Briquetting agricultural waste as an energy source in Ghana

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Abstract: - This article aims at providing biomass as an alternative to wood charcoal using in Ghana. Using agricultural wastes converted into charcoal briquettes to provide much needed source of cheap fuel that is cleaner in burning. It is also intended to create awareness of agricultural wastes briquettes technology in Ghana and to make use of the technology by small scale entrepreneurs. This paper also seeks to explore benefits Ghana can achieve by using agricultural residue as a substitute for wood fuel burning. Agricultural residue includes all leaves, straw and husks left in the field after harvest, hulls and shells removed during processing of crop at the mills.

Keywords: - Agricultural waste, Biomass, agricultural residue, charcoal, briquettes, Wood fuels

1 Introduction

Billions of tons of agricultural residue are generated each year in the developing and developed countries. This volume of biodegradable wastes can be converted to an enormous amount of energy and raw materials. Agricultural biomass waste converted to energy can substantially displace fossil fuel, reduce emissions of greenhouse gases and provide renewable energy to people in developing countries, which still lack access to electricity. As raw materials, biomass wastes have attractive potentials for large-scale industries and community-level enterprises. Ghana, as a developing country depends heavily on wood fuel as a source of energy, contributing about 72% of the primary energy supply followed by crude oil and hydroelectricity in that order . The associated harmful environmental, health and social effects with the use of traditional biomass like firewood and fossil fuel has enhanced the growing interest in the search for alternate cleaner source of energy globally.

2 Current sources and Status of energy consumption

The bulk of energy supply in Ghana is met from wood fuels, i.e. firewood and charcoal. This is due to the fact that the greater portion of Ghana's energy consumptions is in the residential sector. Majority of households, about 80% in Ghana depend on wood fuels for cooking and water heating, the demand for wood fuel has for the past years been on the increase [1]. In addition to the domestic dependence of woodfuels, there is also commercial, industrial and institutional use. This usually involves the direct combustion of these wood fuel in low efficiency traditional furnaces like mud stoves, oven and coal pots as common in most households especially in the rural areas in Ghana. Wood fuels account for about 71±1 percent of total primary energy supply and about 60 percent of the final energy demand. [1]. In 2008 wood fuel contributed about 72% of the primary energy supply to the country with crude oil and hydro making up the rest as shown in Fig. 1. According to the Ghana Energy commission, in 2008, Ghana's biomass energy consumption was 11.7 million tonnes, while petroleum products and electricity consumption were 2.01 million tonnes and 8,059 GWh, respectively. In terms of total energy equivalents, biomass (fuelwood and charcoal) constituted 65.6%, with petroleum products and electricity accounting for 26.0% and 8.4%, respectively [4]. Fig.2 shows Ghana's energy consumption from 2003 from the main sources of energy from 2003 to 2008. As mentioned earlier wood fuels constitute the greater portion of Ghana's energy source with petroleum and electricity following in that other

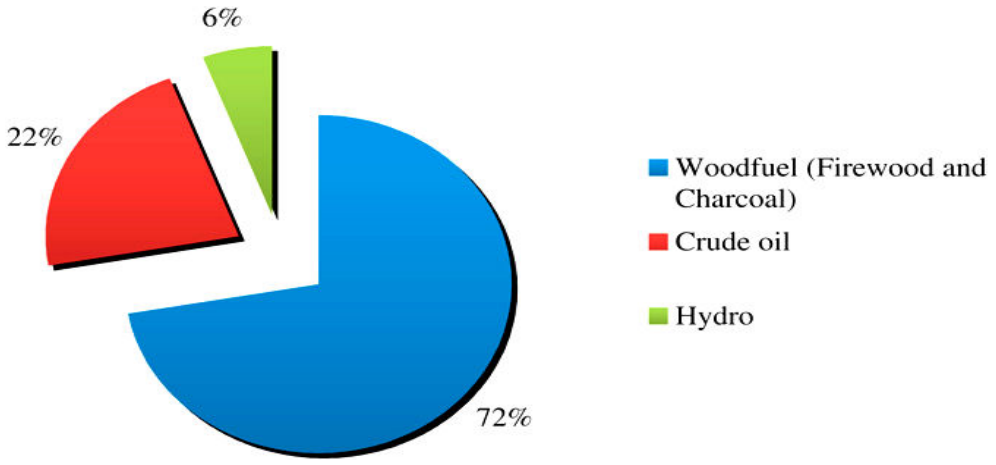

Fig.1. Percentage contribution of primary energy supply in Ghana for 2008[2, 3]

