

Knowledge and Awareness Determinants of Renewable Energy Technologies: A Cross Sectional Study of Rural Residents from Njoro Constituency, Nakuru County, Kenya

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Abstract

Background: Awareness to renewable energy technologies (RET) can have multiple positive effects as it can be a precursor to greater RET adoption levels as well as promotion of the same. The aim of this study was to assess the level of awareness of rural residents of Njoro constituency to the different renewable energy technologies as a precursor to their adoption.

Materials and Methods: The study was based on primary data collected through personal interviews with household heads in Njoro constituency, Nakuru County, Kenya. Two stage cluster random sampling was used to select the 200 households. The results showed that majority of the respondents exhibited a moderate level of knowledge and awareness to RETs.

Results: Results of the study indicated that gender and education level had a significant effect on knowledge and awareness. It was also found that age and social-economic status did not have significant effect on the knowledge and awareness.

Conclusion: The overall finding of the study underlined the high importance in strengthening communication to enhance knowledge and awareness of renewable energy technologies. The findings of this study will be significant to planners, policy makers, researchers and individuals to build the case for proactive promotion of RETs.

Key Word: Knowledge and awareness; renewable energy technologies; rural households

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I. Introduction

Energy is central to sustainable development and poverty reduction efforts. It affects all aspects of development - social, economic, and environmental - including livelihoods, access to water, agricultural productivity, health, population levels, education, and gender-related issues¹. The push for higher economic growth combined with an ever-increasing population has increased the global demand for energy. Where there is lack of electricity and affordable energy resources, economic and environmental constraints occur which manifest in the form of reduced investments, slow economic growth and massive deforestation².

In East Africa, Kenya has been on the forefront in investing in large-scale renewable energy projects, with several large and medium scale electricity generation projects having been commissioned in the past two decades. In 2016 Kenya opened the world's largest geothermal plant at the Olkaria Geothermal field and in 2017 the country completed building the Lake Turkana Wind Power Project, touted as Africa's biggest wind energy farm to generate a fifth of her power. This has been attributed to a change in a number of policies, key being the Energy Act 2006, which allows private individuals to sell off their excess supply of energy to Kenya Power Company (KPC) and the Feed-in Tariff policy (2008, revised 2010) that legitimized private renewable energy power generation.

All commendable progress, but on the flipside, Kenya is faced with many challenges that can be tied to access to energy. About 5,000 hectares of the Mau, a closed indigenous forest ecosystem, are lost each year due to the demand for fuel wood and charcoal leading to serious deforestation and land degradation³. This is paradoxical despite the fact that the tropics are blessed with strong winds, sunny skies, plant residues, heat from the earth and fast-moving water, each of which can provide a vast and constantly replenished energy resource supply. These diverse sources of renewable energy have the technical potential to provide alternative energy and electricity to cater for all peoples' needs especially rural communities. The utilization of renewable energy technologies (RETs) directly contributes to the economic, social and environmental pillars of sustainable development⁴. The Kenya government through the Ministry of Energy and Petroleum, Department of

Renewable Energy, promotes the development and use of RETs, which include but are not limited to, biomass, biodiesel, bio-ethanol, charcoal, fuel-wood, solar, wind, tidal waves, small hydropower, biogas and municipal waste (GoK, 2019).

Despite various interventions, adoption of RETs and related innovations remains low and poorly documented, yet it could catalyse significant advancement in sustainable development, poverty eradication and gender mainstreaming. According to the Union of Concerned Scientists (2013), high RETs adoption rates will increase investments in renewable energy projects and scaling up of new technologies which can afford new prospects for employment and business opportunities among local manufacturers and service providers. It will also increase access to clean energy, reduce greenhouse gas emissions, make renewable energy technologies achieve economies of scale and bring down costs.

Considering the importance of RETs, it has become needful of the hour to adopt. This in turn depends on the community acceptance and participation which again depends on the community awareness regarding RETS and their benefits. With this background the study was conducted to determine the level of awareness about RETs, their benefits and disadvantages among a rural population in Njoro Constituency, Nakuru County, Kenya.

Knowledge and awareness are used interchangeably in this text. Knowledge and awareness have been shown to strongly correlate to behavioural change. In innovation diffusion, the premise is that, the individuals in question first learn about the technologies in question whereby they are able to gauge their desirability and eventually choose to adopt them.

