ASSESSMENT OF THE CONTRIBUTION FIREWOOD CONSERVATION STOVE INSUSTAINABLE USE OF WOOD FUEL ENERGY IN EMBU NORTH SUB –COUNTY, KENYA.

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Abstract- ***Wood energy is a renewable form of energy if sustainably utilized. In Africa, Kenya included, the dependence on natural regeneration compounded with increased use due to population pressure and wood fuel depletion is a major concern in the region. This led to the introduction of the firewood conservation stove to reduce consumption of firewood which is the man insource of domestic energy in Kenya. Although the intervention is in place, sustainable wood energy has not yet been achieved. Therefore there is need to assess the contribution of the intervention measure in enhancing sustainable wood energy use The main objective of the study was to assess the contribution of the firewood conservation stove in sustainable use of wood fuel energy in Embu north Sub County, Embu County, Kenya. The specific objectives are; to assess the level of awareness on the stove in Embu North Sub County, Evaluate how the cost of the stove influenced its impact in sustainable use of wood fuel, finally to assess the level of utilization of the stove and the effect of this to sustainable wood fuel use in the study area. Criterion sampling was used for this study, where 105 house hold were sampled half of whom had the stove and the other did not. The study used survey design where questionnaires, interview schedule, focus group discussion and observation was used in data collection. The study was concluded that firewood stove had great potential in bring wood energy sustainability but was not being utilized due to the faults in design as well as level of awareness. The study recommended that emphasis be put to create awareness of wood fuel conservation stove and community participation designing of the stove to make it user friendly.***

Index Terms- firewood conservation stove, sustainable use,

INTRODUCTION

Wood is considered humankind's very first source of energy. Today, it still is the most important source of renewable energy providing over 90% of the global total energy supply (International Energy Agency [IEA], 2015). Wood energy is as important as any other renewable energy sources. More than two billion people worldwide depend on wood energy for cooking and/or heating, particularly in households in developing countries (Food and Agriculture Organization of the United Nations, 2013). Firewood represents the only domestically available and affordable source of energy. Private households' cooking and heating with fire wood represents one third of the global renewable energy consumption, making wood the most decentralized energy in the world (IEA, 2014).

Wood energy can be a sustainable energy as it is a renewable energy especially with efforts to improve its supply and enhance a sustainable demand (United Nations, 2015). Many conventions and international agreements have been established focusing on alternative sources of energy but it has become clear that the ladder energy theory of shifting energy sources if people have more income is not the case (Taylor *et.al* 2010, Kroon *et.al2013*). Therefore, there is a global shift to view biomass as a sustainable energy source (Campbell *et.al, 2003)*. This has shifted focus from introduction of alternative energy sources to replace firewood to improving firewood technologies to make it more sustainable
(Nansaior*et.al*. 2010).

This led to introduction first of firewood energy conservation stove. This is an improved type of stove which is more efficient in wood use than the traditional three stone stove. It uses wood directly from harvesting having been only dried. Firewood saving is mainly due to the fact that the fired clay liner ensures heat is retained in the stove over a long time. The fired ceramic liner provides the thermal insulation to minimize heat loss (GTZ/PSDA, 2007). The stove can be fixed in the kitchen or can be portable by being enclosed in metal casing commonly known as Kunimbilijiko. According to a research study done in Tanzania, a household using three stones stove consumes around 2880 kg/year of firewood. According to the study, through the use of improved firewood stove consumption is reduced to 1728 kg/year/household, annual saving is around 1152 kg/household (equivalent to more than 20 trees/year) (TA TEDO, 2005). The adoption of firewood saving technologies would go a long way in ensuring sustainable use of the forest resources as the fuel wood demand will decrease. Currently the uptake of the fuel wood improved stove is estimated at 5% (Muchiri, 2008) and yet majority of the rural people in Kenya use firewood as their main source of fuel. Two factors have contributed to the introduction of energy conservation stoves. On one hand is the great effort to reduce excessive use of firewood in the attempt to safeguard forest lands and on the other hand is the effort to bring down the cost of firewood (Wereko-Brobby and Mintah, 2012). As this household fuel becomes more and more scarce, the law of supply and demand dictates that its price must go up. Consequently, there has been a dire need to come up with a strategy that reduces energy waste and hence reduce the amount of firewood that households use. Due to the combined effort of these two factors, the energy conservation stove was introduced (Theuri, 2002). It was hypothesized that it would achieve 30-45% savings on firewood, which means that it would theoretically reduce forest degradation by a similar value (United States Environmental Protection

