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Assessing the Impacts of After-sales Services on the Performance of Household Energy Systems

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Abstract

After-sales services play a vital role on the performance of the system and business development. This study sought to assess the impacts of after sales services on performance of households' energy systems in Rwanda. The study was intended to find out what people currently believe in, the current situation and determine peoples' perceptions towards after sales services. The research study relied on primary data collected using questionnaires and interview guides. Data gathered from the questionnaires were analysed quantitatively using statistical package for social sciences SPSS version computer software which generated both descriptive and inferential statistics. The findings revealed that after sales services are very important in mitigating possible break down of the households' energy systems. Households that receive after sales services for their home energy systems experience less frequent break down of their systems compared to those that hardly receive. The research thus, recommends that firms should ensure that ASS is an integral part of product offering to be given the same value as installation process, to adopt a good pricing strategy and monitoring customers' behaviour to the benefit of both sides.

Keywords: *Biogas, solar energy, suppliers.*

1. Introduction

Energy is a prime driver for economic development as observed by International Energy Agency [1]. Rwanda is one of African countries with fastest growing economy but this development is hindered by limited access to electricity which is currently at 52 % [2]. Globally, close to 840 million people live without electricity access, about 2.90 billion people live without clean cooking methods while 1.7 billion people depend on traditional biomass as cooking fuel [3, 4]. According to GOGLA worldwide survey, close to 51 million units of small solar home system devices with total capacity of 460 MW and approximately 41.8 million household biogas digesters with capacity of 152 million cubic metres of digester volume have been distributed over past four decades [5]. China national biogas program put an emphasis on post installation services rather than constructing many biogas plants to cover big number of households without after sales services to keep them in operational mode [6]. Bangladesh is among most successful solar energy developers in the world, it is implemented in rural areas and the companies in charge of installation offer package range of after sales services.

The use of biogas and solar energy systems has significantly disseminated across Rwanda both in rural and urban settings. Local government authorities plan certain number of biogas plants and solar home systems to be installed in their annual performance targets. This is done in all five provinces of Rwanda for enhancement of sustainable development and raising awareness of renewable energy technologies. Access to electricity in Ngoma district accounts for a low percentage with only 3.4 % household connected to national grid. According to Integrated Household Living Conditions Survey (EIVC3), 76.1 % of households in Ngoma are using lantern as source of energy for lighting and 97.3 % of households using conventional solid biomass as a main source of energy for cooking against 86.3 % at national level [7].

Biogas is the one of the promising technologies that is emerging in Rwanda. Biogas production measured in m^3 is determined by the quantity of cowdung fed the plant and

the capacity of biogas plant installed, generally 25 kg of cowdung is supposed to produce 1m^3 of biogas in 24 hours. Biogas is considered carbon neutral due to its blue colour without smoke [8]. As of 2017, 10,588 domestic and 86 institutional biogas digesters had been constructed across the country [9]. A survey on sample of 1097 households showed estimated biogas market potential of 110,000 biogas digester plants [10]. Prior some biogas plants were constructed under government subsidies at 50 % of total investment cost and technical support from SNV. Survey conducted on three types of biodigesters; fixed dome biogas digester plants (FDBD), flexi bag biogas digester plants (FBBD), fiber glass biogas digester plants (FGBD) in different districts of Rwanda to compare their functionality and robustness, showed that only 70 % of biodigester plants that have been working for at least 5 years were in good working mode [11]. Bedi analyzed the effects of Rwanda's biogas program on energy expenditure and fuel use, the study showed that about 65 % were satisfied with functionality of biogas digesters and sufficient gas produced for domestic use, 25 % of households were disappointed by functionality of their plants while for 10 % of the households, their plants were not in operational at all [12]. According to Rwanda Energy Group-National Domestic Biogas Program (REG-NDBP), 78.3 % of fixed dome biodigesters and 47 % fiber glass biodigesters were found in operation country wide by 2015 [13].

Solar energy is another emerging technology in Rwanda that is being implemented on small scale to generate off-grid electricity to supply population living in remote areas where national electricity grid has not yet reached. Rwanda has an exceptional solar resource due to her geographical location, enjoys long sunny days with high intensity of solar irradiation approximately to 5.2kWh per m^2 per day [14]. Off-grid access in Rwanda has been increased from 0 % to over 10.7 % equivalent to 258,670 households by 2017. [15]. Rwanda electrification strategy has put more effort on development of off-grid and establishment of programs to distribute energy systems to low income earners and encourage participation of private sector to invest.

