of fuel energy such as briquette is adopted. This is furthered buttress by Ben-Iwo et al (Ben-Iwo, Manovic, & Longhurst, 2016) and (Ibrahim et al 2020) that briquette can be a means of waste management for the agricultural waste/biomass, which will relief dependence on the wood fuel and restricting the proportion of deforestation and desertification which may lead to non/low emissions of harmful greenhouse gases from incomplete toxic combustion of natural plant resources. International energy agency (IEA, 2006) reported that the high calorific value of briquette makes it better source of energy fuel, as it tends to undergo complete combustion in the presence of enough oxygen. Sachez et al. (2022) also reported that briquette has lower ash content than coal which limit the emission of harmful substance to the environment. Therefore, bio-mass briquettes can be considered as an alternative energy fuel. The briquette formulation in Nigeria has many advantages such as availability of various of raw materials; indigenous technology for production, ease means of transportation and large ready market.

Briquetting Technology

The need to address the drawback associated with the uses of direct biomass has a fuel has necessitated studies into process techniques in which biomass can be converted into an improved and eco-friendly source of energy (Thliza et al., 2020). According to (Ali et al., 2021), the direct usage of biomass either as a cooking or heating as a sustainable energy resource constitutes some difficulties due to its high moisture presence, low energy value, heterogeneity and low density. Hence, a need for pre-treatment before production. Previous studies highlighted different forms of pre-treatment available for biomass before briquette formulation. for instance, Bach et al. (2027) reported torrefaction pre-treatment which involve thermal degradation of biomass in an inert environment at 200-300ºC for a specified time depending on the nature of biomass. Torrefaction improves the properties of biomass which make it possible for direct usage. Sankaran et al., (2018) reported that torrefaction process dehydrates and decompose protein and carbohydrates to a desire concentration; depending on the reaction time and nature of the biomass. Hemicellulose decomposes from 200°C; cellulose degrades at 27ºC and while lignin decomposes in-between 250 -500ºC (Blasi, 2009). Torrefaction process reduces biomass moisture; increase density, heating value and ignitability (Adeleke et al., 2021). Also, Basu (2013), reported that carbonization process is similar to torrefaction process but is done at high temperature (500 – 900ºC) under inert environment by slow heating of biomass to the high temperature. The slow heating allows sufficient yield of solid fuel, while higher heating rate results in higher liquid products (Basu et al., 2013). Carbonization does not retain maximum quantity of energy of the biomass, and thereby leading to low energy product. Furthermore, pyrolysis process involves heating the biomass at high heating rate with aim of increasing hydrocarbon while decreasing the biochar according to Basu et al. (2013), pyrolysis is specifically carried out for production of liquid extracts from the biomass. carbonization, on the other hand, is to maximize fixed carbon and minimize hydrocarbon content of the solid product, while that of torrefaction is to maximize energy and mass yields with reduction in oxygen to carbon (O/C) and hydrogen to carbon (H/C) ratios. Adeleke et al., (2019) also reported the blend of coal with treated biomass to give an improved briquettes fuel. The effect of heat on the biomass and the corresponding thermochemical is reported in the table below according to (Basu, 2013).

Table 1. Thermochemical process of feedstock at different temperature

Temperature Range of Heating (⁰C)	Process that Occurs	Heating Rate	Process	Solid Product
20-110	The wood is preheated and it approaches 100⁰C, moisture starts evaporating	Low/fast	Drying	Bone dry wood
110-200	Further preheating removes traces of moisture and slight decomposition starts	Low/fast	Preheating Postdrying	Preheated dry wood
200-270	Wood decomposes releasing volatile (e.g., acetic acid, methanol, CO, and CO2) that escape	Low	Torrefaction	Mildly torrefied wood
270-300	Exothermic decomposition starts releasing condensable and non- condensable vapours	Low	Torrefaction	Severely torrefied wood
300-400	Wood structure continues to break down. Tar release starts to predominate	Low	Low temperature carbonization	Low fixed carbon charcoal
		High	Pyrolysis	Liquid
400-500	Residual tar from charcoal is released	Low	Carbonization	High fixed carbon charcoal
		High	Pyrolysis	Liquid
>500	Carbonization is complete		High temperature carbonization	Tar-free charcoal
			Pyrolysis	Liquid, higher gas yield