Agency [US EPA], 2014). In Kenya, the introduction of energy cooking stoves was aimed at reducing firewood use by as much as 60% because the energy conservation stove would save over 60% of firewood compared to the traditional three stone fireplaces (Joint Energy and Environment Projects [JEEP], 2014). A study conducted using 800 households found that the energy conservation stove is capable of saving between 15% and 20% (Wereko-Brobby and Mintah, 2012). The achievement of such huge savings on firewood use would indeed make great contribution towards the reduction in firewood use. However, while the introduction of the energy conservation stove was based on high levels of optimism, the achievement of the hypothesized savings has not yet been determined or sufficient studies on this have not yet been conducted. This research study tried to seal this gap by determining whether the energy conservation stove has achieved the levels of firewood savings forming the basis of its introduction.

Acceptability is a major factor affecting the effectiveness of any technology in achieving its desired goal. High acceptability rates mean high intention, by intended users, to use the technology. However, this does not imply high adoption rate because acceptability is just but one element of the adoption equation where other factors such as cost take effect. The intention to use energy conservation stove is high. In a study conducted in Accra, Ghana, to assess the acceptability of the energy conservation stove, the acceptability rate was found to be at 90% despite the high cost of the same compared to the traditional cooking stove (Wereko-Brobby and Mintah, 2012). In Kenya, on the contrary, a project aimed at protecting the Kakamega forest managed to introduce 3,795 energy conservation cooking stoves to homesteads surrounding the forest within two years (Anon, 2012). Despite massive campaigns aimed at promoting energy conservation stoves, it is worrying that the level of penetration of improved efficient woodstoves for the rural households is still below 5%, yet there is enormous potential (Muchiri, 2008).

Although the energy conservation stove technology has been found to achieve significant reduction in firewood use, such assessments have not been conclusive on its actual level of success in making firewood sustainable. Therefore, there is a need of this study to answer that question.

Objectives of the study

Main Objective.

To establish the effectiveness of the energy conservation stove technology in achieving sustainable use of fuel wood energy in Embu North Sub County.

Specific Objectives.

1. To establish the level of awareness and community perception of the wood fuel conservation stove in achieving sustainable use of fuel wood energy in Embu North Sub County.
2. To evaluate the Level of utilization and impact in achieving sustainable use of fuel wood energy in Embu North Sub County.

II MATERIALS AND METHOD

Research site

The study was carried out in Embu North Sub County, an administrative unit in the larger Embu County. The County covers 111.7Sq Kilometers and has a population density of 661 people per square kilometer (KNBS, 2013). The total population of the Sub County is 73841 people with a total of 19,131 households (KNBS, 2013). Embu people inhabit the region and their main economic activity is farming (KNBS, 2013). Figure 1

