Energy Access for Remote Areas in Ghana: Thinking outside the box a deconstructive approach

[1]Commeh M., K., [2]Mohammed, J.,
[1]Technology Consultancy Centre, College of Engineering, KNUST
[2] African development and Natural Resource Institute (ADRRI)
Email: [1]commehmichael@gmail.com, [2]nakohinaa@gmail.com

ABSTRACT: An attempt to mitigate climate change through energy savings of biomass efficient stoves involves an multi-disciplinary approach. However energy assess through wide distribution of efficient clean stoves seems to be a herculean task as the road network in Ghana and developing world is non-existing. To approach this, an innovative out of box approach is needed to stimulate and trigger a revolution that will create the assess to energy in rural areas to wealth, but, a starting point for mitigating climate change. Mitigating climate change will save the planet in general and Africa in particular from biodiversity degradationwhilst improving health through clean cookstove promotion from the smart carbon credit concept. The annual growth rate of in biomass is 6-7%, and the demand can shoot up anytime prices of liquefied petroleum gas (LPG) goes up. Carbon dioxide emissions geos up as these biomass cooking devices are inefficient. Energy sources and especially firewood are the most used but climate pollutants in Sub Saharan Africa, contributing to about 30% to global warming. This article tends to stimulate a new approach through a smart carbon credit concept that benefits women. These womenwho,in, an attempt to provide good nutritional food and process agro-food as business sacrifice their health from indoor air pollution.These women of which almost (50%) are found in the rural settings use almost 100% fuelwood as their source of energy. The study recommended a mixed approach solution namely; smart carbon credit (to benefit end users mainly women rather than manufacturers) policies,as short term intervention and road infrastructure development.

Keywords: Smart carbon credit,Improved energy technology, Energy micro financing Banks.

Introduction

Energy as it said is a means to an end – the end being the growth in human welfare through development and wealth creation. Energy inadequacy is one of the parameters of basic needs of man that continues to constitute a roadblock to progress against poverty and growth of Sub-Saharan Africa (SSA's) economies. The absence of economic growth, business as usual attitude and poverty, stymie the expansion of energy access and services, compromising, energy security and development in the rural areas. Energy issues are SSA's as well as Global priority in addressing poverty,economic growth and carbon emission reduction from biomass. According to (Adeola and Ewah 2009), poverty and the challenge of the African energy sector are inextricably linked. In addition to this is the health related issues from in-door air pollution (IAP) and tradition cooking gargetsHutton, G., (2011).According Adeola and Ewah (2009), several countries of Sub-Sahara Africa (SSA), use biomass energy as their primary energy supply, and

this accounts for 70–90 per cent. It has been predicted that, one billion Africans will depend on traditional biomass to meet their energy needs by the year 2030.The same authorsclaim that half a million Africans die annually from indoor air pollution as a result of solid biomass fuels usage. In several countries in the region, the proportion of the population with access to electricity is in decline (UNDP, 2008), which means more people are reversing back to solid fuel use. A high fuel price in addition is sending most people back to the use of solid biomass culminating inforest loss(even though farming places a role too) in several countries of the region is occurring at an alarming rate. Biomass energy is seen to be the key contributor to deforestation and an important source of greenhouse gas emissions from the region, fearing to stymie efforts to address poverty and the climate challenge mitigation.

This paper is being written over the lack of progress on energy poverty in Africa, despite numerous documents, articles technical reports etc. Our energy poverty has been often presented as an intractable technical and economic challenge Adeola and Ewah (2009).

MDGs will remain a mirage if sustainable energy is not accessed. Financial challenges, shortage of technical skills and outside box thinking together with good governance structures are the key narratives that can address energy poverty through the empowerment of people to make choices that improve their lives.

Among other energy types biomass energy potential in the form of wood is highly exploited.And World Health Organisation (WHO) has identified indoor air pollution as a major contributor to acute respiratory disease, which is a leading cause of death for women and children. FAO (2000),estimate shows that global production and use of wood fuel energy and roundwood reached about 3,300 (10^6) m^3 in 1999, of which about 55% of this is used directly as fuel, and the developing countries produced and consumed about 90% alone. A worldwide level comparison between the available potential with the usage, shows that about two-fifths of the existing biomass potential is used, and this happens in most areas of the world where the biomass energy use was clearly below the available potential. About 70–75% of the global wood harvest is either used or potentially available as a renewable energy source. This amount does not include the large amount of logging residues and other woody biomass left on-site after logging operations. The use of residues to cover the internal need of energy is often the main utilizing channel for these raw materials. However, direct sales of these products for energy purposes, such as

production of pellets or briquettes, is becoming attractive in several developed countries (Parikka, 2003). And Africa apart from South Africa is no different.

