

Briquetting Business in Nigeria: A Solution to Unemployment

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Abstract - Unemployment rate in Nigeria continue to get worsened in recent years. In 2017, the National Bureau of Statistics (NBS), rated Nigeria at 18.8 percent, which ranked the nation as third after South Africa and Greece in the global unemployment rate ranking. This paper highlights the benefits of exploring a gap in terms of alternative fuel (briquette) source. Briquetting Business provides opportunities which exist for all scale of businesses and can tap into the available market, and with targeted support, the briquetting industry can be developed from a sporadic spread of small enterprises into a wide spread and self- supporting industry which can provide job opportunities and income.

Keywords: Briquette, Biomass, Carbonisation, Solid Fuel, Unemployment.

Introduction

The present world's energy crisis and its related environmental issues as well as increasing trend of fossil fuel prices provide for renewable energy source as an essential field to be explored [1]. In Nigeria, the escalating cost of petroleum products and irregular electricity supply, makes fuel wood to become a major source of fuel for families and small-medium enterprises. Over the 1989-2000 periods, fuel wood and charcoal constituted 32 and 40 % of the total primary energy consumption with 39 million tonnes estimate in national demand in 2000 [2]. An average daily consumption ranging from 0.5-1.0 kg of dry fuel wood per person is being consumed in the country for cooking and domestic purposes [3].

However, the use of wood as a fuel source comes with certain disadvantages: deforestation, climate change, soil erosion, desertification, and health problems as a result of exposure to carbon emission during indoor domestic cooking. There is the need to provide an alternative source of energy that will replace firewood. This alternative source should be economical and affordable to rural dwellers.

Biomass for energy consists of any organic material that can be used as a fuel; including firewood, forest wastes, dung, vegetable matter and agricultural residues. Energy from biomass accounts for 15% of global energy consumption [4]. The use of biomass feedstock(s) for the substitution of fossil fuel(s) has an additional importance from climate change consideration since biomass has the potential to be CO₂ neutral. Raw agricultural residues have many disadvantages as an energy feedstock [5]. These include: relatively low calorific value, difficulty in controlling the rate of burning, large volume or area required for storage, and problems in its transportation and distribution. Several of these disadvantages may be attributed to the low bulk density of agricultural residues which can be converted into high density fuel briquettes.

A briquette(s) is a block of flammable matter used as fuel to start and maintain a fire. Common types of briquettes are charcoal and biomass briquettes. Briquetting can prove to be one among the solutions for supplementing the fuel requirements and socio-economic development of the rural areas by providing employment to rural people. Many poor families' household budgets suffer from domestic energy expenses. Deforestation has become a worldwide epidemic due to poverty, poor management policies, pressures of population growth, greed, and so on. Therefore, success in fuel briquetting depends on understanding its benefits for the community. The enormous benefits of fuel briquettes include: environmental protection, income and employment generation, time, energy and life saving and so on.

Nigerian unemployment rate is currently rated at 18.8% [6] and the need for fuel is ever increasing as such fuel briquetting can serve as a source of income and employment to Nigerians. The technology on Biomass briquettes production can be transferred to unemployed people in rural areas and rural entrepreneurs to serve as an alternative fuel supply to the rural people and also to low income earners in the urban areas too.

Briquettes

Worldwide, many different types of briquettes exist for a variety of applications. In industrialized countries briquettes are commonly used as a fuel in industrial boilers and biomass cogeneration plants [6]. In Africa, particularly East Africa, where biomass dominates the domestic energy market, briquetting technology is gaining momentum particularly as wood resources become scarcer and the price of regular charcoal increases [3]. Although they come in assortment of shapes and sizes, there are basically two main types; carbonised and non-carbonised.

What is a Briquette?

A Briquette (or Briquet) is a block of flammable matter used as fuel to start and maintain a fire. Common types of briquettes are charcoal briquettes and biomass briquettes [7]. A number of companies in India have switched from furnace oil to biomass

briquette to save cost on boiler fuels. Use of biomass briquette can earn credits for reducing carbon emission to the atmosphere [8]. Throughout China, cylindrical briquettes, called “Fengwomei” are used in purpose built cookers.



Figure1: From left-right: honey-comb briquette (hydraulic press); non-carbonised straw briquette (piston extruded); carbonised charcoal dust (roller press); hand-made charcoal dust briquettes

Biomass for Briquettes

Briquettes can be made out of any biomass material, although the choice of feedstock can determine its heating potential as a fuel. The available biomass resource consists primarily of [3,8]:

- Wood
- Agricultural Waste (field residues and process residues)
- Animal Manure
- Municipal Solid Waste (Household and Food Processing Wastes)

While wood from trees constitutes the greatest amount of biomass stock available and consequently the most used form of biomass (including its use for charcoal), crop residues are also utilized and are receiving increased attention as awareness of the un-sustainability of the wood and charcoal trades grows.