Follow-up services/after sales services comprised of training users, monitoring cleanliness and conditions of the systems, timely repair and maintenance, development of demonstration for technology upgrade and dissemination. After sales services (ASS) brings up customer satisfaction, puts in place personal contact and correspondence with the systems supplier, it strengthens the relationship between system suppliers and customers. It is through follow up services that biogas digester plants and solar home systems can continue yield effectively and stay in good working state. A study by Hussain showed that consumer satisfaction increases with better service delivery comprised of after sales services [16]. Electricity and modern clean cooking fuels are the most basic needs that can raise standards of living and deprive people from energy poverty. [17, 18]. Studies that scrutinized techno-economic performances of biogas and solar home systems for small communities revealed the strength and potential of these renewable energy technologies [19-22].

The SERVQUAL model represents service quality as the discrepancy between a customer's expectations of service offering and the customer's perceptions of the service received [23]. Service quality and customer satisfaction are very important concepts that companies must understand in order to remain competitive in business and hence grow. It is very important for companies to know how to measure dimensions of servqual model from the consumers' perspective in order to better understand their needs and hence satisfy them [24]. Service quality is a measure of how well the service level delivered matches customer expectations and also a vital indicator for satisfaction. Knowing the importance of service quality can advantage the organization to win competitive edge of the market [25-26].

This study sought to analyse the significance of after sales services on performance of households' energy systems in Rwanda. There were three objectives of this study: 1. To assess the impacts of after sales services on performance of household energy systems in Rwanda. 2. To ascertain the influence of after sales services on peoples' buying decision

of household energy systems in Rwanda. 3. To determine peoples' perceptions towards after services on household energy systems in Rwanda.

2. Methods

2.1 Study Area

The study was conducted in Ngoma districts of eastern province of Rwanda. Ngoma district covers an area of 867.74 km^2 with total population about 336,928. According to Rwanda Energy Group (REG), 531 home energy systems were constructed in Ngoma district as of 2017. The study was dwelt on biogas digester plants and all the solar PV systems installed.

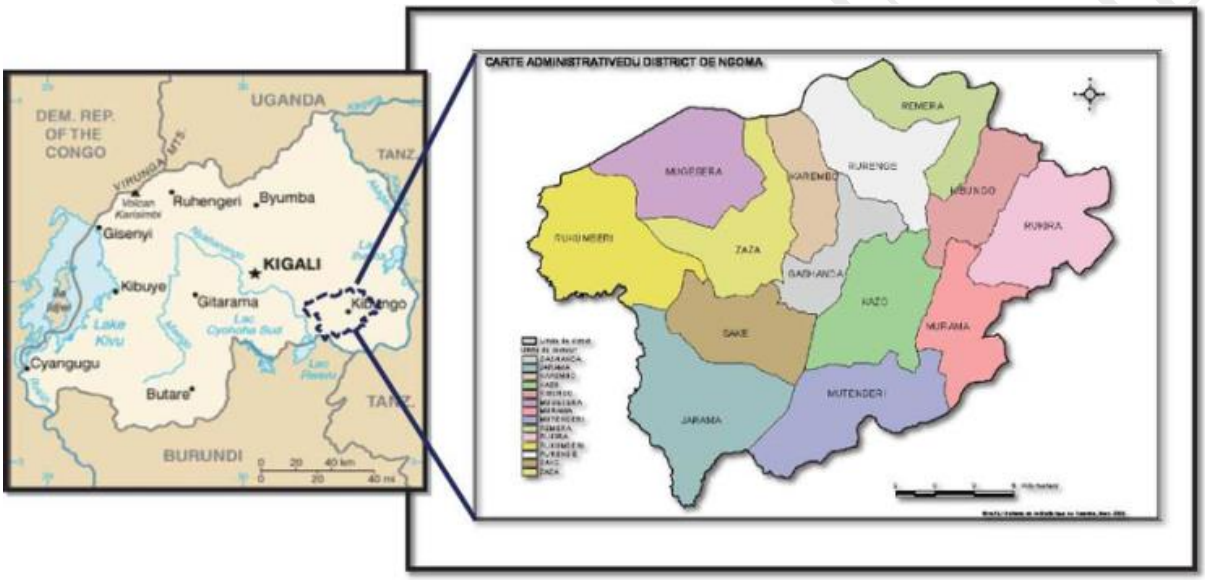

Figure 1: Administrative map of Rwanda, Ngoma District

2.2 Sample Size

The households were selected randomly representing the population of 531 having home energy systems. Krejcie and Morgan's [27] table was used to select the sample size, which presents an acceptable margin of error (about 3 %). Krejcie and Morgan use the following formula to determine the sample size [28]:

$$S = \frac{X^2 NP(1-P)}{d^2(N-1) + X^2 P(1-P)}$$

Where S is the required sample size, X^2 is the table value of chi-square for one degree of freedom at the desired confidence level, N is population size, P is the population proportion, and d is the degree of accuracy