Consumption of modern energy in sub-Saharan Africa is very low. Between 1980 and 2000, per capita consumption of modern energy in east and southern Africa remained small and stagnant, falling from an average of 317 kgoe (kilogrammes of oil equivalent) to 292 kgoe (World Bank, 2003). Large-scale biomass utilization encompasses direct combustion for process heat, ethanol production, gasification, heat cogeneration, biogas production, and briquetting (Karekezi and Kithyoma, 2003)

With populations increasing and economic/development goals becoming more difficult to achieve for countries in this region, the reliance on the nature or forest products is likely to increase.

The study showed a mixed approach namely; smart carbon credit as a financing mechanism (to benefit end users mainly women rather than manufacturers) policies, operationalization of trust and road infrastructure development.

Certainly there are some future research works that need in-depth investigation namely; level of trust by which stakeholders will be committed to conserving nature and forest, secondly investigating into evolving metaphors of the post-modern impressionist in relation to man's dialogue with nature and particularly in relation to sub-Saharan Africa.

These concerns have prompted one to aim at;

- enhancingclean energy access in remote areasof Ghana

The objectives to this aim are;

- Finding common ethical policy(ies) by which stakeholders will adoptand commit to the use and promotion of clean energy sources and devices in rural areas
- Investigating into the ethno-philosophicalvalue chain activities of the total energy dynamicsand its relationships to nature/biodiversity conservation

For the second objective, the application of geographic information system and remote sensing were used. Considering the volume of number of interviews conducted, not all quotes or response could be added in the final write up. I therefore briefly elaborate on the method used in the selection of the final excerpts. Commons answers for each theme that convey a specific point are examined and comparisons made across interviews. Analysis introduced used alternative scenarios on a particular theme or topic, to identify how respondents responded to an idea.

Method(s) and Methodology

Based onintegrated theory of reflexive dialogue, the fundamental method applied for the objectives were qualitative, using questionnaires and exploratory. The methodology includes a systematic search based on the major electronic databases and the websites of a number of major international organizations and by publication status as well asconsidering the volume of number of interviews conducted, not all quotes or response could be added in the final write up. One therefore briefly elaborate on the method used in the selection of the final excerpts. Common answers for each theme that convey a specific point are examined and comparisons made across interviews. Analysis introduced used alternative scenarios on a particular theme or topic, to identify how respondents responded to an idea. The interpretation method was drawn from deconstruction philosophy of Jacques Derrida.

Energy generation, production, and consumption data were collected as secondary data from the February, 2013 National Energy Statistics report by the Energy Commission of Ghana. Ghana as a developing country is industrializing, implying that CO_2 emission from energy consumption is expected to increase with years. CO_2 emission factors for the calculation of the emissions in Ghana of the study period from 2001 to 2012 are shown in Table 1. The major conversion made from the reported data (EC, 2013) was 1 GWh to 86 TOE (Tonnes of Oil Equivalent) to determine the biomass consumption from the total energy consumed.

Literature Review

Data sources and Carbon Dioxide (CO_2) emission factors

One collected energy generation, production, and consumption data from secondary data from Energy Commission of Ghana's National Energy Statistics report from February, 2013. Any

country that wants to industrialise will emit Co_2 as energy is used. And Ghana a developing country is no exception. CO_2 emission factors for the calculation of the emissions in Ghana of the study period from 2001 to 2012 are shown in Table 1. The major conversion made from the reported data (EC, 2013) was 1 GWh to 86 TOE (Tonnes of Oil Equivalent) to determine the biomass consumption from the total energy consumed.

Table 1. CO_2 emission factors

Fuel Type	**CO_2 factor (CO_2 lb/mmBtu)**
Biomass (wood)	213
Gasoline	154.91
Residual Fuel Oil	171.98
(CO_2 kg/mmBtu)	
Kerosene	75.20
Aviation Turbine Kerosene	72.22
Premix	70.22
LPG	62.98
($kgCO_2e$ per unit)	
Grid Electricity (kWh)	0.5246
Gas Oil (tonnes)	3528

Carbon Emission

The mean local emission factor for electricity in Ghana calculated over 2001 to 2012 is -0.1890±0.08. This implies that the emission factor by local consumption is zero from the adopted formulae from Sustainable Energy Action Plan (SEAP, part 2). One gets negative emission factor per the formulae, when one exports of electricity to neighbouring countries mainly Burkina Faso, Togo, Cote d'Ivoire and Benin since power generation is higher than consumption.

Carbon dioxide (CO_2) emissions in Ghana are mostly originating from the consumption of biomass (firewood and charcoal) and petroleum products and electricity followed in that order as shown in Table 1 above, Bessah, and Addo, A., (2013).
Biomass has a higher CO_2 emission rates than the other two sources of energy, implying that the higher the biomass consumption the higher the amount of CO_2 emitted.