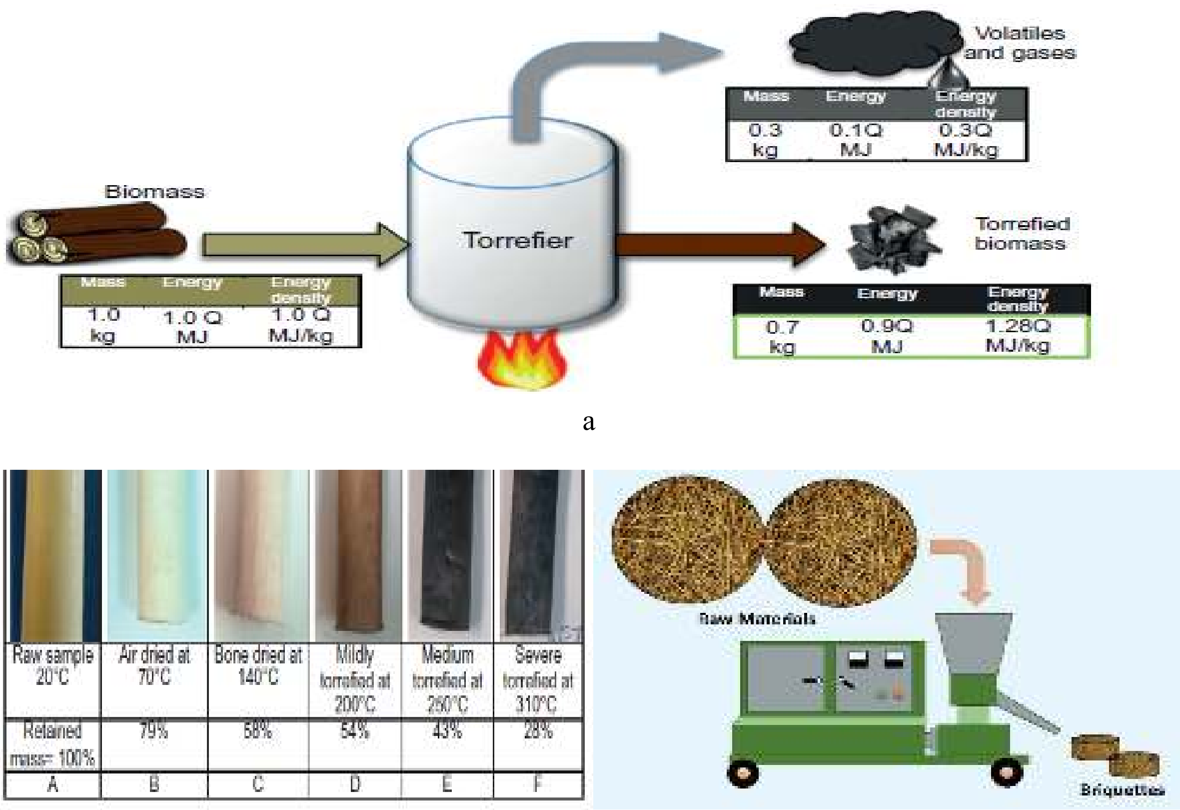

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Figure 1. (a) Mass and energy changes of a feed undergoing torrefaction (Basu, 2013), (b) Progress of torresfaction of the branch of maple tree. (c) Densification of biomass to produce briquette (FAO, 2020)