Table 1. Sample Size

Category	**Number of households**
Operational Biogas Digesters Plants	30 Households
Non-Operational Biogas Digester Plants	20 Households
Solar Home Systems	60 Households
Total	**110 Households**

2.3 *Data Collection*

The main instruments used to collect data for the study were structured questionnaires and open-ended interviews with the respective users and suppliers in charge of constructing and installing households' energy systems. The study adopted an interactive approach rather than 'question and answer session' with the respondents to enhance the quality of data collected and captured data through both binary and a 5-point likert scale type. Marshall and Rossman, points out that questionnaires are appropriate for studies because they collect information that is not directly observable as they inquire about opinion, motivations, feelings, achievements as well as experiences of those respondents under study [29]. The study used same questionnaires for biogas energy systems users and solar energy systems users.

Data gathered from the questionnaires were analysed quantitatively using statistical package for social sciences (SPSS version 22) computer software. Descriptive statistics including the mean, percentages, frequencies, cross tabulations and standard deviation were used to capture the characteristics of the variables under study. Inferential statistics; chi-square, t-tests and ANOVA was used to analyse the relationship of the variables.

3. Results

3.1 After Sales Services

The study asked the respondents to indicate whether they have been receiving after sales services from their system suppliers. The findings presented in figure 1, revealed that 60% of the households that participated agreed that they received after sales services from the system suppliers while 40 % did not receive after sales services from their suppliers.

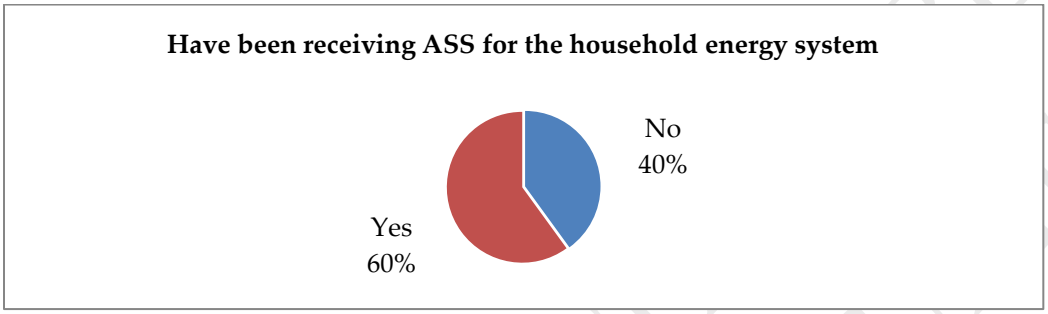

Figure 2. After Sales Services for Home Energy Systems

3.2 Effectiveness of Households Energy Systems

The survey sought to establish from the respondents whether home energy systems operate effectively. The survey findings indicated that 52 % agreed while 48 % disagreed. These findings may suggest the need for after sales services from the suppliers that distribute home systems to customers to ensure that their systems continue to operate in effectively and efficient manner.