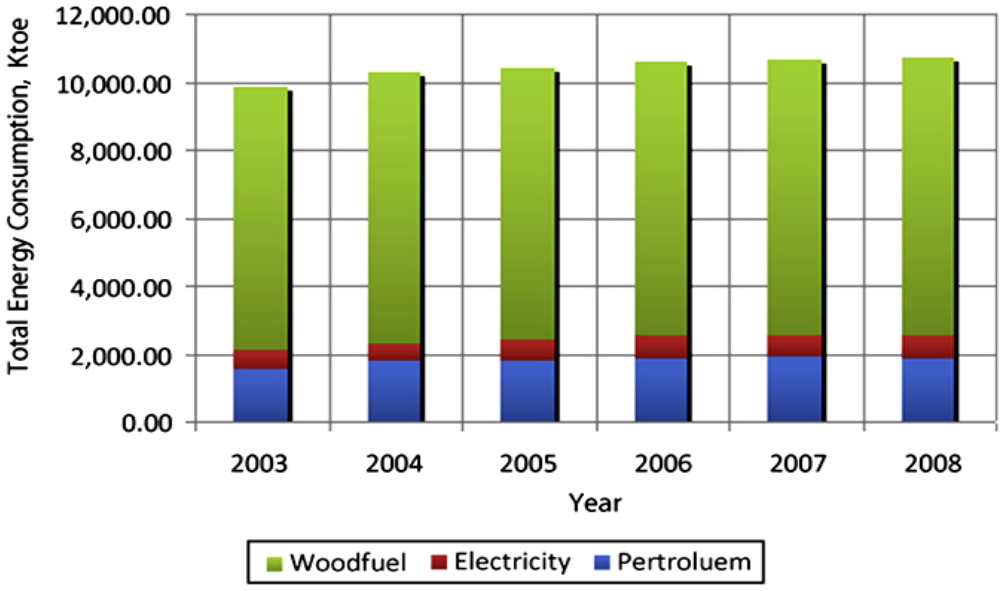

Fig.2. Total energy consumption by energy type in Ghana from 2003 to 2008[2, 3]

The use of wood fuels and other environmental degrading forms of energy in Ghana is compounded by unaffordability and inaccessibility of conventional forms of energy like electricity by both urban and rural poor. Should the Ghana Poverty Reduction Strategy (GPRS) targets to usher the country into a middle income range of US$1000 per capita in 2015 be realised, demand for woodfuels would grow from about 14 million tonnes in 2000 to 38-46 million tonnes by 2012, and 54-66 million tonnes by 2020 [2,5]. This increase in demand would put the nation's dwindling forest under undue stress which could culminate into serious deforestation. The effect of this may subsequently have serious impact on climate change, agriculture and water resources, if no significant action is taken. Women in Ghana bear the brunt in the use of the wood fuel based energy economy in the country. The health impacts of indoor air pollution from traditional biomass fuels and their negative impacts on women, girls and babies remain a critical issue.

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3 Agricultural residues

Agricultural waste can be defined as wastes normally associated with the production and processing of food and fiber on farms, feedlots, ranches, ranges, and forests which may include animal manure, crop residues, and dead animals; also agricultural chemicals and their residues and containers, which contribute contaminants to surface and subsurface water. (ASAE S292.5) Agriculture is the main contributor in Ghana's economy, the sector drives the Ghanaian economy accounting for almost 86% of household heads involvement and 35% of export earnings since 2000 [2]. Therefore there is the need to combine old technologies with modern trends to achieve sustainable development. Ghana has a long agricultural tradition and it has been expanding and improving gradually. With this expansion also means there is an increase in the amount of agriculture waste generated. To achieve sustainable agricultural sector, waste generated from agricultural process must be treated also as a by-product.

Agricultural waste is an ideal source for charcoal. When we harvest any crop, we generally harvest only grain, fruits, coffee, pods, and tubers. This constitutes only about 30 to 40% of the total biomass. This means that about 60 to 70 % of the total agricultural biomass is the waste biomass produced annually

All kinds of tropical crops are in cultivation and residues such as maize cobs, rice husks, palm branches, shells and nut are major potential fuel used in many parts of the country. They are normally popular fuels that burn rapidly and well and are usually used in relatively small quantities to supplement or augment ignition when the main fuel is forest wood or charcoal. There are many instances where they are used exclusively for heating purposes such as in traditional palm oil processing, fish smoking, small scale smelting and palm kernel oil processing.[6] There is little use of agricultural waste in Ghana and it is mainly use as animal fodder, manure while the greater portion is burnt openly on the field.