Briquetting Process

Briquetting sometimes called *densification* is the process of converting low bulk density biomass into high density and energy concentrated fuel briquettes [8]. Briquetting is carried out on raw biomass to improve the density, burn time and other energy characteristics and to turn it into a size and shape to suit its purpose [9]. Raw materials are sometimes carbonised first to produce char, which can then be compacted into a briquette. If the feedstock is not already in powder form, it needs to be ground prior to briquetting [10]. Depending on the material, the pressure and the speed of compaction, additional binders such as starch or clays-oil may also be needed to bind the matter together.

Briquettes can be made on small scale and industrial scale. Although a variety of types and scales of machines and equipment can be used, the main processing steps remain the same [11 & 12].

Feedstock Preparation

Before compacting into a briquette, the feedstock must be in a powder form. Some raw materials such as sawdust and rice husks are already in small particle form, however others such as bagasse, straw and large charcoal fines need powdering. This can be done manually by crushing, chopping or by using mechanised milling machines. It is often then sieved to ensure consistency in the powder [13 & 14].

Carbonisation Process

Carbonisation (or partial pyrolysis) drives off volatile compounds and moisture leaving a fuel with a higher proportion of carbon remaining (char). This is the same process that creates charcoal from wood and is preferred particularly in urban environments for its superior burning characteristics and smokeless use. Conversion to char in a controlled process also reduces the amount of harmful emissions compared to when raw biomass is burned. The decision to carbonise depends on the application. Methods of carbonisation in developing countries largely follow traditional charcoal making techniques, which achieve conversion efficiencies of less than 10%. However some improved processes have been developed for small scale char production, with improved efficiencies of up to 30%. [14]

Binding Process

Binding is the process of ‘sticking together’ the compacted material by the use of a binding agent. If subjected to sufficiently high temperature and pressure biomass materials can bind together naturally, without the addition of extra-binding agents. High temperature can melt a naturally occurring substance called lignin and under pressure this can act as glue. If high temperatures cannot be achieved (as is the case with most locally made briquette machines) additional binding agents need to be added to enhance or activate the binding process.

Common binders include:

- Cassava flour
- Molasses
- Wheat flour
- Fine clay
- Red soil etc

Table 1: Comparison between different methods of carbonization [15]

Carbonisation method	Yield %	Duration	Capital investment	Labour investment	Cost US\$
Earth pit kilns	10-15	Days	Low	High	0
Brick & steel kilns	25-30	hours	Medium/high	medium	50-200
Large-scale plants/retorts	30-40	Continuously	High	Low	3,000-5,000

Briquetting Technologies

Worldwide a number of machines and techniques have been developed for briquetting on a range of different scales. The leading types are described here [8 &16].

Piston extruders are machines in which a heavy piston forces biomass material through a tapered die. These are capable of producing non-carbonised briquettes as well:

- Biomass is forced through a tapered die by a ram using high pressure
- Briquettes are extruded as a continuous cylinder.

The area of the die tends to determine the output of a machine; the larger die (and correspondingly larger machine components) results in a larger production rate. Flywheel drive machines can produce between 250-750kg of briquettes per hour while hydraulic machines typically produce up to 200kg per hour

Screw extruders use a screw action to extrude a briquette through a die. Biomass is fed into the machine from a hopper into the screw chamber. Powered by an electric motor, the screw forces the material through a die and out of the machine as a continuous (usually cylindrical) briquette. Examples of screw extruders include: conical die screw, heated die screw, plain screw extruders etc [17].

Roller Presses are commonly used to make charcoal briquettes. They involve two adjacent counter-rotating rollers with indentations in the shape of the desired briquette. Powder is fed from above, which falls into the indentation and is compressed as the rollers turn. The briquette then exits the machine as a single pillow shaped lump. The level of compaction achieved by a roller press is relatively low compared to a piston or screw extruder and so is suited more to briquetting of wet powders containing a binding agent. However production rate of a roller press can be very high, reaching 1.5 tonnes per hour. Roller Presses are used by most of the largest East African producers of carbonised briquettes.

A considerable number of low-capital **manual techniques** have been developed both for carbonised and non-carbonised feed stocks. Many of these designs have been disseminated in developing countries to encourage the production of briquettes among rural communities who would otherwise lack access to industrial technology.