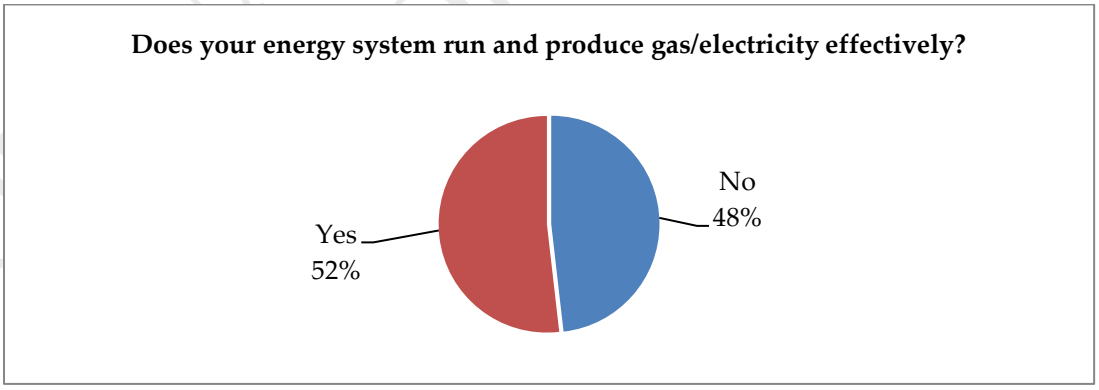

Figure 3. Effectiveness of Households Energy Systems

3.3 Purpose for Acquiring Households Energy Systems

The study sought to find out the main reason why the households acquired their household energy systems. Figure 4, indicated 51.8 % of the households acquired their home energy systems for lighting, charging and TV watching while 48.2 % indicated that they acquired their systems for cooking purposes only. Some households purchased biogas systems for the purpose of cooking and lighting as some types of biogas plants support both. Other households purchased solar home systems for the purpose of lighting, charging and TV watching. The findings implied that majority of the people who demanded home energy systems were for purpose of provision of energy for lighting, charging and TV watching. Whilst a study in Bangladesh shown that; the main purpose of acquiring household energy systems are cooking and lighting. Other home appliances use dry cells and batteries [8].

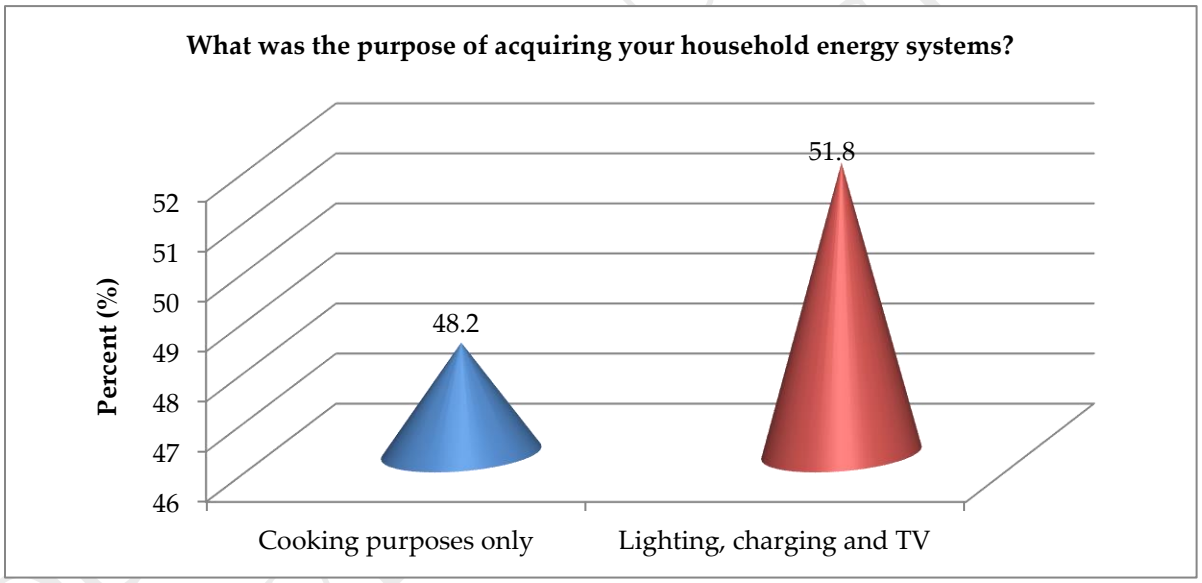

Figure 4. Purpose for Acquiring Households Energy Systems

3.4 Household Energy Systems achieving Intended Purpose

Respondents were asked to indicate the extent to which their home energy systems had achieved its intended purpose. The results presented in Table 2, showed that 29.1 % of the households indicated low extent, 27.3 % indicated moderate extent, 20.9 % indicated

high extent, and 14. 5% indicated very high extent while 8.2 % indicated very low extent. The finding indicated that in some households their energy systems achieved its purpose. For household with solar home system mostly were satisfied with their systems, as an addition they gained ways of charging their cell phones and watching TVs while on other hand systems such as biogas did not achieve its purpose, as most households were complaining about insufficient gas production. Respondents had various types of biogas plants, fixed dome, fiber glass and flexi bag biogas plants. Fixed dome and fiber glass only support biogas lamp due to the capacity of gas production while flexi bag type does not. Biogas owners chose to use gas produced for cooking purposes only as it was found that in most cases, plants do not produce enough gas to meet both purposes (cooking and lighting). These findings underline the need for after sales services to households with the home energy systems most specifically on biogas which requires more of users' training and maintenance for maximum performance of the plant.