4 Charcoal Briquettes

Agricultural wastes (grass, dry leaves, sugarcane trash, etc) and residue which are produced in huge quantities in Ghana is put to little use. The conversion of agricultural wastes to char, by an environment friendly, continuous batch process, briquetting of the char into a solid fuel form and use as an efficient, clean source of fuel. Charcoal can be made from anything containing carbon. The traditional material has been wood[8] but due to the adverse effect this is having on the environment as a whole there is the need for alternative material for making charcoal . A given quantity of charcoal produces approximately twice as much heat as the same weight of wood [7]. The briquetting system is the conversion of agricultural waste into uniformly shaped briquettes that are easy to use, transport and store. The idea of briquetting is to use materials that are otherwise no usable due to lack of density compressing them into a solid fuel of convenient shape that can be burned like wood or charcoal. The briquettes have better physical and combustion than the initial waste. Briquettes will improve the combustion efficiency of existing traditional furnaces. [10] The charcoal briquettes from agricultural waste can be used as fuel in place to ordinary wood charcoal in the rural houses in Ghana and as well in the urban cites too. The good is that the type of cooker or stove needed for using charcoal briquettes is manufactured readily and almost can be found in every home in Ghana and it is referred to as the coal pot. Test conducted in India have shown that biomass charcoal briquettes shows higher energy, quick heating in less time with less smoke as compared to wood charcoal. [10] The comparison of wood charcoal and biomass charcoal briquettes are below in table 1

Briquette charcoal	**Wood charcoal**
Smokeless	Smoke
It exhibits faster heat release and greater heat value	Less heat release and smaller heat value
Low production cost when compared to purchase price of wood charcoal at local market	High production cost
Reduce impact of deforestation	Enhance deforestation impact
It can burn for long time (2-3 hr)	It can burn for short time (1-2)

Table 1**:** Comparison of briquette charcoal and wood charcoal [7]

5 Charcoal Briquettes making process and tools

5.1 The carbonizer and the carbonization process.

Charcoal is a carbon substance that remains when organic matter is heated to a high temperature in a low-oxygen environment. The carbonizer is a simple design that provides a means of creating this low-oxygen environment. The carbonizer can be made of cylindrical oil drum which is readily available in Ghana. The two ends of the drum can be replaced with two conical shapes made of sheet metals that are welded at the bottom in such cases the upper part has 24 holes for removal of smokes and the lower one with no holes so the path of the smoke is upwards using the inserted cylindrical pipe at the middle of the carbonizer which is welded with the two conical shapes [9] or the top end is replaced with a conical chimney and the lower side can have two fire ports with a door (12'' high X 20'' wide). An iron perforated sheet fitted with holes is then fixed above the firing portion. [10] The agricultural biomass waste is separated into stems, leaves, fruits etc and cut in to pieces**.** The biomass is tightly packed into the inner drum and fired for 45 minutes to 1 hour (depending upon the biomass) [9]. The size of the carbonizer determines the amount of biomass you can carbonize and the time involve and also the carbonization process produces at 30-40% char powder on the average but the char yield varies according to the type of agricultural biomass waste used. [10]

5.2 Binding and binder Material

The binder material is used for strengthening the briquettes. The carbonized char powder is mix such that every particle of char is coated with binder. It will enhance charcoal adhesion and produce identical briquettes. The binder can be commercial starch, rice powder, rise starch (rice boiled water), starch made from cassava which is well known in Ghana and readily available and other cost effective materials like clay soil mixed in different proportions and shapes with the help of the briquetting machine. The starch is added to water in ratio of 10:1 then heated for 10 minutes or when the solution feels sticky and after poured on the char and mixed until all particle of the char are coated with the binder. [10]

5.3 Making the Briquettes

A meat mincer mould (model No.32) along with a 1HP electric motor fitted appropriately [10] or an extruder machine which a screw type press made of a sheet metal which welded on a solid steel shaft [7] or a simple design like the brick mould have with the dimensions of the briquettes in mind.

Briquetting is one of several compaction technologies to form a product of higher bulk density, lower moisture content, and uniform size shape, and material properties.[7] The charcoal mixture with binder can be made into briquettes either manually (extruder or mould type) or using machines(meat mincer mould with 1HP motor). For mechanical operations, the mixture is directly into the briquetting mould/ machine to form uniform-sized briquettes. [10] For manual operations, the amount of briquettes produce and time taken depends of the operator. The comparison of making biomass charcoal briquettes and wood charcoal is shown below.