II. Materials and Methods

Study Areas: Njoro Constituency, Nakuru County was selected as a viable place to assess household awareness to RETs. Njoro constituency has a population of 238,233 with 61,271 households with each household having 3.9 members (Kenya National Bureau of Statistics (KNBS), 2019). Njoro Constituency also borders the Mau Forest, one of the last remaining closed indigenous forests of Kenya, where most residents source their wood fuel and charcoal from, contributing to massive deforestation and degradation

Sample Size & Sampling Procedure: Assuming the prevalence of good awareness about RETs as 50%, along with absolute precision of 7%, the sample size arrived at was 200. Two Stage Cluster Sampling technique was used to select households within the wards in Njoro Constituency Nakuru County. The reason for the choice of cluster sampling was because the target population is divided into divisions, locations, wards and villages. The decisions about sample size took into consideration the size of the target population being researched and the level of accuracy required from the research.

Data collection procedure: The study was explained to the participants and informed consent was obtained. All the participants were interviewed within their household using pre-tested, semi-structured questionnaire by trained investigators in the national language, Kiswahili.

The study tool comprised of two sections. Section I comprised of Socio-demographic details such as age, sex, education, occupation, marital status, leadership position in the community and monthly household income. Section II was about self-reported knowledge of RETs, the benefits and disadvantages of the three RETs being tested for; Solar, Biomass Briquettes and Improved cookstoves (ICS).

Operationalisation of variables

Household Socio Economic Status: Socioeconomic status was defined as the position and status of the head of household in the community as dictated by his/her asset-based wealth level, educational level, and status in society.

The variable was operationalised in Likert scale from Very High Status, High Status, Moderate Status, Low Status to Trivial or no status. The socioeconomic status variable was constituted by educational level, asset-based wealth index, and status in society, which was constructed into an index by summing up of the three indicators.

$$SES = Edl + Abws + SIS \tag{1}$$

Where; Edl = education level; Abws = Asset Based Wealth Index; SIS = Status in Society

Household Awareness: Household awareness of RETs was defined in this study as the degree of knowledge and understanding (by the head of household) of the RETs and the benefits accruing from their use by the household.

The variable was operationalized in Likert scale from Very High Degree, High Degree, Moderate Degree, Low Degree to Trivial or no knowledge/understanding.

In order to extract the scale several metrics were used.

1. The first measure was self-reported knowledge of RETS which was weighted as 0.5. SRK= 0.5
2. The respondent was asked to list the number of Renewable energy technologies that they know. It is from this list that their knowledge was inferred and weighted

3. The respondent was asked to list the benefits of the selected RETs (Solar, Biomass Briquettes and Improved cook stoves), where the researcher scored them on the number of correct answers. Correctly listed benefits (RETwb) were weighed and averaged as follows;

$$\text{RETwb} = (\text{ICSwb} + \text{Swb} + \text{BBwb})/3 \quad (2)$$

Where ;ICSwb = Improved cookstove weighted benefits; Swb = Solar weighted benefits, BBwb = Biomass briquettes weighted benefits,

4. The researcher asked them to list the disadvantages and scored them on the number of correctly listed answers. Each tested technology was weighted and the average for the total was used (RETwd)

$$\text{RETwd} = (\text{ICSwd} + \text{Swd} + \text{BBwd})/3 \quad (3)$$

Where ;ICSwd = Improved cookstove weighted disadvantages, Swd = Solar weighted disadvantages, BBwd= Biomass briquettes weighted disadvantages

$$\text{Degree of Knowledge and Awareness of RETS} = \text{RETwd} + \text{RETwb} + \text{SRK} \quad (4)$$

Statistical Analysis

Data analysis consisted of examining, categorizing, tabulating or otherwise recombining the evidence to address the initial prepositions of the study. The Statistical Package for the Social Sciences (SPSS) Version 22 software was used to compute descriptive and inferential statistics. The qualitative variables are described in the form of proportions and quantitative variables are described in the terms of mean, median, range and standard deviation. Significance of difference in proportions (qualitative variables) was calculated using appropriate parametric and non-parametric tests e.g. chi square test. Significance of p value was taken as $p < 0.05$.

III. Results

The gender composition of respondents revealed an almost even proportion of male respondents (50.8%) to female respondents (49.2%). Age distribution of the study respondents ranged between 17-83 years with the mean (SD) of 44.79(±15.80).

Among the study participants, a majority (33%) had moderate level of knowledge and awareness to RETs, with 27% having a high degree, 25% having a low degree with 11% having trivial of no knowledge and understanding and 4% having very high degree of knowledge and understanding.