Table 2. Extent to which Household Energy Systems Achieved Its Intended Purpose

To what extent has your home energy systems achieved its intended purpose	**Frequency**	**Percent**
Very high extent	16	14.5
High extent	23	20.9
Moderate extent	30	27.3
Low extent	32	29.1
Very low extent	9	8.2
Total	**110**	**100**

3.5 Amount Spent on Energy before Installing the Home Energy Systems

The respondents were asked to indicate the amount of money (RWF) they had spent on energy either on cooking, charging cell phones, lighting the house before construction/installation of their home energy systems. The findings revealed that on average households spent 20,370.39 RWF on basic household energy needs however, some households spent as high as 39,955 RWF while other spent as low as 3,013 RWF on

energy. Similarly, these findings confirmed that various households were spending money depending on their level of income and preferences, buying other sources of energy for home use.

Table 3. Amount Spent on Energy before Installing the Home Energy Systems

	N	Min	Max	Mean	Std. Deviation
How much did you spend on energy before installing the biogas/ solar energy systems (RWF)	110	3,013	39,955	20,370.39	10,443.066
Valid N (list wise)	110				

3.6 Amount Saved by Using Home Energy Systems

The study further sought to find out amount of money the households saved for the period they had used the energy systems. The results revealed that on average, households saved 21,373 RWF per months by using their home energy systems. The maximum amount saved per month was 34,968 RWF while the least was 4,075 RWF as indicated by results presented in Table 4. These results implied that it's economical for households with home energy systems since a lot of money is saved per month to cater for other households demands.

Table 4. Amount Saved by Using Home Energy Systems

	N	Minimum	Maximum	Mean	Std. Deviation
How much money do you save by using the biogas/solar energy systems (RWF)	110	4,057	34,968	21,373	10,938.579
Valid N (list wise)	110				

3.7 Amount of money Spent on Maintenance of Home Energy Systems

The findings presented in Table 5, further revealed that sampled households spend an average of 28,912.02 RWF annually. The households that spend the most on the maintenance of their home energy systems spent 44,954 RWF annually with the least maintenance spending 12,103 RWF annually. Constructed/installed systems with-in guarantee are maintained freely by field technicians from system suppliers. Once system is out of guarantee agreement, it is households' responsibility to look for a technician to fix the problem which turn to be quite expensive. The results indicated that various households spend different amount which implied that household maintenance of home energy systems could depend upon whether they receive after sales services from their suppliers.

Table 5. Amount Spent on Maintenance of Home Energy Systems

	N	Minimum	Maximum	Mean	Std. Deviation
How much do you spend on maintenance of your biogas/solar energy systems (RWF)	110	12,103	44,954	28,912.02	13,875.026
Valid N (list wise)	110				

3.8 Frequency of Breakdown of the Home Energy Systems

The study sought to find out from the households how often their home energy systems break down. The findings presented in figure 5, indicated that there was 65.5 % break down of home energy systems once in every six months whilst 34.5 % responded that their systems broke down once every three months. The findings implied that home energy systems owned by households in Rwanda broke down less often. These findings agree to the reported low maintenance costs of the home energy systems. Provision of the after sales or follow up service by providers supplying such systems will further reduce

the maintenance costs hence significantly reducing the costs associated with these energy systems.