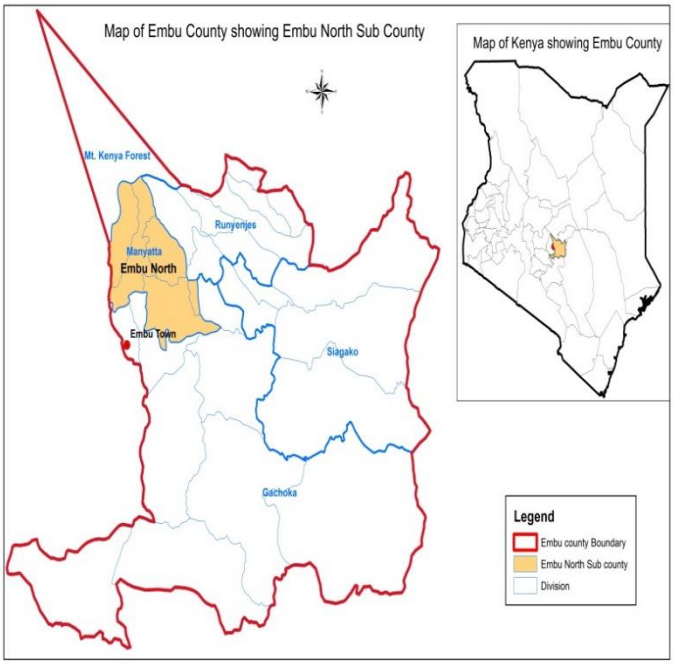


Figure 1.0: Map of Embu North, the Study Area.

Embu North is a cool and wet area on the south east of the slopes of Mt. Kenya on the windward side at an altitude of 2070 meters above sea level (Kenya Information Guide, 2015). Wood energy is readily available considering that the Irangi forest and the Mount Kenya forest are nearby; however, the move by the government to regulate tree harvest has resulted in dire shortage of the source of energy for families. Mt. Kenya is one of the main water towers in the country. Its destruction from deforestation has caused concern (Kenya Information Guide, 2015). Therefore firewood conservation stove was introduced by the government as well as the NGOs to enhance sustainable wood energy use. Little impact has been felt in reduced demand of firewood. Therefore the need to assess the level of success of the intervention in enhancing sustainable wood energy.

Sampling and Sampling Techniques

Sampling Frame describes how the researcher determined her sample size and sampling techniques used. As ample is that number of people selected from the entire population for the purpose of research by the researcher (Creswell, J. W., 2013). This study adopted the stratified and purposive technique as an alternative to probability technique due to limited time and resources.

The sampling method used the administrative units in the Sub County to classify the households in distinctive strata. There are a total of 7 administrative units in Embu North Sub-County(Marlow, 2003), states that at least 30% of the

total population is representative. Thus, 30% of the accessible population is enough for the sample size. The total number of households in the sub county was 19,131. The target Population were all households that had acquired any type of wood energy conservation stove, these were 513 households. The total number of sampled households was therefore 123. This makes up 36.9 % of the target population. Further, key informants were also included in the sample where one respondent was selected from each administrative unit. The total sample size for the study was therefore was 130.

Table 1.Sampling method

Administrative unit/Village	Target population (N)	Key informants	total respondents(n)
Ruguru	50	1	15
Ngandori west	68	1	20
Kathanagrire	70	1	21
Mbovuri	46	1	13
Gaturi North	96	1	28
Kimbugu	107	1	32
Ngandori East	76	1	22
Total	**513**	**7**	**123(7+123= 130)**

RESULTS AND DISCUSSION

Evaluation of Firewood conservation stove for sustainable energy use.

Firewood conservation stove technology was evaluated based on its effectiveness in reduction of firewood consumption, as a measure of enhancing sustainable wood fuel energy use in the study area. The first part analysed the perception and level of awareness of the house holds about the technology. The second part analysed the stoves utilisation in comparison with other biomass stoves; that is the traditional three stones stove and the charcoal stove. The third part presents findings on the stoves impact on firewood consumption. The final part will analyse the challenges facing the utilisation of the stove.

Level of awareness and community perception of the technology.

Table 2. Level of awareness of the conservation stove

	%	N
Aware of the stove	11%	14
Aware and have acquired	9%	12
Aware and have not acquired	1%	1
Not aware	79%	103
Total	100	130

It was found that the uptake of the conservation technology was very low (10%); table two, though this was above the average countrywide uptake of 5% (Muchiri, 2008). Factors highlighted for the low levels of awareness and acquisition of the conservation stove were; unavailability of the stoves as well as artisans to make them. The technology was mainly promoted by one NGO and community based organisation in the study area. The organisations mainly dealt with the portable firewood stoves, which were found to be less popular than the fixed stoves.