According to (Bessah, and Addo, A., 2013), the total CO_2 emission in 2012 was 30.51 Million tonnes, higher than previous years. This may be attributed to the higher consumption of biomass in that year due to increasing prices of electricity and petroleum products though these products increasedin accessibility. Figure 1. shows the percentage emissions of carbon dioxide by energy type in Ghana in 2012. Biomass had 1% increase of CO_2 emission to consumption. The growth in Industry represented by GDP (from 20.4% in 2008 to 27.6% in 2012) (GSS, 2012) reflects the increase in energy demand and consumption in the country meaning a lot more people are reversing back to cheap biomass fuel. Meeting this demand will boost the economy and create wealth, but it might also be a significant contributor to global warming if energy strategies and products are not clean.

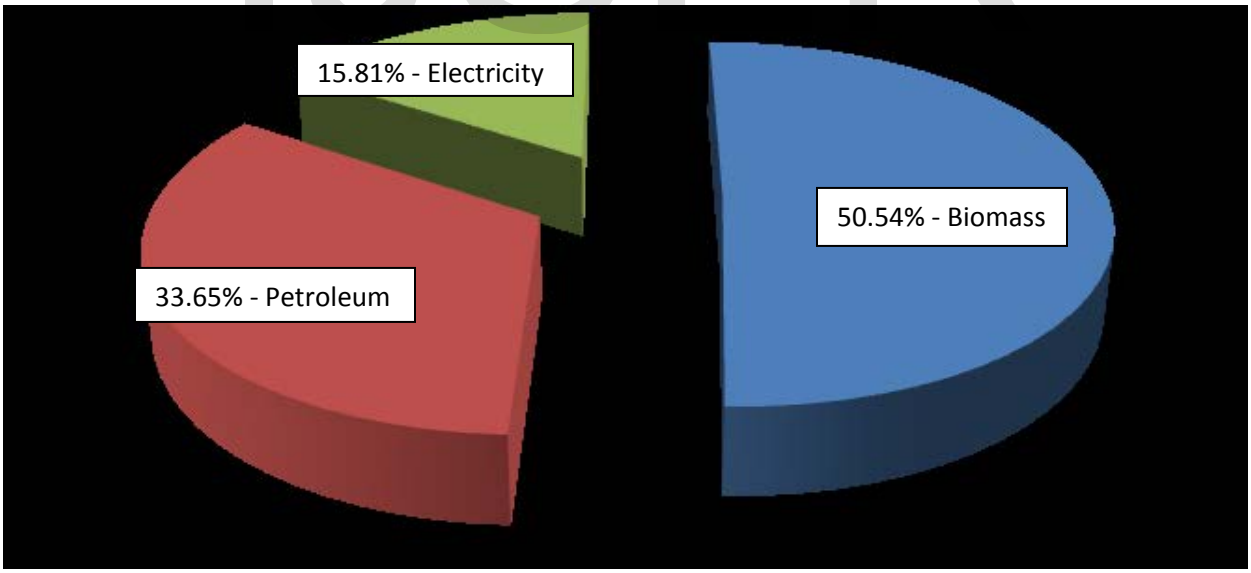


Diagram 1. CO_2 Emissions from 2012 Energy Consumption: Source-Bessah and Addo, (2013),

Significance of strategies and development plans to CO_2 emissions reduction

The Energy Sector vision of achieving access to modern energy forms by 2020 (Mahu & Essandoh, 2011) proposed energy consumption of Biomass, electricity, LPG and other petroleum products to be 30%, 20%, 25% and 25% respectively and the annual growth in the demand for fuel wood and charcoal is estimated at 3% per annum. Electricity demand, on the other hand, is growing between 6% and 7% annually while consumption of petroleum products is estimated to increase at about 5% per annum. Achieving this goal means that Ghana will cut down CO_2 emissions from Biomass by 20% which is approximately 6.14 Million tonnes with 16% (≈0.8 Million tonnes of CO_2) and 7.5% (≈0.8 Million tonnes of CO_2) increase in electricity and petroleum products respectively.

Energy consumption by type (2001 to 2012)

Biomass accounted for 49% of the total energy consumption in 2012 (EC, 2013) compared to about 71±1% of total primary energy supply and about 60% of the final energy demand in 2008 (Arthur et al., 2010 in Bessah and Addo (2013).

Biomass (wood fuel) consumption was followed by petroleum products at 41% and electricity making up the rest as shown in Figure 2. The industrial sector of the economy consumes the highest of an average of almost 49% of Ghana's electricity consumption while biomass is the leading energy consumption in the residential sector. The significant residential sector share of the Ghana's energy demand is due to the high usage of Biomass comprising mainly of firewood and charcoal which is 66.3% (EC, 2013). Electricity and Petroleum comprise Hydro and Thermal and Liquefied Petroleum Gas (LPG), Kerosene, Aviation Turbine Kerosene (ATK), Gasoline, Gas Oil, Premix, Residual Fuel Oil (RFO) respectively.