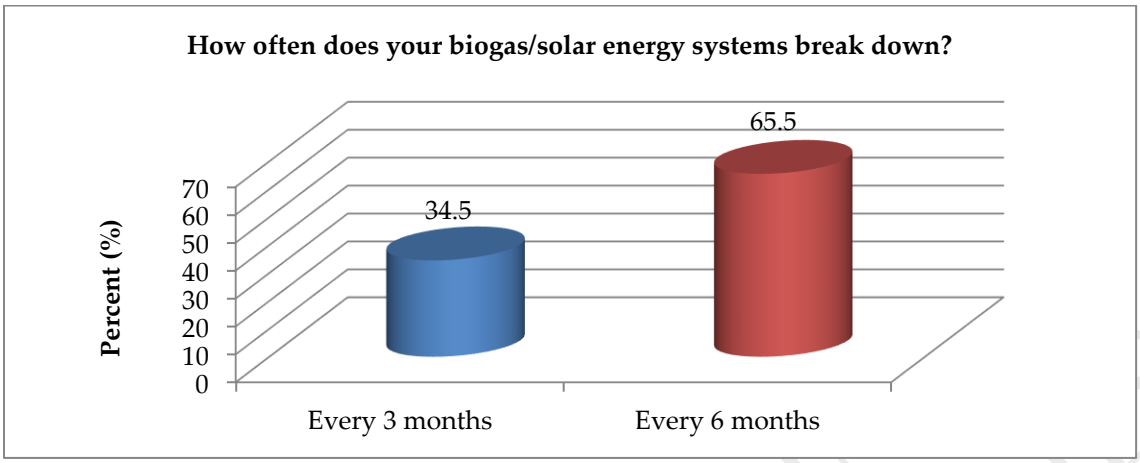

Figure 5. Frequency of Breakdown of the Home Energy Systems

3.9 After Sales Services and Effective Operation of Home Energy Systems

The study sought to establish whether there was difference in effectiveness in operation for the home energy systems in households that received after sales services and those that did not receive such services. The results presented in table 6, shows that 57 households agreed that their systems operated effectively out of which majority 37 also agreed that they received after sales services from their system suppliers. These findings revealed a significant relationship between after sales services and performance of households' energy systems in Rwanda.

Table 6. After Sales Services and Effective Operation of Home Energy Systems

	Does your home energy system run and produce gas/electricity effectively?			
		No	Yes	Total
Have been receiving after sales services for the home energy systems (Biogas/Solar Systems)	No	24	20	44
	Yes	29	37	66
	Total	53	57	110

3.10 After Sales Services and Purpose of Acquiring Home Energy Systems

This section compared after sales services and households energy systems achievement of the intended purpose. The results presented in Table 7, revealed all the households that indicated their energy systems had achieved its intended purpose by high extent, received after sales services from the system suppliers. Close to a half that indicated high extent also receive after sales services. These findings further confirmed that after sales services significantly enhanced performance of household energy systems and helped the households to achieve the intended purposes. Therefore, there is a need for system suppliers that supply households with energy systems to continue offering after sales service to ensure the systems operate efficiently and optimally.

Table 7. After Sales Services and Purpose Achievements of Energy Systems

	To what extent has your energy systems achieved its intended purpose						
		Very high extent	High extent	Moderate extent	Low extent	Very low extent	**Total**
Have been receiving after sales services for the home energy systems (Biogas/Solar Systems)	No	0	12	17	12	3	**44**
	Yes	16	11	13	20	6	**66**
	Total	**16**	**23**	**30**	**32**	**9**	**110**

3.11 Affordability of the After Sales Services

The survey sought to establish the affordability of the after sales services offered by the home energy systems supplying companies in Rwanda. The survey findings indicated 38.2 % households received free after sales services from their system suppliers, 38.2 % indicated after sales services were unaffordable, 16.4 % indicated after sales services were affordable while 7.3 % indicated after sales services were expensive but they can afford on regular basis. These findings implied that affordability of the after sales services played critical role in customer demand for such services.

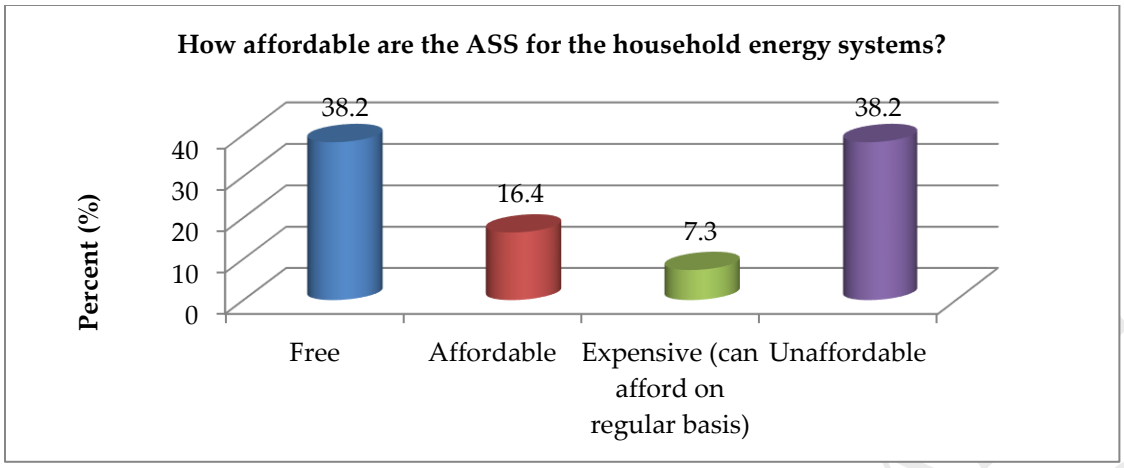

Figure 6. Affordability of the After Sales Services

3.12 Reasons for Lack of After Sales Services

The study sought to determine the reasons why households lacked after sales services for their home energy systems. The findings revealed that the major reason why some households did not receive after sales services for their energy systems was that the suppliers/distributors and manufacturer of energy systems did not offer such services to their customers.