Figure 2:Three stones firewood stoveFigure 3:Portable firewood ConservationSource: Researcher stove. Source: Researcher

Figure 4: Fixed firewood Conservation stove. Source: Researcher

Level of Utilisation.

Number of households with conservation stove		
	%	N
Always	30	4
Sometimes	10	1
Rarely	20	3
Never	40	6
Total	100%	14

Table 3: Level of Utilisation of the firewood stove

From table three the level of utilisation of the stove among those who had acquired it was at 60%.This showed that acquisition did not directly mean utilisation of the technology. The term conservation stove was mainly interpreted to mean the charcoal conservation. With 80% stating that the wood fuel conservation stove only utilised charcoal. It was clear that the level of awareness and understanding of the technology has reduced its uptake and utilisation.

The charcoal conservation stove was introduced as the main wood fuel energy conservation technology. This stove was commonly known as KCJ-Kenya Ceramic stove, it was developed through a design process spearheaded by the Ministry of Energy. The stove easily found acceptance among urban stove producers who were initially offered free training and marketing support by the ministries of Energy, Agriculture, and Environment and Natural resources. Therefore the introduction of the firewood conservation stove found challenges as it came as a secondary solution to the KCJ stove.

Impact of firewood stove on wood fuel consumption

It was found that the conservation stove reduced firewood consumption from about 3 loads per week to about 1.5 loads per week. The study estimated one load to weigh on average 20kg. This brought the consumption of the three stone stove to 3120kg/year. With the conservation stove the consumption halved to1560kg/year. This accounted for 17.95%. These results were similar to the studies done in Tanzania, a household using three stones stove consumes around 2880 kg/year of firewood. According to the study, through the use of improved firewood stove consumption is reduced to 1728 kg/year/household, annual saving is around 1152 kg/household (equivalent to more than 20 trees/year) (TaTEDO, 2005)

Table 4: Impact of firewood stove on wood fuel consumption.

Wood fuel consumed per week	**load in kgs** **(1 load =20kgs)**
Wood fuel consumption with traditional stove	60kgs (3loads)
Wood fuel consumption with conservation stove	30kgs (1.5 load)

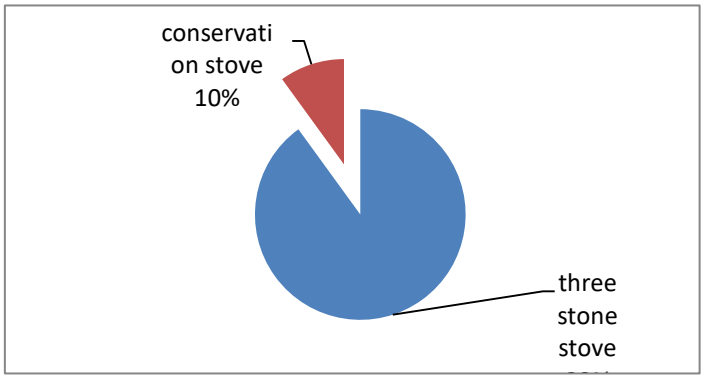
Comparison with other biomass stoves

There are three main stoves utilised in the study area which are the traditional three stones stove, the improved charcoal stove and the firewood conservation stove. This part of the study compared the firewood conservation stove with the two other stoves in terms of their level of acquisition and utilisation in order to understand their influence on the use of the Firewood conservation stove.

Comparison with three stones traditional stove

Figure 6: Comparison of use between three stone and fire wood conservation stoves.

It was found that only 10% of households used the fire wood conservation stove, while 90% used the three stone



traditional stoves. It was found that the fixed firewood conservation stove was more available in the house holds than the mobile stove. This was said to be because the fixed stove as modelled mainly by women groups and thus done to their specifications mainly address their needs. While the mobile one was fabricated by the organisations introducing them and had challenges in the design that made it hard for the women to use them. This led to some households who had acquired them not to use them. A majority of the respondents (90 %) in the study area reported that they had never used improved firewood stoves. However, about 9% of the respondents reported always using the improved stove compared to less than 1% who used it sometimes.