Briquette charcoal	**Wood charcoal**
No need of digging a ground to prepare shallow pit of charring	Digging is required
Mobile (Its mobility allows working at a spot of harvesting, farmstead and anywhere)	Not mobile
It is not fire hazardous	sometimes it is fire hazardous
It is safe in the view of health factor	It is not safe

Table 2. Comparison of wood charcoal and briquette charcoal making process

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5.4 Drying, Packaging and Marketing

The briquettes are collected in a tray or spread raffia mats or collected on a surface like that used in the case of cocoa beans and dried in the sunlight for 2 to 3 days [10] and packed in bags for sale or as it done mostly in Ghana, arranged on a table in the market place and sold.

6 Capital investments

The raw materials in the form of agricultural biomass waste are readily available and free of charge. They can be collected from the farms after harvest and in the vicinity of the villages or in the forest. There is no transportation cost as most of the activities if not all will be done on site. The labor can be a famer and his family or minimum of 4 persons; 2 will do the collections process and 2 will be in charge of carbonization and briquetting [10]. Low cost binding material and in the case of cassava starch the person can prepare themselves. The only investment cost will be the briquetting machine and the carbonizer. The drum can be obtain free of charge in certain parts of Ghana or at a lower price of 2-5 GHS (1-2 Euros) and the workmanship of the welder who will form the conical chimney. At the beginning of the project the person can employ a simple mould crafted by an artisan with like 10 briquetting holes until they save for a mechanical mould or construct an extruder. Therefore the total capital investment for the project can range between 10 to 20 GHS (5-10Euros). The current sale price of a bag (40kg) of wood charcoal in Ghana is 12 GHS (6 Euros) so if the project yields 40kg of biomass briquettes a day and is sold at the same price as wood charcoal and let's says a day's expenditure is 2 GHS then the project is very much cost effective.

7 Discussions and Conclusion

The fact is agricultural biomass wastes are available in abundant quantities in rural areas hence it improves the viability of making biomass charcoal briquettes in the rural areas of Ghana. Since there is little or no cost of Cost of transporting the biomass and hence the profit increases. Development of biomass charcoal briquettes production technology in Ghana will go a long way to help elevate the unemployment situation in rural areas and help establish rural entrepreneurs. With the assistance of government and some none governmental agencies, Biomass charcoal briquettes production centers can be set up. This will again help to ease the pressure on the forest cover from wood charcoal making and help solve the deforestation problem in Ghana. Due to the cleaner nature of biomass charcoal briquettes, the health risks posed by the use wood fuel burning to women and children will be reduced drastically. International experience shows that biomass serves as a promising option of renewable energy. These experiences coupled with the available potential should be used to take the nation forward towards a clean and secure energy source.

References

[1] Energy Commission-Renewable Energy Division, Woodfuel use in Ghana: an outlook for the future? Http://www.energycom.gov.gh/pages/docs/General%20Documents/Renewable%20Ghana%20Woodfuel%20Outlook.pdf [accessed 12.04.11].

[2] Richard A., Martina F. B., Edward A., Biogas as a potential renewable energy source: A Ghanaian case study, *Renewable Energy* 36 (2011) 1510-1516

[3] Energy Commission (EC). Energy statistics; 2000-2008 [Ghana].

[4] Ministry of energy, Ghana, 'Energy sector strategy and development plan'. February 2010

[5] Energy Commission (EC). Strategic national energy plan (2006-2020) and Ghana energy policy. Accra, Ghana: Main version; 2006.

[6] Sefa - Bonsu A., biomass technologies in Ghana, http://www.nrbp.org/papers/046.pdf [accessed 12. 04. 11]

[7] Making Charcoal: The Retort Method. Volunteers in Technical Assistance, 1815 North Lynn St, Suite 200, Box 12438, Arlington, VA 22209. 1980. ISBN 0-86619-07

[8] Gary G., Charcoal DCNR Forester http://www.puffergas.com/historic/rules/rules.html [accessed 12.04.11]

[9] Wondwossen B., *Preparation of Charcoal using agricultural waste*; 1993

[10] Booklet Biomass charcoal briquetting, Shri AMM Murugappa Chettiar Research center Taramani, Chennai – 600113.Dec 2010