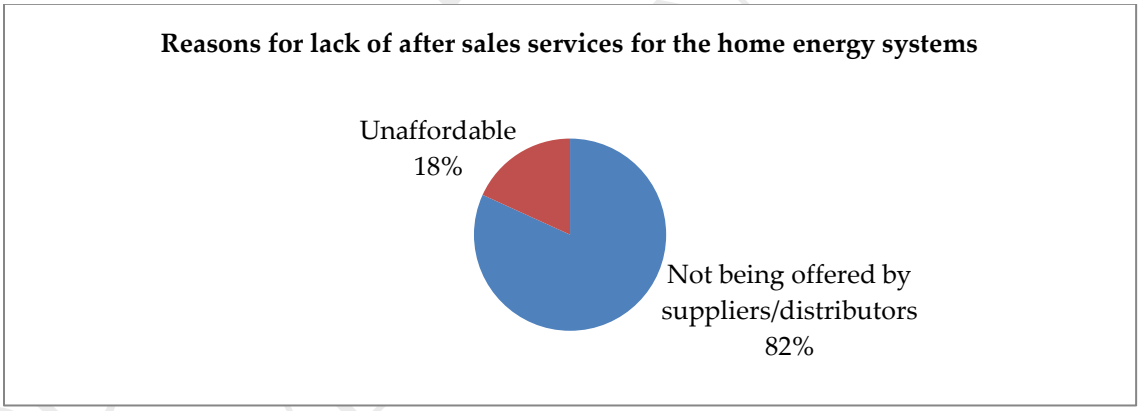

Figure 7. Reasons for Lack of After Sales Services

3.13 After Sales Services and Buying of Home Energy Systems

The study sought to establish type of the home energy systems that receive after sales services more frequently. The findings showed that 66 out of 110 households that participated in this study received after sales services. Out of the total households that received after sales services, 36 of them owned solar systems, 19 owned operational

biogas plants while only 11 households that owned non-operational biogas plant receive after sales services. The findings implied that companies supplying solar energy systems provided after sales services more frequently compared to companies that supplied biogas systems. Solar home system are pre-paid, suppliers have to provide needed technical support to keep the system in good working mode within the 3 years guarantee while for the biogas system, a company constructs and arrange the after sales services according to agreement with district officers and customers. The large percentage in the findings may suggest that after sales services/follow up services influenced buying decision of home energy systems among the households in Rwanda.

Table 8. After Sales Services and Type of Home Energy Systems

	Indicate the type of household energy systems you have				
		Operational biogas plant	Non-operational Biogas plant	Solar Home Systems	**Total**
Have been receiving after sales services for the home energy systems (Biogas/Solar Systems)	No	12	10	22	**44**
	Yes	19	11	36	**66**
	Total	**31**	**21**	**58**	**110**

3.14 Necessity of After Sales Services

The study also sought to establish respondents' perceptions on whether without after sales services from qualified technicians energy systems would not operate efficiently. The study findings revealed that 41.8 % of the respondents agreed, 37.3 % strongly agreed, 8.2 % disagreed, 7.3 % strongly disagreed. Choudhary and Akhter analysed the impact of after sale service characteristics on customer satisfaction, findings indicated that service delivery had a greater t value of 5.66 compared to that of installation 5.047 and warranty 4.158. All these variables have been found to have a significant effect on customer satisfaction that is coherent to the findings of this study [30]. The findings

confirmed that respondents prefer suppliers of home energy services that offered after sales services.