The principle behind briquette production involves densification of treated/untreated biomass feedstock to produce a solid material called briquette. According to Ibrahim et al (Ibrahim, Bello, & Ibrahim, 2020), briquette technology involves the compressed blocks of agricultural and forestry residues. This can be achieved with binder and without binder. According to Ichu et al., (2020), the binder usually employed in briquette formation includes starch derived from cassava flour, rice flour and sweet potato. also, starch derived from molasses and arabic gum from the bark of a tree. The essence of a binder is to improve the stability of the briquette. The food and Agricultural Organisation (FAO, 2020) emphasized the need to use binder when the briquette formation is done using manually operated machine, as there is limit to the degree of densification that can be perform by this machine. The choice of binder is also important as it may affect the compact and quality of the briquette such as stability and smokeless. Bhattacharya and Kumar, (2005) reported that mechanized production of briquette is absolutely powered by electricity, so densification/compression pressures will be higher, which means the briquette formed from this method may not require the application of binder, as the high pressure leads to more densified product thereby improve stability and quality of the briquette. According to Mahoro et al., (2022), there are two major basic high-pressure technologies. These methods are the ram/ piston press machine which was fabricated by Europe and the United States, while screw extrusion machine was solely designed and produced by Japan. While piston press briquettes are completely solid, screw press briquettes have a concentric hole that increases the surface area of the briquette and so facilitates burning. Most indigenous briquette process technology in Africa is modelled after plain screw extruders due to their ease of fabrication; easy to operate and availability of spare parts. Also, (UPSR, 2005) affirmed that briquettes made by screw press are consistent in size with a high resistance to disintegration, burns fast and may be utilized in the numerous applications such as a substitute for coal in a boiler. This is due to their ability to exert high pressure during briquette formation as this impact the quality of briquette produced (Faxälv & Nyström, 2009). The finished briquette tends to have low ash content; high thermal value, uniform and low rate of combustion. Also, Low moisture content and high density of briquettes gives it better boiler efficiency. Furthermore, Huang et al., (2017) reported biomass briquette can be reused as a compost, as against one time use of coal and oil. Also, Rezania et al. (2015) reported that briquettes burn with minimal smoke and a steady flame with no odor. This was plausible as a result of no Sulphur, low ash content which make it an eco-friendly fuel and can replace fossil fuel and wood fuel especially for domestic cooking and heating process.

Table 2: Briquette Technology according to Pressure

Densification technologies	Advantages	Disadvantages
Low pressure technologies	i. Low start up-cost ii. Minimum technical skills required for operations iii. The producer can easily take care of the breakdowns	i. Low volume production ii. Variable quality iii. Requires high manpower
Medium pressure technologies (e.g. screw extruders, agglomerator, roller drums, and hydraulic presses)	i. Technology is locally available ii. Spare parts can be sourced locally iii. Higher production volumes compared to low pressure technologies iv. Higher quality compared to the low-pressure technologies v. Minimum labour is required	i. Local machines are of poor quality and are therefore prone to breakdowns ii. Require electricity to run Compared to low pressure technologies the cost is higher
High pressure technologies (heated-die screw, ram/piston, and hydraulic presses)	i. High production volumes ii. Less labour is required as most work is automated	i. High initial cost ii. Requires skilled manpower, iii. Spare parts may not be locally available, iv. High electricity costs and maintenance cost compared to medium and low-cost technologies

Source: (CTCT, 2020; Atluri et al., 2017)

Briquettes of various shapes and sizes (Ichu , 2020)

Ceramic Stove for briquette (Faxälv & Nyström, 2009)

Manually fabricated handpress (Aliyu, et al., 2021)

Manual screw press (CTCT, 2020)

Motorised screw press (CTCT, 2020)

Mechanical co-centric screw press (CTCT, 2020)

Figure 2. Briquette and types of machines for its production

.

Hydraulic Piston press

Extruder Piston Press

Domestic briquette

Industrial Briquette

Figure 3. Domestic and industrial briquettes and the machines for their production

Raw Materials

Previous studies had revealed that numerous materials can be utilized for briquette. This includes agricultural residues such as tree leaves, rice husks, ground nut shells, maize husks, straw, and grass. Also, Akpenpuun et al., (2020) reported that processed materials such as waste paper can be used with other biomass such as charcoal fines and saw dust. Moreover, the calorific value of each type of biomass differs, which may have impact on their combustibility of briquette. This can be improved by blending different kind of biomass to improve briquette heating power.

According to Faxälv & Nyström (Faxälv & Nyström, 2009), the choice of raw materials for briquette formation is majorly on its ability to exercise bonding capacity when densified, in which fiber-content biomass has been proved suitable for briquette as a result of their ability create strong bonds after hydrotreatment. Also, briquette formation will be determined by the raw materials that are available, cost of production, technological availability and closeness to markets (CTCT, 2020). According to Food and Agricultural Organization (FAO, 2014), the common biomass used for the production of briquette are briefly listed at Table 3.