Advantages of the technology

1. Smokeless: The charcoal briquettes burn without much smoke during ignition and burning.
2. Low Ash content: Minimum residual ash formed is less than 5% of the original weight of the charcoal.
3. Calorific value: ~ 6243.58Kcal/Kg (wood charcoal - 6592.52 Kcal/Kg).
4. Odourless: Contains minimum evaporative substances thus eliminating the possibility of odour.
5. Sparkless: No sparks are produced like wood charcoal.
6. Less crack & better strength: Helps burn for a longer time.

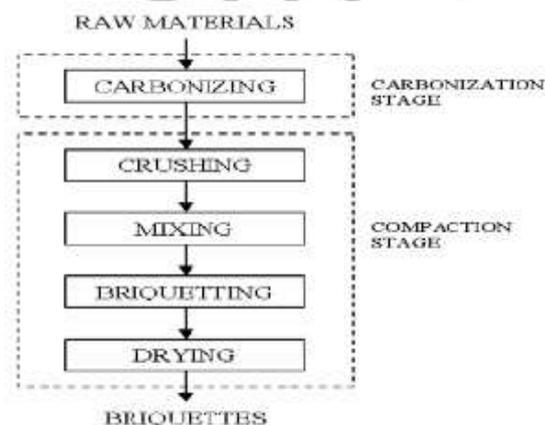


Figure 2: Biomass Briquetting Process

Briquettes and their Potential

Briquettes have the potential to be a source of renewable energy if they are made from sustainably harvested biomass or waste agricultural residues. Crops grown in Nigeria such as maize, cereals, roots, cane sugar and groundnut all produce residues that are suitable for briquetting as does dried organic municipal solid waste (MSW) [18]. According to food and Agricultural Organisation Statistical Data base (AOSD), Nigeria contribute about 51% of the total food supply in West Africa which invariably indicates the quantity of agricultural wastes available to be used as Biomass for briquettes.

Nevertheless, practical limitations such as seasonal variations, competing uses and collection are factors that can significantly lower the amount of raw material available for commercial opportunities. Hence, briquettes alone will not have the potential to fully address the approaching biomass crisis in Nigeria, however they will certainly be part of the solution and there is large scope for growth from an industry that is starting from a very low base which equally provide employment opportunities.

Table 2: Estimated crop output in Nigeria in the year 2004 in Million MetricTonnes. [17]

Crop	Production (Metric Tonnes)
Cassava	45,000,000
Yam	33,500,000
Millet	8,000,000
Maize	7,500,000
Sorghum	11,000,000
Rice	4,600,000
Potato	1,000,000
Cowpea	3,000,000
Groundnut	2,800,000
Oil Palm	1,800,000
Sugar Cane	800,000
Sweet Potato	3,000,000
Cocoyam	2,000,000
Cotton	5,000,000
Coffee	200,000
Cashew	180,000
Cocoa	150,000
Plantain	250,000

Table 3: Biomass resources and estimated quantities in Nigeria (2004) [2].

Resources	Quantity (million Tonnes)	Energy value ('000MJ)
Fuel wood	39.1000	531.0000
Agro-waste	11.2444	147.7000
Saw dust	1.8000	31.4333
Municipal solid waste	4.0750	

Why Briquette Businesses?

The cry for alternative energy source has put charcoal and fire wood fuel in the fore front in Nigeria and the Globe at large. The high demand of these products makes their prices to keep increasing substantially year after year. In contrast, Briquettes are made from materials that cost little or no money to obtain which makes them economical viable as an alternative for fuel and as a source of income. In Nigeria, the availability of crop residues from maize, cassava, millet, plantain, groundnuts, sorghum, oil palm, palm kernel, and cowpeas have been estimated at about 58million tonnes in year 2004 which is projected to about 80million tonnes in year 2010. These residues when converted to energetically usable forms can substitute or complement the fossil fuel energy sources in the country by more than 80% [18].

Table4: Fuel Comparison: calorific values. [2]

Types of Fuel	Energy (Kcal/kg)
LGP	11,100
Natural gas	9,100
Wood Charcoal	7,500
Charcoal dust briquette (carbonized)	7,400
Sawdust briquette (non-carbonised)	4,800
Raw wood	4,100

Who will get benefited?

- Un-employed people
- Self-help groups (SHGs)- men & women
- Farmers
- Rural and urban enterprises

Market Opportunities

The market for briquettes are enormous in Nigeria, highest possible potential targets are restaurants and institutions such as schools and hospitals, which have need for large quantities of fuel and whose cooking requirements are suited to briquettes (as

they are longer burning) [19]. Domestic markets on the other hand may look difficult to penetrate due to the lack of awareness (and acceptance) poised among household consumers. Media campaigns will be an effective way to reach consumers and promote awareness of briquettes.

