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ICT Usage: the Good, the Bad and the Ugly

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Abstract

Information Communication Technology (ICT) is a general term for any electronic facility (hardware, software and services) capable of supporting information capture, storage, sharing and communication. Such facilities include, but not limited to, radio, television, digital cameras, multimedia projectors, cellular phones, PCs, computer network systems, satellite systems, and services, such as video-conferencing and distance learning. The good side of ICT is seen as its benefits to the society, the bad side is seen as its abuse and negative social impact on the lives of people while the ugly side is considered as the security challenges posed to the society by this same ICT. This paper conducted a survey of one hundred respondents. The impact of ICT on the society towards a real and sustainable infrastructural development was assessed. We gathered opinions, drew conclusions, offered some recommendations.

Keywords: *Internet, Electronic, Multimedia systems.*

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Background to the Study
Information Communication Technology (ICT) is a general term for any electronic facility (hardware, software and services) capable of supporting information capture, storage, sharing and communication. Such facilities include, but not limited to, radio,

Television, digital cameras, multimedia projectors, cellular phones, PCs, computer network systems, satellite systems, and services, such as video-conferencing and distance learning. The Internet, cell phones and related technologies are profoundly affecting social, economic and political institutions worldwide, particularly in new and emerging civilization, (National Democratic Institute, n.d.). Many organizations are disconnected from the Internet, not because they lack telecommunications infrastructure or providers of equipment and training, nor because they lack recognition of the importance of getting connected and communicating or sharing information. They remain disconnected because they lack either the financial resources required or the technical and managerial expertise to adequately plan for and procure the needed equipment, systems and services (NDI, n.d.). The good side of ICT is seen as its benefits and numerous advantages to the society at large. The bad side of ICT is the negative effects of ICT on the society. What is seen as an advantage of ICT by someone can also be seen as a disadvantage by another person. The ugly side of ICT is the security challenges it poses to the society.

Literature Review
Societies today are far more dependent on technology-mediated communication than before. All processes of society depend on well-functioning communication infrastructures and services. The communication applies to business transactions where business-to-business interactions are increasingly conducted on networks and where business-to-consumer interactions also witness a growing number of network-based applications. ICT supports provided by either the government or private institution are intended to add value to our environment. Such facilities like street cameras, Internet services, global positioning systems, tracking devices, etc., have been abused by the society. As good as it is, access to the Internet, has created a high level of moral decadence in the society. For instance, dating sites, pornography and cult-related activities on the Internet have influenced the society negatively. As civilization increases, ICT awareness also increases, thus, increasing the rate of abuse of these services. Meanwhile, this same ICT has bridged the distance and space making communications much easier.

Positive Impact of ICT
A) Enhanced communication speed
In the past, it took a long time for any news or messages to be sent. Now with the Internet, news and messages are sent via e-mail to friends, business partners or anyone fast and efficiently. With the capability of bandwidth, broadband and connection speed on the Internet, any information can travel fast at an instant. It saves time and is inexpensive, (F33za, 2012 and Rifhan, 2013).

B) Lower Communication Cost
Using the Internet is cost-effective than other modes of communication such as telephone, mailing or courier Service. It allows people to have access to large amounts of data at a very low cost, (Masita, 2010 and Rifhan, 2013).

C) Paperless environment
ICT has created a paperless environment. Meaning that information can be stored and retrieved through the digital medium instead of paper. Online communication via email, online chat, and instant messages also help in creating a paperless environment, ((F33za, 2012 and Rifhan, 2013).

D) Effective Sharing of Information
People can share and exchange opinions, news and information through discussion groups, mailing list and forums on the Internet. These enable knowledge sharing that will contribute to the development of knowledge-based society, (Rifhan, 2013).

E) Data Back-up
The computer can create copies of documents and files on a vast storage device for future use. This device is capable of storing thousands of documents for a long period of time.

F) Repetitive Action
Computer can carry out same task or similar tasks over and over, very quickly and with high accuracy.

G) Ability to produce Different Output Formats
Information can be output on-screen or printed, in the form of graphs, charts, reports, pictures, sound, etc., (StudyMode, (2013).