Table 3: Common materials used for briquette and their sources

Source	Raw materials that can be used
Agricultural wastes	Cassava stalk, coconut frond, cotton stalks, corn stalks, straw, millet, oat straw, frond palm oil, rice straw, rye straw, sorghum straw, soybean straw, sugar reed leaves, wheat straw
Industrial processing residues from agriculture	Cocoa beans, coconut shells, coffee husks, cotton seed hulls, peanut shells, cobs and wrap corns, oil palm stalks, waste from olive pressing, rice ball, sugar cane bagasse
Forestry development	Leaves, branches and twisted trunks.
Bioenergy crops	Acacia spp, Cunninghamialanceolata, Eucalyptus spp, Pinus spp., Populus spp., Platanus spp., Robiniapseudoacacia y Salix spp

Table 4. Biomass availability in Nigeria (ECN, 2013)

Types	Sources	Quantity
Biomass (non-fossil organic matter)	Municipal waste	18.5 million tonnes produced in 2005 and now estimated at 0.5kg/capita/day
	Fuel wood	43.4 million tonnes/yr. fuel wood consumption.
	Animal waste	245 million assorted animals in 2001.
	Agricultural residues	91.4 million tonnes/yr. produced.
	Energy crops	28.2 million hectares of arable land; 8.5% cultivated.

Table 5. Crop residue available in Nigeria (Ichu et al ., 2020)

Crop	Production (‘000 t)	Component	Weight available in million tons	Total energy available (PJ)
Groundnut	3,799.25	Shells	1.81	28.35
		Straw	4.37	76.83
Rice	3,368.24	Straw	7.86	125.92
		Husk	1.19	23.00
Maize	7,676.85	Stalk	10.75	211.35
		Cob	2.10	34.19
		Husk	0.92	14.32
Cassava	42,533.17	Stalks	17.01	297.68
		Peelings	76.56	812.30
Soybean	365.06	Straw	0.91	11.27
		Pods	0.37	4.58
Sugar cane	481.51	Bagasse	0.11	1.99
		Tops/Leaves	0.14	2.21
Cotton	602.44	Stalk	2.25	41.87
Millet	5,170.45	Straw	7.24	89.63
Sorghum	7,140.96	Straw	7.14	88.39
Cowpea	3,368.24	Shell	4.89	95.06
Total			145.62	1,958.94

3. Challenges associated with briquette usage in Nigeria

According to Food and Agricultural Organization of United Nations (FAO, 2016), Nigeria practices much agricultural activities which 71,000,000ha out of the 91,077,000ha available land areas were utilized for the purpose of agricultural activities. This generated much agricultural waste which can be converted to biomass. Unfortunately, despite this huge availability of biomass, briquetting in Nigeria has remained underdeveloped, even with the appropriate funding and conducive environment (Ichu et al., 2020). A lot of people in sub-urban and rural dweller have no access to briquette, talk less of its affordability. Locally made briquetting machine has been made in order to encourage the indigenous technological process, but the production has not been commercialized. This section will take a look on the barriers to commercializing briquette technology in Nigeria. Some of the barriers discussed here are sourced from literature; interactions with scholars, charcoal retailers and charcoal end users. The barriers will be discussed as below:

Poor planning

Planning for briquetting requires inclusive evaluation of all factors of production involve in converting the residue to final product till it gets to end users. This involves sustainability; continuous supply of raw materials and feasibility studies to predict the market demand-supply system. Unfortunately, there is scarce in-depth studies on the part of organization with assumption of free supply of feedstock. Other factors such as transportation; technicality around machine operations and economical consideration should be adequately considered.

Alternative uses of Agricultural Residue

According to USAID (2010), alternative uses of agricultural residue has remained a major setback to successful briquetting in Africa. The alternative usage includes using agricultural residue such as sorghum; maize as a perimeter to wither house or farm near the resident areas. Also, residue with fiber content are usually used to reinforce the mud block for either building or perimeter fence. This has severe impact on the quantity of feedstock available for briquetting and the continuous supply of such feedstock.

The low cost of wood fuel in Nigeria

The low cost of wood fuel such as firewood and charcoal in Nigeria has led to poor acceptance of briquette fuel among the populace. This problem is similar to cases in Darfur, Sudan the low cost of wood fuel sabotage the effort for establishing briquette as an alternative fuel (USAID, 2010). While in to Malawi, the price of briquette can compete with the price of charcoal, making briquette partially patronized in the country (Faxälv & Nyström, 2009). also, Uganda is doing well with briquetting technology.

Lack of Funding

The private investors remain the major reason behind the booming of briquetting in Uganda. The investor partnered with local farmers in term of funding to make feedstock abundantly available for briquetting. The lack of fund as a result of the disinterest of private investors in briquetting has crippled its production in Nigeria. Most of the briquette produced had left on the shelf in laboratory with no hope of commercializing the technology.