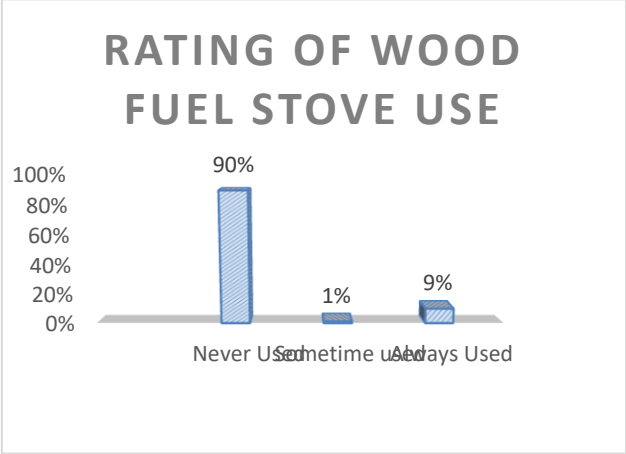


Figure 5: Rating of wood fuel stove use

The fabrication of the fixed stove was highlighted as being time consuming and required skill set to produce a viable stove. This was unlike the traditional stove that just required having the stones of approximately same size and shape and the distance between them could be adjusted as per the size of the cooking pan in use. With the three stone stove the households were able to use crop residue which was not possible with mobile firewood stove. This made the households to opt for the three stone stove though most knew that its wood consumption was high.

The traditional stove was found to be multipurpose unlike the improved stove as it was being used to light the kitchen as well as for heating the house at night which was not possible with the improved stove due to the ceramic lining

Comparison with conservation charcoal stove

The study showed that charcoal was second in use from firewood. The charcoal conservation stove was prominent

than the firewood improved stove as found in figure4.2. The charcoal stove acquired by 88.6% of the households with the fire wood stove acquired by only 10%.It was found that all the households who had acquired charcoal stove had the traditional three stones stove which was used as the main source of energy and the charcoal stove mainly used to warm the house at night and supplement in cooking. While those that used the mobile conservation stove did not have the charcoal stove.

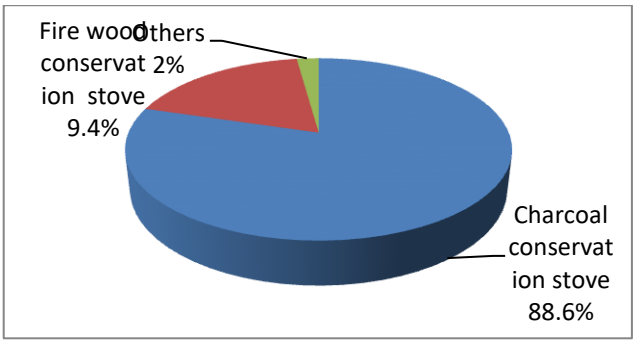


Figure 7: Cooking technologies used in the study area

There was a moderate negative correlation between the cost of the firewood conservation stoves and the number of devices households were able to acquire with Pearson's Correlation value of r = -0.284, n=10, and p=0.05

The higher the cost of the stove, the less was the likelihood of affordability by households hence not acquired. There was a significant positive correlation between cost of charcoal stove and the number of devices acquired (r- 0.296, n-343 and p-value of 0.01) Thus, cost of the charcoal stove could be used to predict acquiring of the stove due to the fact that the cost of this stove is relatively low ranging between Ksh.100-300 with the mean price being Ksh.150. The positive correlation could be attributed to the perception in the market that the improved charcoal stoves which are very cheap are of very low quality and thus might not last long. The Ksh 300 for a better quality stove is still within the reach of many households in Embu North Sub County. These cook stoves were readily available in most shops both in the urban and the rural areas. Thus it was relatively affordable by both the low income earners as well as the high income earners.