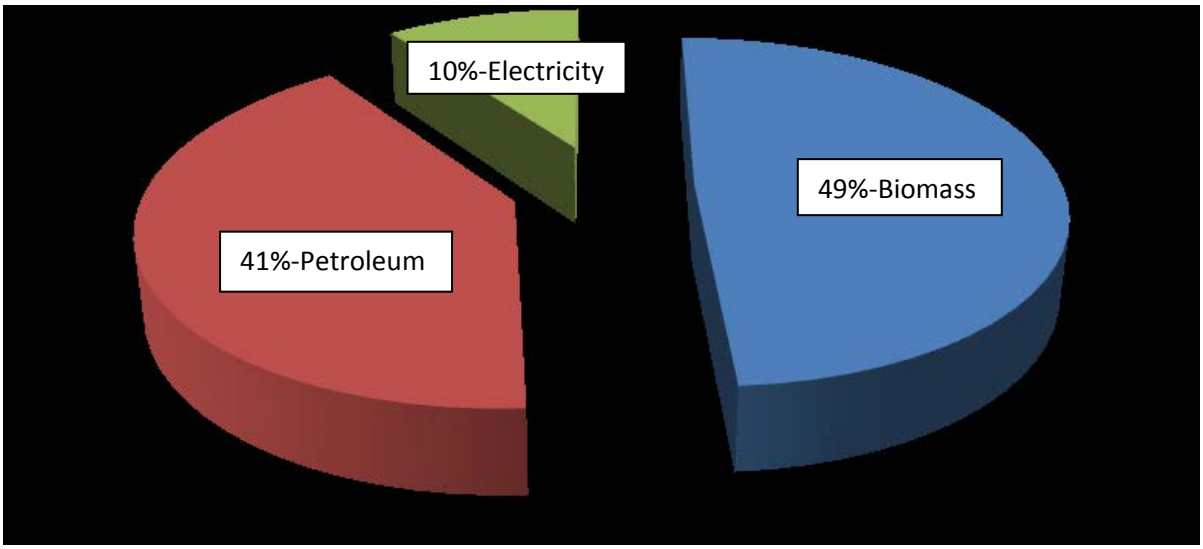


Diagram 2. Energy Consumption in 2012. Source: Bessah and Addo (2013)

The total energy consumption from 2001 to 2012 has been increasing, obviously due to increase in population and the industry sector. From Figure 3, Biomass reduced from 2001 to 2010 at an average rate of 1.82±3.18% and began to rise at about 7.82% to 2012. Petroleum products consumption was unstable, with increase from 2004 to 2007 and began to drop till a rise at an average rate of 10.8% while Electricityconsumed over this period dropped in 2002, started rising from 2003 to 2006 and went down again in 2007 before maintaining an increasing average rate of 7.81±31.92% to 2012 (Diagram2). The high deviation in the increasing rate of power consumption was due to the small increase of 71 GWh from 2011 to 2012. These trends perceive to show the increase in petroleum products and electricity generation in the nation but does not mean a decrease in firewood and charcoal usage.

This issue is inextricably linked to poverty. The poor are perceived to make do with solid fuels and inefficient stoves, and many are trapped in this situation: the health and economic consequences contribute to keeping them in poverty, and their poverty stands as a barrier to change. But close analysis and observation also shows entrepreneurs in the bakery and agro food processing industry using fuelwood extensively. It is perceived that when where socioeconomic circumstances improve, households generally move up the energy ladder, carrying out more activities with fuels and appliances that are increasingly efficient, clean, convenient, and more expensive, Bessah and Addo (2013).

The pace of progress, however, is extremely slow, and for the poorest people in Sub-Saharan Africa and South Asia, there is little prospect of change. In the case of indoor air pollution in households using biomass fuels, the risks also seem to be fairly strong, presumably because of the high daily concentrations of pollutants found in such settings and the large amount of time young children spend with their mothers doing household cooking

Health and Energy

The use of or burning of biomass and fossil fuels for the purposes of cooking and space heating are main cause of indoor air pollution in the developing world. Four billion world are affected by indoor pollution health related issues.The reason being the free or low cost availability of biomass, and the higher cost or limited availability of cleaner fuel options in rural areas (e.g. electricity, liquefied petroleum gas, or LPG)., This means that a major share (67%) of households in developing countries continue to use solid fuel (Rehfuess, Mehta et al. 2006)
Anthropogenic, or man-made, air pollution can be traced back to when humanity discovered how to make fire. While air pollution in those days was insignificant compared to the present time, burning biomass in enclosed spaces for space heating or for cooking purposes would have exposed humans to risk of respiratory diseases and injuries. As human populations became settled and increasingly burned biomass and fossil fuels (such as coal) indoors, the exposure to air pollution and its negative consequences rose significantly. According to (Rehfuess, Mehta et al. 2006) in Hutton (2011)) the percentage of populations in developing countries burning solid fuels indoors, ranges from 16% of households in Latin America and the Caribbean and Central and Eastern European regions, to 74% in Southeast Asian and Western Pacific regions and 77% in Africa. The use of biomass has it adverse effect on the ecosystem or biodiversity.