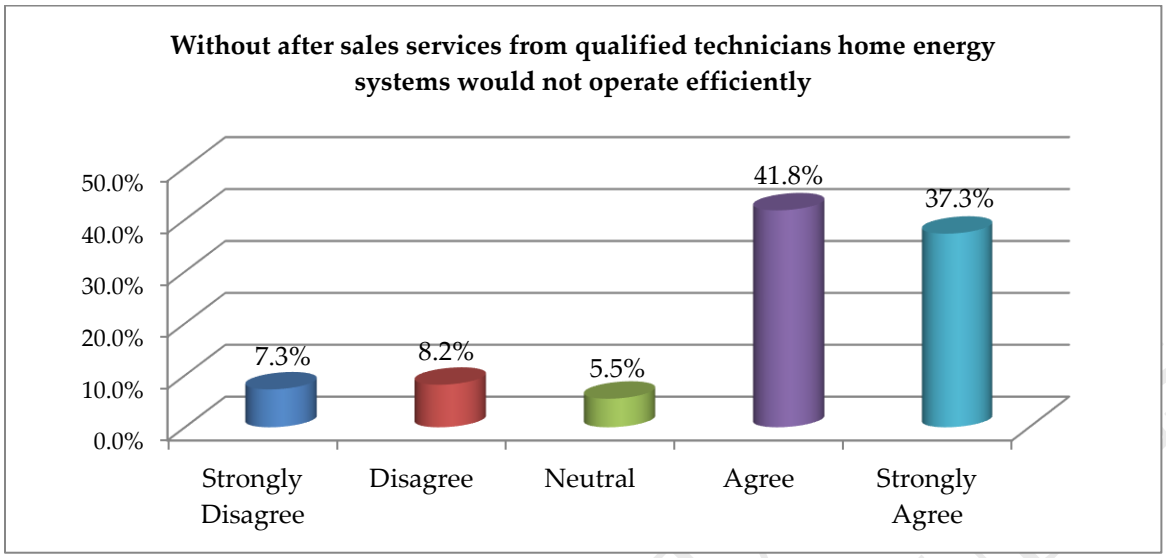

Figure 8. Necessity of After Sales Services

4. Conclusions and Recommendations

The main objective of the research was to assess the impacts of after sales services on performance of households' energy systems in Rwanda. Specifically, the study sought to ascertain the performance of household energy systems that have after sales services included in the package and those that never had after sales services; to investigate the extent to which people are buying home energy systems from suppliers that offer after sales services; and finally to determine peoples' perceptions towards after sales services on households' energy systems in Rwanda.

On the performance of household energy systems with after sales services and the systems without after sales services in Rwanda, the research findings revealed that there was a significant relationship between after sales services and performance of households' energy systems in Rwanda. This is because households that received after sales services for their home energy systems operated effectively and efficiently. Similarly, respondents confirmed that after sales services significantly enhanced performance of their energy systems and helped them to achieve the intended purposes.

Therefore, there is a need for companies that supply households with energy systems to continue offering after sales to ensure the systems operate efficiently and optimally. These findings further revealed that after sales services are very important in mitigating possible break down of the household's energy systems. Households that receive after sales services for their home energy systems experience less frequent break down of their systems compared to those that did not receive. Results showed that after sales services are affordable once terms and conditions are respected.

The second objective of the study sought to establish the influence on after sales services on buying of home energy systems. The findings revealed that after sales services/follow up services influenced buying decision of home energy systems among the households in Rwanda. The results further showed that many households bought solar home energy systems because the providers offered after sales services more frequently than providers of biogas energy systems.

Finally, the third objective of the study sought to determine the peoples' perception about after sales or follow up services. The study findings revealed that households were more willing to refer providers of energy systems that offered after sales services. The result further showed that people considered after sales services before procuring home energy systems and also agreed that home energy systems are complex and requires after sales services to keep them efficient. The finding also revealed that without follow up services from qualified technicians, home energy systems would not operate efficiently.

Based on the findings, the research concluded that buyers of home energy systems considered after sales services very important when procuring the home energy systems. The study concluded that home energy systems that received after sales services from their providers performed better than those that did not receive such services. The study further concluded that household energy systems break down is contributed by lack of adequate after sales services from the providers. The households that received after sales services achieved its intended purpose of procuring those energy systems. The study also

concluded that customers were influenced by after sales services when buying their home energy systems. Firms that offered after sales services sell more than firms that hardly provide after sales services. On the perception of customer on after sales services, the study concluded that customer perceived after sales services to be critical components when procuring the systems.

- The study recommended that utility providers and management of renewable energy systems that do not provide after sales services should consider providing such services to buyers of their products while those that offer such service less frequently should consider making after sales service part of their overall offer. This will ensure that they attract new customers and maintain the existing ones hence generating more profit also this will contribute to the sustainability of renewable energy in Rwanda.
- The study also recommended that system suppliers should enforce policies on follow up services to ensure their employees offer such services to the customers regularly. Systems suppliers should carry out market analysis by taking into consideration after sales services as means of business to generate revenues.
- The government of Rwanda in their quest to increase penetration of renewable energy usage should come up with policies to compel suppliers/distributors of household energy systems to offer after sales services and have a technician in charge of monitoring implementation of after sales services. Apart from after sales services that mainly comprised of delivery, installation and warranty, suppliers should also include a component of user training for home energy systems and development of technology demonstration. This will ensure the performance of such systems and more people will be encouraged to procure more home energy systems. The government should also ensure that there are progressive policies and regulation to manage providers of renewable energy home systems to protect consumers from substandard services from suppliers.

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