When multiple regression analysis using the stepwise method was done, it was found out that the cost of the two stoves were good predictors for their acquisition, where the cost of improved charcoal stove (t-value 7.161 and sig. p-value-0.000) had a positive influence while the cost of improved fuel wood stove had a negative influence (t-value --6.658 and sig. p-value-0.000). Thus the higher the cost of the improved firewood stove the less likely the household was able to acquire the technology. The cost of firewood conservation stove ranged between Ksh. 400- 3000. These prices were high, for many households who had limited sources of income and would rather use the traditional methods of cooking than buy new stove. From the multiple regression analysis, the independent variables that seemed to be good predictors of acquisition of the energy conservation stoves identified were; cost of the improved charcoal stove, cost of the improved fuel wood stoves. According to (Barnes*et. Al*, 1994), the price of stoves can be a significant barrier to their acquisition and surveys reveal that in most of Africa, middle-income families have adopted improved stoves far more quickly than poor families (Johnson *et.al 2007*).

An independent sample t-Test done showed that the difference in the acquisition and use of improved firewood stove between the sample mean of households with on farm trees and the ones without was 0.000, with a 95% confidence level, the t-Test statistic value was 3.726 with 382 degrees of freedom and an associated p value of 0.000). Thus the conclusion in this case is that there is a significant difference in the mean number of fire wood stoves devices acquired between the farmers with and without on farm trees whereby there are significantly more improved firewood stoves in the households with on farm trees than in the ones without. This showed that the farmers with on farm trees are keen on further conserving energy by addressing both the demand and supply side of the wood energy sustainability. This showed that level of awareness on the intervention measures necessary to conserve wood energy made the house holds to address both the demand and supply in enhancing sustainability.

The acquisition and use of firewood stove is quite low compared to the number of households who were using wood fuel as their main source of fuel for cooking and heating purposes. The findings are much lower than those of Karanja (1999) in a study done in Kathiani, Kenya where the use of firewood conservation stoves was 43.4% compared to 9.8 % in Embu North Sub County.

The findings were in agreement with (Owino, 2006) and also (Johnson, 2007) who stated that there was low utilization of the improved wood stove in Kenya. In the study area the reasons for the low uptake and utilization was attributed to the high cost of the stoves and minimal availability of the stoves in the local market.

Challenges facing firewood cook stove

The success of the firewood conservation stove was found to be minimal though there is great potential due to the high dependence of the community to wood energy in the study area. The key issues highlighted as the main challenges to utilisation were the retention of ashes in the combustion chamber, slow in cooking, as well as accommodating small sized pieces of wood thus requires constant addition and attention. This made multitasking by the women hard. All these hampered the effective utilization of the stove.

The cost of the stove was found to be inhibitory to its acquisition this was more so because the alternative technology which is the traditional three stone stove has no installation cost and thus most of the households were not finding it as a necessary cost.

The stoves' availability was also a challenge. The stove was promoted mainly by one NGO and therefore is not able to distribute effectively due to the inadequate capacity. The artisans trained on its installation are also few and at the

same time though trained by the NGO on the installation they are paid by the individual household they install for which brought a challenge since most community members expect free services from the NGOs. Unlike in the Charcoal saving stove the government had not played a role in the introduction of the firewood conservation stove. Since the government involvement gives legitimacy to a technology the firewood stove lacked this support.

The design of the cook stove has several limitations in its utilization; it requires finely split wood fuel which is a challenge to the women. The design restricts use to only cooking, while it is not effective in warming or lighting of the house as the traditional three stone stoves. The respondents highlighted a difficulty in utilization of the stove mainly the mobile one due to the clogging of the ventilation holes by ashes which makes the stove not to light. Thecharcoal stove is more available and affordable compared to the firewood stove. This makes the households to opt for as an alternate for the three stone stoves.