Among the study participants, 161 (91.5%) reported to know of renewable energy technologies (RETs). Only 1.1% could correctly list more than 6 RETs, with 7.7% listing 5, 11% listing 4, 24.3% listing 3, 24.9% listing 2, 19.9% listing 1 and 11% listing none. When it came to stating benefits of individual selected RETs results varied. It would be good to note that the researcher opted to measure knowledge of both benefits/advantages and disadvantages. The premise behind this is that having knowledge of something does not mean knowing only the positive attributes of the topic of discussion, having negative information also constitutes part of the body of knowledge⁷. When technology or experience is concerned, studies show that people are more likely to remember negative cues/ attributes than they are of positive ones. According to Vaish, Grossmann, & Woodward⁷, "there is ample empirical evidence for an asymmetry in the way that adults use positive versus negative information to make sense of their world; specifically, across an array of psychological situations and tasks, adults display a negativity bias, or the propensity to attend to, learn from, and use negative information far more than positive information".

A majority of the participants, (51.4%) could correctly list 1-≥2 advantages of Improved Cook Stoves (ICS) with (26%) listing zero and (22.7%) managing to list 3 or more. When it came to disadvantages of ICS a majority (63.5%) correctly listed 1-≥2 disadvantages while (33.7%) did not get any correct answer and only (2.8%) could list 3 or more.

The participants were most knowledgeable about solar, where (63.5%) correctly listed 1-≥2 advantages while (35.4%) correctly listed 3 or more and only (7.7%) could not list any correct answer. As for disadvantages of solar (74.6%) could list 1-≥2 answers correctly, (18.8%) did not list any correct answers while (6.6%) were able to list 3 or more.

Biomass briquettes proved to be the least understood RET among the three, where (69.6%) of the respondents did not give any correct answer, with (25.4%) getting 1-≥2 answers correctly, while only (5%) managed to answer 3 or more correctly. When it came to disadvantages, the participants were no more knowledgeable with (63.5%) not listing any correct answer, (34.2%) managing to get 1-≥2 correctly and only (2.2%) managing to correctly list 3 or more disadvantages of biomass briquettes correctly.

Gender and Household Awareness to RETS

The researcher performed independent T-Test in SPSS, a parametric test used to determine if there are any differences between two continuous variables on the same scale from two unrelated groups. The P value (Sig.) was zero ($0.05 > 0$) therefore the Data did not Assume Equal Variances. The P value was 0.041

(0.05>0.041) indicating a significant difference in RET awareness between males and Females (Table no1). Males were significantly more aware of RETs (3.058±1.34) than females 2.715±0.86), t(155.5) =2.058, p<0.041 (Table no1 and Table no2)

Table no1: Group Statistics Gender and Awareness to RETS.

	Gender	N	Mean	Std. Deviation	Std. Error Mean
Household awareness	Male	92	3.058	1.338	0.140
	Female	89	2.715	0.857	0.091

Table no2: Independent Sample Test (Gender and Awareness to RETS).

		Levene's Test for Equality of Variances		t-test for Equality of Means					
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Household awareness	Equal variances assumed	15.901	0	2.044	179	0.042	0.3426	0.0117	0.6734
	Equal variances not assumed			2.058	155.535	0.041	0.3426	0.0137	0.6714

Age and Household Awareness to RETS

A Kruskal-Wallis H test showed that there was no statistically significant difference in Degree of Knowledge score between the different Age Groups , $\chi^2(2) = 1.801$, $p = 0.615$, with a mean rank knowledge score of 95.25 for UnderAge (<18yrs), 83.44 for Youth(19-35yrs), 89.65 for MiddleAge(36-55yrs) and 95.34 for Seniors (56Yrs<) (

Table no3 and Table no4).

Table no3: Descriptive Statistics Age Categories and Degree of Knowledge and Awareness to RETs.

	Age Categories	N	Mean Rank
DEGREE OF KNOWLEDGE AND UNDERSTANDING OF RETs	Under Age (<18yrs)	2	95.25
	Youth (19-35yrs)	62	83.44
	Middle Age (36-55yrs)	53	89.65
	Seniors (56yrs<)	61	95.34
	Total	178	

Table no4:Kruskall Wallace Test (Age – Household Awareness to RETS).

Test Statistics ^{a,b}	DEGREE OF KNOWLEDGE AND UNDERSTANDING OF RET
Chi-Square	1.801
df	3
Asymp. Sig.	0.615
^a Kruskal Wallis Test	
^b Grouping Variable: Age Categories	

Education level and Household Awareness to RETs

An ANOVA was run where Education Level was noted to affect the mean Degree of Knowledge and Understanding Score, $F(3,176)=3.136$, $p=0.027$ (Table no5).