Biodiversity, ecosystem and Energy production

Investigating into the ethno-philosophy activities of the indigenous people and its effect on nature deals with the search for activities in general and socio-economic activities in particular that are affecting the vegetation in the study area. This research was done to find out whether these ethno-philosophy activities have some effect on the biggest national park.What emerged

was staggering. One observed that biomass energy, road network and farming played quiet a massive role in biodiversity or ecosystem degradation and which remotely is affecting national park.The period of analysis over 20 years from 1984 to 2007.

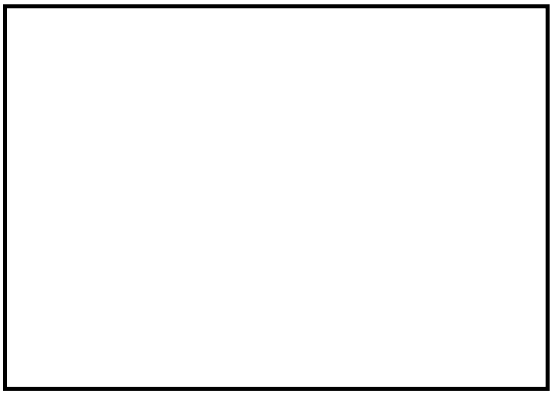


Image1: Vegetational changes within 20 years. Source the Author.

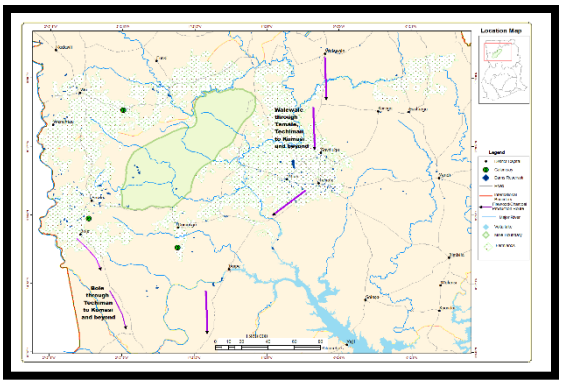
From the north eastern side of the park has a lot of settlements or communities or villages who are engage in yam farming, an environmental destructive food crop and activity. The farming activity has increase because of increase population in the big cities both near and far; namely Accra and Kumasi. Baukina Faso, Mali, Niger and Nigeria are major market centres for charcoal and firewood. And in an attempt to cash in on the increase demand for charcoal and firewood and food crop like yam, farmers have increased their production at the detrimentof the environment. In trying to maximize production to maximize profit, inefficient charcoal production and farming methods are employed. The current efficient charcoal production method (simple metal kiln) is 24%. In addition lots of smoke emissions are released into the atmosphere. Unlike the Kayape, a Gé-language-speaking tribe a native people living in the northern Brazilianrainforest who practice sustainable agriculture based on philosophy of manipulating the fields or forest without injuring it, Hartman (2004, pg129, in Commeh PhD thesis unpublished), the practice by the communities in the study around the northeast of the Mole natinalapplication of exposes the soil to evapo-transpiration, etc. through fertilizer application and cutting of trees shades. This is likely to reduce the groundwater level, since low vegetational cover as seen in fig. 4, will facilitate run off rain water in addition to evapo-transpiration. The provision of huge pans of water for irrigation of rice, onions, legumes etc. together with population growth, human and infrastructural activities over 30 year span, have probably accounted for the sharp negative

vegetational change as shown by the satellite imageries. The relatively good first class road in the middle corridor (Kumasi-Techman-Tamale-Bolga to Mali and Niger) has also facilitated the environmental destructive socio-economic activities Map1.

Figure 3: A typical Fuelwood market. Source the Author

Wood fuel forms about 99.5% of the energy need of the population around MNP and probably 95% in the big cities like Tamale, Techiman etc.. Nationally 86% of Ghana use solid fuel GSS (2010). This therefore has put pressure on the wood forest thus adding to the contributing factor and reason of the vegetational change found in the satellite image in figure 4 above. The relative first class road has facilitated an easy transportation to the demand destinations.