Conclusion and Recommendation

Conclusion

According to the study the following conclusions were made:

The use of the firewood conservation stove reduced firewood consumption by 17.95% compared to the traditional three stone stove ,regardless of this the level of acquisition and use was found to be below 10%.This was due to the level of awareness of the firewood conservation stove that was found to be at 10%. In comparison the firewood conservation stove was least used compared to the three stone traditional stove and the charcoal stove.

The main challenges found to the utilization of the stove were; availability, cost and poor design.

5.3 Recommendation

1.Awareness creation and focus on the firewood conservation stove so as to make more available as well as affordable by the NGOs involved in the sector as well as the Kenya Forest Service.

2. There is need for aggressive campaign in dissemination of improved firewood stoves technology in order to reduce pressure on forest and other woodlands surrounding Irangi block of Mt. Kenya forest mainly by the KFS.

3. An energy center needs to be established in the Embu North Sub County which can act as the focal point for dissemination of energy efficient technologies.

4. It is important to build capacity of field extension staff in the energy sector ministries e.g. Ministry of environment, Ministry of energy,

There is need for standardization in the design and making of energy efficient stoves so that quality may not be compromised in expense of quantity in order to make more money. Compromise of quality may make households revert back to metallic stoves which lasts longer but are energy inefficient.

The conservation of wood energy should be given a priority through promotion of improved stoves with higher efficiency

The improved stoves to be promoted for adoption should consider users' needs which include cooking comfort, convenience, health, safety and their affordability as these factors influence adoption of improved cooking devices.

Strengthen wood energy institutional framework Wood energy systems have multi-disciplinary characteristics with many stakeholders strongly integrated between the socio-economic layers of rural areas, all requiring technical agencies from forestry, agriculture and industry sectors. Therefore, wood energy development strategies should be pursued as common task by all the relevant sectors. The coordination and linkages among the sectors concerned has been weak and need to be strengthened, (IJST, 2012). Enabling wood energy policy and planning Firewood production strategy should be developed with prime objective of making each county self-sufficient. Decentralized area based wood energy planning is the most suitable in Kenya as wood energy situation and problems are site-specific and vary from one region to the other. Therefore, the implementation strategies in the decentralized wood energy plan should be site specific depending on the prevailing problems.

Improvement of wood energy database to improve wood energy data within the country, wood energy databases should be established at regional and national levels. These can be achieved through establishing regular field surveys for wood energy, supply, demand and data analyses to monitor the changes over time. Regular surveys need to be undertaken in future preferably at five year intervals to enable updating the data for future wood energy plans and policy formulations.