Poor Marketing

Wood fuel has been a major means of domestic cooking and heating for a long time. Accepting briquette may take a long time as more effort need to gear towards sensitization on the important of using briquette. It is quite unfortunate that even people living in urban area has yet to see briquette talk less of those in sub-urban and rural areas that need this technology mostly. The poor briquette image is as a result of poor marketing of the production and it accompany benefit both to the individual and the environment.

Technicality challenges

The technicality deals with operation and maintenance of the machine. This has been partially handled by patronizing indigenous or locally fabricated machine with simple principle of operation. Also, lack of internal maintenance capability, and unrealistic support services from indigenous fabricator also underline the adoption of the technology.

4. Implications

High rate of Unemployment

The recent sharp down curve of the national gross domestic product according to the National Bureau of Statistic can be attributed to lesser engagement of labor resource. According to Olorunfemi (2021), about half of the Nigeria's population is made up of youth, which some 42% are below the age of 15 and another

29% are between the ages of 15 and 29. This is an indication of abundant labor force. Unfortunately, the abundant labor force translates to abundant unemployment as the few organizations operating could not absorb even half of the population. According to National Bureau of Statistics (NBS, 2020) the youth unemployment between age 15–34 years were at 35 per cent (%). While 28 per cent of youth employed were reported to be underemployed (working 20–39 hours a week) and 37 per cent were working full time (40 or more hours per week). The establishment of briquetting factory can be an answer to this high level of unemployment in the country. For instance, (GVEP, 2013) estimated that briquette operations can employ 9 employees on the average, while Food and Agricultural Organization (FAO, 2020) affirmed that briquetting can be another source of job opportunities, even among the females as the process are genderless and less stress.

Deforestation and Desertification

Forestation and tree planning have been deployed as a general means of carbon capture technology (plant absorbs carbon monoxide (CO_2) for photosynthesis while emits oxygen (O_2) as by-products). According to Ogunwale (Ogunwale, 2015), deforestation refers to the rangy and rapid clearing of forests while leaving the soil exposed to weather. (Rainforest, 2020) tree removal without replanting, leading to reduced forests, habitats, and biodiversity. This practice has a detrimental effect on the environment. Nigeria's Forest Reserves consist of 1,160 designated areas covering approximately 107,527.02 square kilometers (41,516.41 sq mi). These reserves constitute around 11% of Nigeria's total landmass, spread across 362 local government areas. According to Global Forest Watch (Global Forest Watch, 2023), deforestation activities in Nigeria are estimated to be at 163 Kha/year, while the nation has lost more than 12% of total tree between 2001 and 2022. Also, Ahmed and Aliyu (Ahmed & Aliyu, 2019) reported an activity of deforestation in different geopolitical zone of the nation. Accordingly, between 1979 and 1995, total forest deteriorated by 48% in the North-central; 60% in the North-west, 7% in the North-east, 12% in the South-west, 13% in the South-south and 53% in the south-east respectively.

Wood fuel among other factors is responsible for massive deforestation in Nigeria as Ogunbunmi & Mwando (2014) reported that over 120 million Nigerians rely on wood fuel (charcoal and firewood) for their domestic need such as cooking and heating as a result of high cost of cooking gas and kerosene. According to World Wildlife Fund (Infoguide, 2015), wood fuel is responsible for more than 50% of trees illegally removed from the forest. Therefore, securing alternative to wood fuel is alternatively preventing the forest.

Green House Gas (GHG)

The releasing of carbon dioxide (CO_2) gas and its equivalent to the atmosphere has been reported to cause ozone layer depletion which its consequence is reflected in rises in temperature known as global warming. Nigeria is privy to international climate change treaties, like the Paris Agreement, which prioritize the global goal of achieving carbon net-zero by 2050 by engaging in activities that reduces greenhouse gas (GHG) emissions to the atmosphere through techniques like biological approaches, such as planting trees and increasing the amount of carbon stored in the soil, and engineered approaches, such as enhancing the rate at which certain minerals weather and devices that directly capture CO_2 from the air. According to the cable climate (Climate Cable, 2022), Nigeria witnessed an 46% increase greenhouse gas emission (GHG) with CO_2 accounted for 56 percent of the total GHGs in the nation. Also (Carbon brief profile) reported that Nigeria was occupying 25th position with nations that emit greenhouse gases in 2019, while occupying second highest emitter of GHGs in Africa. The severe impact of this GHGs was witnessed in massive flood (The Carbonbrief, 2022) and untold rise in temperature creating difficulties for middle- and low-income earner who can’t afford air conditioner (The carbonbrief, 2022). In order for Nigeria to meet up with carbon net-zero vision 2060, there is a need to shift to low-carbon energy. Briquetting may promise this since more than 50% of Nigeria engaged in wood fuel.