Figure 4: Parked Charcoal by the Highway. Source the Author



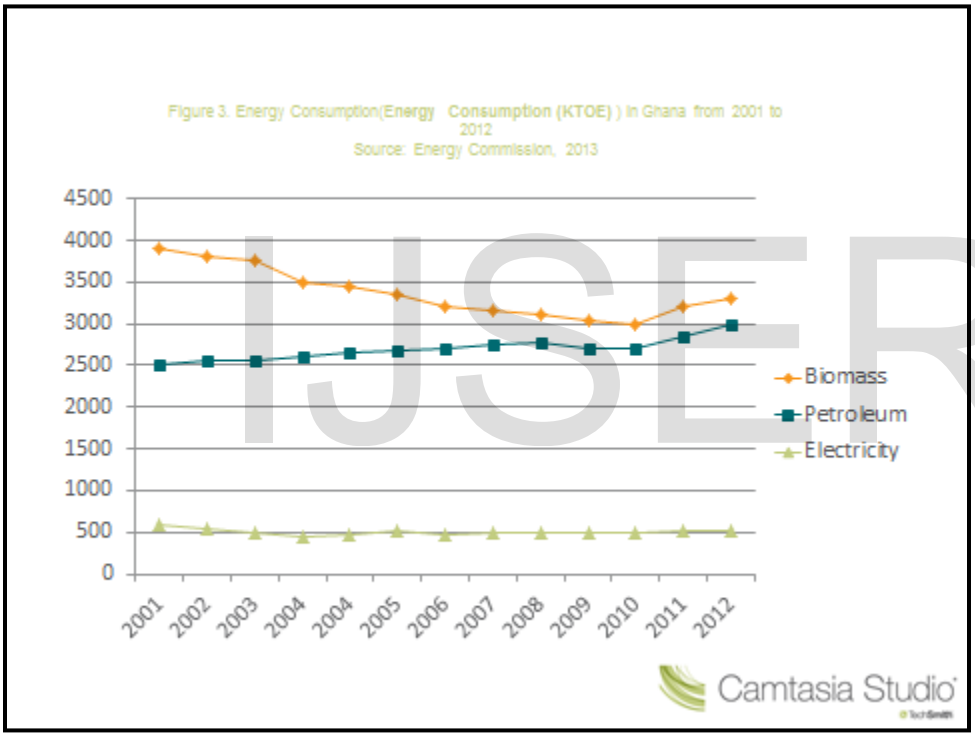
Map 1: Movement of Charcoal, Bushmeat and food crops from the study area. Source the Author

Results and Discussion

Biomass seems to be the blood bank of this nation and probably the developing world. Biomass accounted for 49% of the total energy consumption in 2012 (EC, 2013) compared to about 71±1% of total primary energy supply and about 60% of the final energy demand in 2008 (Arthur et al., 2010). Biomass (wood fuel) consumption was followed by petroleum products at 41% and electricity making up the rest as shown in Diagram 1. Ghana pays 300% of electricity bill as compared with neighbouring West African countries as well as the developed world. In terms of sector wise utilization of electricity, the industry sector of the economy consumes the highest of average almost 49% of Ghana's Electricity consumption but the residential sector leads in Biomass consumption. The significant residential sector share of the Ghana's energy demand is due to the high usage of Biomass comprising mainly of firewood and charcoal which is 66.3% (EC, 2013). Electricity and Petroleum comprise Hydro and Thermal and Liquefied Petroleum Gas (LPG), Kerosene, Aviation Turbine Kerosene (ATK), Gasoline, Gas Oil, Premix, Residual Fuel Oil (RFO) respectively.

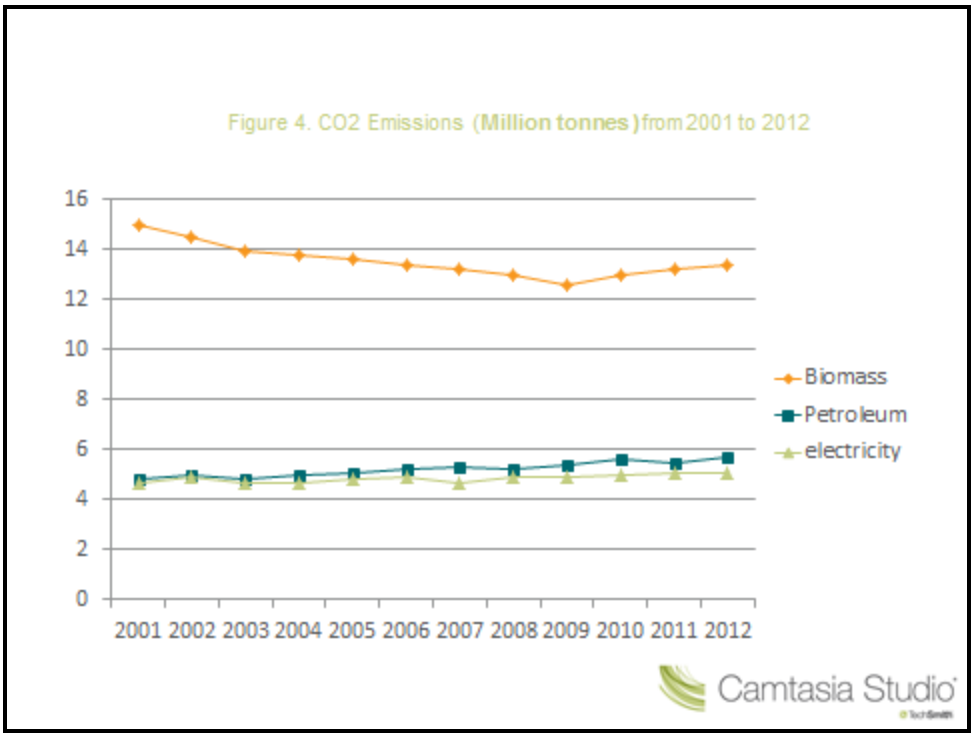
The total energy consumption from 2001 to 2012 has been increasing, obviously perceived to be due to increase in population and the industry sector. From Graph 1, biomass reduced from 2001 to 2010 at an average rate of 1.82±3.18% and began to rise at about 7.82% to 2012. The increasing biomass from 2010 as shown in Diagram 1, is the fact that the LPG supply especially is erratic and price keep going up, forcing people to easily fall back to biomass which is relatively cheap and available. Petroleum products consumption was unstable, with increase