The hypothesis is that the population means are equal for all levels of education. P (“Sig.”) = 0.027 is less than 0.05- the null hypothesis was rejected: the population means are not all equal. Some education levels result in lower mean Degree of Knowledge and Awareness scores than others.

The different education levels account for some 5.1% of the variance in the Degree of Knowledge and Awareness scores. This is the effect size as indicated by partial eta squared. Partial Eta Squared is the Sums of Squares for Education level divided by the corrected total sums of squares (9.973/916.55= 0.051). Sums of Squares Error represents the variance in Degree of Knowledge and Awareness scores not accounted for by Level of Education.

Table no5: ANOVA Education Level and Degree of Knowledge and Awareness of RETs.

DEGREE OF KNOWLEDGE AND UNDERSTANDING OF RET						
Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	9.973 ^a	3	3.324	3.136	0.027	0.051
Intercept	522.712	1	522.712	493.08	0	0.737
Education level	9.973	3	3.324	3.136	0.027	0.051
Error	186.577	176	1.06			
Total	1693	180				
Corrected Total	196.55	179				

^a R Squared = .051 (Adjusted R Squared = .035)

SES and Household Awareness to RETS

A Kruskal-Wallis H test showed that there was no statistically significant difference in Degree of Knowledge score between the different Social Economic Status Groups , $\chi^2(2) = 4.631, p = 0.099$, with a mean rank knowledge score of 78.7 for Trivial or no status, 87.43 for Low Status and 101.75 for Moderate Status (Table no6 and Table no7) .

Table no6: Descriptive Statistics SES and Degree of Knowledge and Awareness to RETs.

	Household SES	N	Mean Rank
DEGREE OF KNOWLEDGE AND UNDERSTANDING OF RETs	Trivial or no status	27	78.7
	Low Status	98	87.43
	Moderate Status	55	101.75
	Total	180	

Table no7:Kruskall Wallace Test (SES – Household Awareness to RETS).

Test Statistics ^{a,b}	DEGREE OF KNOWLEDGE AND UNDERSTANDING OF RET
Chi-Square	4.631
df	2
Asymp. Sig.	0.099
^a Kruskal Wallis Test	
^b Grouping Variable: Household Social Economic Status	

IV. Discussion

The study explored the knowledge and awareness of renewable energy technologies among the rural community of Njoro as it is one of the constituencies bordering the Mau Indigenous Forest. It was found that knowledge and awareness of RETs differed significantly between male and female genders with men being more aware of RETs than women. This compares with other studies done by Chukuezi (2009), which showed that women may have lower awareness levels, especially, in rural areas due to the fact that they are not the main decision makers in the family. Traditionally, rural women are normally occupied with household obligations, which leaves very little time for information seeking.

In the study, age did not have a significant bearing on the knowledge and awareness of RETs by the respondents, however, a study by Zyadin et al.,(2014) offer contrary finding where age was shown to have slightly significant effect on knowledge of RETs.

Education level was observed to significantly affect the level of knowledge and awareness of RETs, this is consistent with other study findings by [1]Çakirlar, Altuntaş & Turan (2018) and [8] Mosly & Makki (2018) where significant differences in the participants' grade level, field of study, source of information, and awareness of renewable energy sources were observed. As well, various studies, [4,9] Foell, Pachauri, Spreng, & Zerriffi (2011); Pachauri & Spreng (2011) point out that higher education levels are determinants to access of varied and diverse information sources.

The socioeconomic status did not have a significant effect on the knowledge and awareness of RETs by the respondents. This could be explained by the fact that the majority of the respondents interviewed belong from moderate to lower economic status cadres thus in a sense this agrees with studies which point towards the fact that the higher the economic status the higher the knowledge and awareness level.

V. Conclusion

From the study findings, it was clear that majority of the study participants had moderate knowledge about RETs. For ICS and Solar it was observed majority could list between 1-2 benefits and disadvantages, but scored lowly on the same for biomass briquettes. This is understandable, whereas solar and improved cook stoves get some airplay in the media and other information communication channels, for example, through adverts and paid promotions, biomass briquettes do not get featured much. As well due to lack of electricity and the increasing cost of kerosene, cheaper solar based lanterns have emerged which have given families more access to the technology, which means they are intimately aware of the benefits and their drawbacks.

Nonetheless, RETs need to be promoted actively, hence it is recommended that RET education campaigns should be more aggressive and targeted. RETs education would be provided through various strategies including social media, mass media and using audio visual aids. A clear link should be made on health benefits of RETs as well as economical savings that are accrued from their use.

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Conflict of interest: None declared

Ethical approval: The study was approved by the Kenya National Commission for Science, Technology and Innovations (NACOSTI).

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