Respiratory Diseases

According to Ferkol and Schraufnagel (Ferkol & Schraufnagel, 2014), respiratory diseases are responsible for global major burden of morbidity, with health conditions such as tuberculosis and acute lower respiratory tract infections being the foremost issues. Also, allergy and related conditions such as asthma, chronic obstructive pulmonary disease (COPD) and lung cancers contributes to the high burden of respiratory diseases. In Nigeria, Akor et al. (2019) reported that an estimated 10.4% of hospital admissions at the emergency ward were related to respiratory diseases. Therefore, effort to curb respiratory disease is tantamount to reducing the cases of emergency at the hospital. While most of respiratory disease are caused by biological process such as tuberculosis by bacteria (Agbalaya, 2020; Ahmad & al, 2019), there are few that are caused by habit or environmental factors. For instance, inhaling of smoke could lead to lung cancer and weak lungs (Dobbie et al., 2012). It is a common tendency that people who usually utilized fuel wood inhale smoke inform of CO_x, NO_x and other harmful compound such as Sulphur. On long exposure, it may cumulate to respiratory difficult or worsening the existing respiratory condition. Therefore, briquetting can help in reducing burden of diseases associated with air pollution

5. Way Out

Media Sensitization of the Briquette

It is a known fact that briquette fuel is in obscurity in Nigeria. Most middle-income earners who are patronizing wood fuel are aware of the its carbon credit to the environment, but unaware of the low-cost alternative fuel such as briquette. There is a need for mass sensitization on the advantages of patronizing briquette fuel for mass acceptability.

Meeting with the stakeholders

The Federal Government through its research and technology agencies such as National Research incubator should have a meeting with stakeholders such as investors; captain of industries, researchers, community and religious leaders on how to develop a low-cost and quality briquette product that will gain acceptability from the masses.

Research and Development on alternative raw materials

Since the agricultural residue has alternative usage in Nigeria, waste materials can be incorporated into agricultural residue to produce a quality briquette. For instance, environmental campaign to reduce the use of polyethylene nylon (especially one-time use) has increase paper usage which generate a lot of waste. This paper can incorporate into other agricultural residue to produce briquette as the similar case in Malawi. Also, waste and leftover food such as rice; eba, tuwo etc when dried can also be used with another biomass for briquette production. This will reduce the cost of briquette and make it feasible to compete with the price of charcoal.

Funding for small and medium enterprises in Briquetting

The briquetting production would not thrive more than the encouragement and support received from external body. According to, the briquette formation was encouraged by the fund made available by the government for the solely purpose of briquetting and gasification of biomass. For instance, (USAID, 2010) reported that Indian Government encourages the commercialization of the briquette technology through financial assistance and technical support. As at 2001, Indian Agency (IREDA) has supported briquetting in the form of loans up to INR 174 million. The Federal Government of Nigeria can borrow a leaf by creating an agency that will give platform for funding and technical support for briquetting formulation.

Enforcement of Environmental Control and Drought Mitigation Regulation

In 2011, Federal Government of Nigeria (FGN, 2011) established environmental (desertification) control and drought mitigation regulation which is saddle with the responsibility of developing framework to protect forest and tree cutting while sensitizing the masses on the causes and detrimental effect related to desertification and land degradation. This regulation should be enforced in order to reduce the indiscriminate felling of tree. In some locality, especially the rural areas, the impact of State is always at minimal level. Therefore, there is a need to mobilize local hands in enforcing the regulation.

6. Conclusion

Briquette technology is an old technology that has tendency to contribute immensely in achieving the Sustainable Development Goals (SDG) 2030. This is due to its eco-friendly nature and lower inhibit of harmful substance during usage. The briquette technology has the capacity to boost employment in the country, while utilizing various feedstock that are abundantly available in the country. There is a need for collaborative efforts in order to harness the opportunities embedded in briquette production and to overcome barriers that has relegated briquette formation to the laboratory. The commercialization of briquette will reduce dependency on wood fuel; preserve the forest, improve quality of life and contribute to overall National Gross Domestic Product (GDP).

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