References

[1] Anon, N.D. (2012).Kakamega Forest Integrated ConservationProject:EnergySavingTechnologies.Retrievedfromhttp ://www.mnh.si.edu/kakamega/energy.html.
[2] BarnesD., OpenshawK.,SmithK.R.,andVanderPlassR.1994.*Whatmakes peoplecookwithimprovedBiomassstoves.A comparative internationalreviewofstoveprograms.* Theinternationalbankfor reconstruction and development/the WorldBank.WashingtonD.C USA.
[3] Campbell, BM, VermeulenSJ. Mongono JJ. , Mabugu R. (2003). The Energy Transition in action; UrbanDomestic fuel choice in a changing Zimbambwe. Energy Policy 31(6) 553-562
[4] Constitution of the Republic of Kenya, 2010
[5] Creswell, J. W. (2013). Research Design: Qualitative, Quantitative and Mixed Methods Approaches. SAGE Publications.
[6] Food and Agriculture Organization of the United Nations (2013). *Wood Energy.* Retrieved from http://www.fao.org/forestry/energy/en/
[7] Forests Act, Laws of Kenya, Act No. 7 of 2005
[8] Githiomi JK, Mugendi DN, Kung'u JB (2012). Analysis of household energy sources and firewood utilization technologies in Kiambu, Thika and Maragwa districts of Central Kenya. J. Hortic. For., 4(2): 43-48.
[9] GTZ, 2008. Biomass Energy Strategy (BEST), Lessons learned and recommendations for cooking energy interventions. Policy Briefs.
[10] GTZ/PSDA, 2007. How to make, install and care for an improved JikoKisasa and a fireless cooker. Jacaranda Designs Limited. pp 4-5.
[11] International Energy Agency (2015). *Renewables.* Retrieved fromhttp://www.iea.org/topics/renewables/subtopics/bioenergy/International Journal of Applied Science and Technology Vol. 2 No. 10; December 2012.
[12] Joint Energy and Environment Projects (2014). Energy Saving Stove Technology. Retrieved from http://jeepfolkecenter.org/activities/energy-saving-stove-technology
[13] Johnson,M.A.,Edwards,R.,Ghilardi,A.,BerruetaV.andMasera,O., 2007.*Why current assessment methods may lead to significant underestimation of GHG reductions of improved stoves*. Boiling Point, 2007-NO54.
[14] Karanja L. (1999). *Adoption of energy conserving technologies by rural households in KathianiDivision, Machakosdistrict*, Unpublishedthesis ,Kenyatta University ,Kenya.
[15] Kenya Information Guide (2015). Embu County- Kenya. Retrieved from http://www.kenya-information-guide.com/embu-county.html
[16] Kenya National Bureau of Statistics (2013). *Kenya Counties.* Nairobi: KNBS.
[17] Kroon, B., Brouwer, R. &Beukering, P. J. H. (2013). The Energy Ladder: Theoretical Myth or Empirical Truth? Results from a Meta-Analysis. Renewable and Sustainable Energy Reviews, 20, 504-513.
[18] Marlow, C. R. (2011). *Research Methods for Generalist Social Work* (5th Ed.). Belmont, CA: Brooks/Cole Cengage Learning.
[19] Muchiri, L. (2008) Gender and Equity in Bioenergy Access and Delivery in Kenya, Practical Action. Nairobi: Kenya.
[20] Mugenda, O. M., &Mugenda, A. G. (2003). Quantitative and qualitative research methods
[21] Nansaior A., PAtanothai A., Rambo A T., SimaraksS. 2011. Climbing the energy ladder or diversifying energy sources? The Continuing Importance of household use of biomass energy in urbanizing communities in North Wes Thailand. Biomass and Bioenergy Journal 35(10) 4180-244
[22] Opens W., Keith. (1982) *Inventory of biomass in Kenya: a conditionally renewable energy*. Nairobi: BeijerInstitutefor Energy and human ecology.
[23] Tanzania traditional Energy Development and Environment Organization (2005) Sustainable Energy and Development. ISSN 0856-9266
[24] OwinoA.G,2006.*Changes inhousehold fuel&stovechoicesinNairobiandtheir implicationforindoorairqualityandclimatechange*.Unpublished Master's thesis-KenyattaUniversity.
[25] Taylor MJ. Michelle J., Moran T., Edwin J., Silves E. 2011. Burnin for sustainability: Biomass energy International Migration and the move to cleaner fuels and cook stoves in Guatamala .Annals of the Association of American Geographers 101(4) 918-928
[26] Theuri K (2002). Firewood Policy and Legislation in Kenya; a paper presented during the Regional Workshop on Firewood Policy and Legislation held in ICRAF, Nairobi, Kenya. p. 8
[27] United Nations (2015). Millennium Development Goals Indicators. Retrieved from http://mdgs.un.org/unsd/mdg/Metadata.aspx?IndicatorId=0&SeriesId=712
[28] United States Environmental Protection Agency (2014). Consumers- Energy Efficiency and Wood – Burning Stoves and Fireplaces. Retrieved from http://www.epa.gov/burnwise/energyefficiency.html
[29] Wereko-Brobby, C. Y. &Mintah, I. K. (2012). Ghana's Renewable Energy Development Programme. In A. A. M Sayigh (Ed.). Energy Conservation in Building: The Achievement of 50% Energy Saving: An Environmental Challenge?

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