from 2004 to 2007 and began to drop till a rise at an average rate of 10.8% while Electricity consumed over this period dropped in 2002, started rising from 2003 to 2006 and went down again in 2007 before maintaining an increasing average rate of 7.81±31.92% to 2012 (Graph 3). The high deviation in the increasing rate of power consumption was due to the small increase of 71 GWh from 2011 to 2012. These trends show the increase in petroleum products and electricity generation in the nation but not necessarily replacing the local firewood and charcoal usage. The increase biomass usage is as explained earlier is because biomass is cheaper than the increasing cost of electricity and petroleum products.



Graph1. Energy Consumption in Ghana from 2001 to 2012: Source: Energy Commission, 2013

Correspondently, the CO_2emission is going up after 2010. This is due to increase in prices aggravated by erratic supply that plaque the country. 2001 to 2009 shows downward trend of CO_2 emission and this was because there was the available of petroleum products especially LPG and relatively low price for consumption to argument for the erratic electricity supply. More so, the introduction of fairly efficient cookstoves (Gyapa mainly) drastically contributed to downward trend of the CO_2 emissions.



Graph2. CO_2 Emissions from 2001 to 2012

From the first objective, respondents mainly women and consumers showed lack offinancing, survival value, road network, trust and availabilityof the clean cookstove product as themostdeterrent of the purchasing and use of the clean cookstove. For manufacturers, road network, trust and lack of finance are the most narratives preventing them from expanding and making them available for distribution or marketing the product. These answers were core ethical issues shared by most respondents.In addition, the researcher's observation point to the view that very little research had been done to solve the inefficiencies of cookstoves of all kinds for all purposes. Manufacturers claim to have improved cookstoves but failed simple water boiling test (WBT). Most researchers will tell you there are no funds for proper research.

From the respondents concerning objective two,lack of financing, survival value, road network, trust and availability of the clean cookstove product. As shown in the satellite imageries in Image 1 and Map 1, the two highways have facilitated increased volume of fuelwood and charcoal to the big town and cities in the Southern part of Ghana. Some fairly large amount is leaving the northern neighbouring countries as well. One can observe the alarming degradation of the

biodiversity along the Teckyiman-Tamale-Bolga highway as charcoal production is fast increasing due to the good roads. In addition lack of improved scientific technique contribute to low grade products and production output of the energy sources as well as limited variety of energy sources like briquette, pellets etc.

Policy Formulation and Conclusion

Though most concepts for carbon credits benefit manufacturers and marketers no such credit benefits consumers mainly women. These consumers are made to go through some labourious and seemingly complicated registration of forms for carbon credited distributors. Women in Ghana bear the brunt in the use of the wood fuel based energy economy in the country, constituting the highest percentage of energy consumption till now. The health impacts of indoor air pollution from traditional biomass fuels and their negative impacts on women, girls and babies remain a critical issue. Reducing biomass usage by reaching 50% household with LPG by 2015 will reduce the negative health implications it has on women. Inefficient biomass stove also emit more CO_2 than fossil fuel (Bituminous coal = 205.3 lb CO_2/mmBtu, Natural gas = 117.8 lb CO_2/mmBtu) at 213 lb CO_2/mmBtu. Reducing biomass usage through advanced efficient cookstoves as well as establishing dedicated woodlots for fuel wood will preserve forest and biodiversity to sequester carbon as an adaptation measure in the country.

The first recommendation is fundamentally finding a policy that will trigger an economic dynamics that will meet the common ethical values in the value chain of energy system in rural areas of Ghana and Africa or Global in general. Effective trustworthy leaders are needed toensure trust through the perpetual evolving learning process as a prerequisite for successful adaption. Research addressing questions on how stakeholders involved in energy consumption and management, can develop ‘trust’ as a culture would be a very interesting area for further exploration. The quick construction of road network within the study area will enhance socio-economic activities through the quick access to market. It will also engender biodiversity restoration as scientist will willing and quickly access these rural places easily. This will certainly improve food security by reducing post-harvest loses.