A further opportunity worth exploring is fuel supply to small scale industries. Rural industries are increasingly making use of raw biomass as fuel for boilers and biomass cogeneration plants.[20]

Local Dye industries, Groundnut oil industries in the Northern part of Nigeria use saw-dust with wood shavings, used engine oil, waste tires, wood (which they usually consider as expensive) and any other combustible material they can lay their hands on not considering the health effect and environmental pollution caused.

In industrialized nations, briquettes are preferred for use in biomass boilers as they offer superior and well controlled burning characteristics. Despite the extra expense of a processed fuel and the need for compatible boilers, increased attention to energy efficiency may make a case for briquettes [21]. This is an area that requires more detailed market research and analysis.

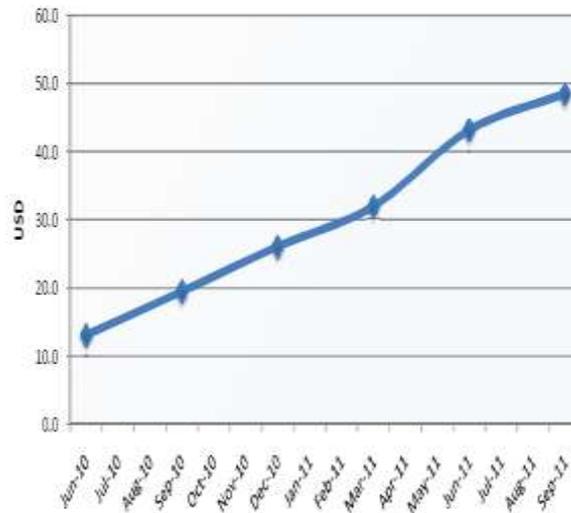


Fig 3: Average Monthly Sales (USD) of DEEP Briquette Businesses in Uganda, Small-Scale Briquette Production

Manual making briquettes is simple; it requires the handling of manual extruders. Very little capital is required at this level and there is abundance of raw materials from agricultural wastes and charcoal dust. It is still a good income generating activity for individuals to engage in and offers an opportunity for rural employment. Selling briquettes is often more profitable than other rural professions in places like east Africa. Chardust Ltd, Nairobi, Kenya was founded in 1999 as an alternative energy company that manufactures and sells over 2,000 tonnes of carbonised briquettes per year, mainly to poultry farms, restaurants, hotels and safari camps for space and water heating.

Appliances for Biomass Briquettes

Briquettes can be used in any appliances meant for burning wood or coal. However, certain changes in operating parameters especially regarding the distribution of primary and secondary air will have to be incorporated into the conversion. One should first understand the specific characteristics of briquetted biomass before taking steps to make changes in appliances. Briquettes have a density twice that of common fuel wood. Porosity is very low and, accordingly, char produced during combustion is denser than wood or biomass charcoal. Moreover, screw pressed briquettes with a central hole have better combustibility than ram pressed solid briquettes and are considered to be better fuel than coal, wood and solid briquettes. This is mainly due to: (1) the larger surface area per unit weight or volume for the same size; (2) in spite of low porosity the effective thickness or resistance for release of volatiles is relatively much less and thus their flammability is much higher; and (3) char left after combustion is also twice as dense as wood and it burns slowly due to higher ash content. Since inventory of this char is much higher for the same thickness of bed, the briquettes have a higher heat capacity i.e., they retain heat for a longer period and keep the appliance at a higher temperature which then facilitates easy ignition of fresh fuel charges. The applications of briquettes include the following :

Boilers: For steam generation

Food processing industries: Distilleries, bakeries, canteens, restaurants and drying etc.

Textile process houses: Dyeing, bleaching etc.

Agro-products: Tobacco curing, tea drying, oil milling etc.

Clay products: Brick kilns, tile making, pot firing etc.

Domestic: Cooking and water heating

Gasification: Fuel for gasifiers

Charcoal: Suitable for making charcoal in kilns

Conclusion

From the enormous importance of fuel briquetting and its cheap technology together with the paralytic fuel supply for cooking constitutes an avenue to be explored to an ever-ending unemployment problem in Nigeria. Apart from the foreseen danger in

deforestation, the rate of unemployment and poverty level in Nigeria is high and alarming, as such, engaging in briquetting businesses in Nigeria will go a long way in solving so many problems ranging from health issues to environmental degradation to providing a safer alternative and also serving as a source of income.

Nigerian Government and various NGO's also have a role to play, by creating an industry for briquettes production, proving regulations on charcoal and most importantly, providing support and capital investment which if channeled properly can certainly be an important part of the solution to unemployment and poverty alleviation program. Briquetting business opportunities exist for all scales of business to grow and tap into the available markets and with targeted support the briquette industry can be developed from a sporadic spread of small enterprises into a widespread and self-supporting industry which can provide job opportunities and income.

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