The question is how do we help the women in the rural settings switch to and access a clean energy system? What practical innovative policy or policies is/are needed to promote or encourage rural access of clean energy as well as stimulate economic dynamics that positively?

One would therefore recommend a policythat will engender education to contextually and contently involve how ‘trust’ can be taught to become a culture, to facilitate quality relationship, as a prerequisite for effective management of any system. The second recommendation for objective two, is the application of Carbon credit benefiting end users mainly women rather than manufacturers or stakeholders in the value chain of the clean cookstove dynamics. These women are fundamentally vulnerable and carbon credit will help in various ways; one to enhance survival/security of the women and children and help inhabitants to understand the relationship between reduced energy sources use and forest regeneration. Two and most important, it will reduce indoor and outdoor air pollution as they encourage by carbon credit to purchase clean cookstoves. An amount of USD$30 million over three years can for these women in the rural setting will encourage at least 5 million benefactors to stimulate 10million cookstove to be purchased over the three year period. This approach can generate USD$150 million into the value chain of the clean cookstoves system.

Conclusively, the absences of trust, improved road network, smart carbon credit is pre-requisite to food insecurity, poor quality relationship among stakeholders and reduced socio-economic activities leading to stress that will lead to enhancing conflict. The acceleration of the destruction of forest, worsening climate, poor health of women within the next 15years will also be experienced from the same parameters. .

Certainly, there are some future research works that need in-depth investigation namely; level of trust at which stakeholders will be committed to conserving nature and forest and secondly investigating into the evolving metaphors of the post-modern impressionists in relation to man’s dialogue with nature and clean energy availability particularly in relation to sub-Saharan Africa.

Large amounts of investments is going into government policies to increase hydropower production in the energy sector of Ghana with sixteen potential sites all over the country, with un Bui Dam being the latest to be on line last year. Though, hydropower is seen as a low-emission energy source that cannot meet the growing energy demands of Ghana it has its own vulnerabilities to climate change. These vulnerabilities on hydropower as well as thermal power have to be carefully considered to know what role hydropower and thermal power should play in the country’s energy future. The energy strategy and development policy should be, access of clean energy in the rural areas and climate inclined, and also the need to know how climate will

impact the strategyBessah, and Addo,(2013). It cheap to conserve energy than to provide more power

References

Hutton, G., (2011), Air Pollution; Global Damage Costs of Air Pollution from 1900 to 2050, PhD Thesis, Assessment Paper Copenhagen Consensus on Human Challenges
2011

Bessah, E. and Addo, A. (2013), "Energy Reforms as Adaptation and Mitigation Measures to Climate Change: A Case of Ghana", International Journal of Development and Sustainability, Vol. 2 No. 2 (In Press).

Rehfuess, E., S. Mehta and A. Prüss-Üstün (2006). "Assessing household solid fuel use – multipleimplications for the millennium development goals." Environmental Health Perspectives**114**(3): 373-378.

Mahu, S. and Essandoh, O., (2011), "Ghana Investment Opportunities in the Energy Sector", Ghana country report, Ministry of Energy,

Adeola, I., E., and Ewah O., E.,(2009), Prospects for Africa – Rethinking Biomass Energy in Sub-Sahara Africa ;The Role of Development Cooperation. International Centre for Energy, Environment & Development (ICEED).

FAO, 2000. The global outlook for future wood supply from forest plantations by C. Brown. Working Paper GFPOS/WP/03, Forest Policy & Planning Division. FAO, Rome, Italy.146 p

FAO, Forest Resources Development Service, Viale delle Terme di Caracalla, 00100 Rome, Italy. jim.carle@fao.org; Website: http://www.fao.org/forestry/index.jsp

Parikka, M., (2003). Global biomass fuel resources. Biomass and Bioenergy 27 (2004) 613–620 upgraded biofuels (e.g. wood pellets, briquettes) and wood. Department of Bioenergy, Swedish University of Agricultural Sciences (SLU), P.O. Box 7060, 75007 Uppsala, Sweden

Karekezi, S., and Kithyoma, W.,(2003). Renewable Energy fin Africa Prospects and Limits: Renewable Energy Group. The Workshop for African Energy Experts on Operationalizing the NEPAD Energy Initiative Operationalizing the NEPAD Energy Initiative. 2- 4 June, 2003 Novotel, Dakar, Senegal

GSS (2012), "Provisional Gross Domestic Product 201", Ghana Statistical Service, National Accounts Statistics, Ghana.

EC (2008), "Energy statistics: 2000 – 2008", Energy Commission, Ghana.

EC (2013), "National Energy statistics: 2001 – 2012", Energy Commission, Ghana.

Arthur, R., Baidoo, M.F. and Antwi, E. (2010), "Biogas as a potential renewable energy source: A Ghanaian case study", Renewable Energy, Vol.36, pp.1510 – 1516.