Some of the Negative Sides of ICT are Listed Below

1) **Human error:** example, entering incorrect transactions; failing to spot and correct errors; processing the wrong information; accidentally deleting data, (Tutor2u, n.d., and VineMoble, (2013).
2) **Technical errors**: example, hardware that fails or software that crashes during transaction processing, (Tutor2u, n.d.)
3) **Fraud** - deliberate attempts to corrupt or amend previously legitimate data and information, (Tutor2u, n.d.)
4) **Commercial espionage**: example, competitors deliberately gaining access to commercially-sensitive data (e.g. customer details, pricing and profit margin data, proprietary designs), (Tutor2u, n.d.)
5) **Malicious damage**: where an employee or another person deliberately sets out to destroy or damage data and systems (e.g. hackers and creators of viruses), (Tutor2u, n.d.)

Some of the Security Issues with ICT are Listed Below (Ugly Side)

1) Internet Fraud
2) Internet hacking
3) ATM Frauds, etc

Purpose of the Study

1. To find out the benefits and advantages of ICT and its usage
2. To examine the negative use of ICT and its implications on the society
3. To further examine the security issues emanating from the use of ICT gadgets

Research Questions

a) Is it necessary to have ICT gadgets?
b) Does ICT have a negative effect on the society?
c) Does ICT usage make our society insecure?
d) Does the use of ICT limit interaction among the members of society?
e) Can the use of the Internet be controlled by the government and its agencies?

Methodology

A questionnaire containing twenty-seven (27) items in three (3) sections was employed for data collection for the study. The total population used in this study was one hundred. The analysis of respondents according to their age range is as follows; age (18-25) =30; age (26-34) =40; age (35-45) =15; age (45 and above) =15. Respondents were selected randomly in Laderin Workers Estate, Abeokuta, Ogun State. Section A of the questionnaire was meant to collect background information of the respondents. Section B contains question on the use of ICT gadgets. Section C includes ten research questions on the use of ICT with a mean score to determine the general remark.

Data Analysis

The table below shows the analysis of the responses.

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Table 1: Respondents by Age

Age Range	No of Respondents	% of Respondents
(18-24)	30	30
(25-35)	40	40
(34-45)	15	15
(45-Above)	15	15
Total	**100**	**100**

Table 2: Educational Level of the Respondents

Educational Level	No of Respondents
Primary	0
Secondary	15
Tertiary	85
Total	**100**

Table 3: Respondents by Gender

Gender Distribution	No of Respondents	% of Respondent
Male	40	40
Female	60	60
Total	**100**	**100**

Table 4: Employment Status of the Respondents

Employment Status	No of Respondents	% of Respondent
Employed	80	80
Un-employed	20	20
Total	**100**	**100**

Table 5: Marital Status of Respondents

Marital Status	No of Respondents	% of Respondents
Single	60	60
Married	28	28
Divorced	10	10
Widow	0	0
Separated	2	2
Total	**100**	**100**

Table 6: Analysis of Research Questions

S/N	Question	SA	A	N	D	SD	Mean (X)	Remark
1	It is a good thing for children to have access to ICT	44	40	-	10	6	4.06	Agree
2	It is necessary for every family to have ICT gadgets	50	30	5	5	10	4.05	Agree
3	ICT gadgets have negative effects on the society	25	20	20	25	10	3.25	Agree
4	ICT gadgets have negative effects on your family	10	20	-	50	20	2.50	Disagree
5	ICT gadgets limits interaction between family members	50	30	5	11	4	4.11	Agree
6	ICT gadgets are replacing face-to-face communication	40	30	15	10	5	3.90	Agree
7	People prefer to communicate using ICT gadgets	55	40	-	5	-	4.45	Agree
8	The Internet is now used negatively by your children	10	5	5	40	40	2.05	Disagree
9	People find it hard to control the use of the Internet	50	40	-	5	5	4.25	Agree
10	The use of ICT gadgets makes our society insecure	20	20	20	20	20	3.00	Neutral

Table 7: Analysis based on line chart

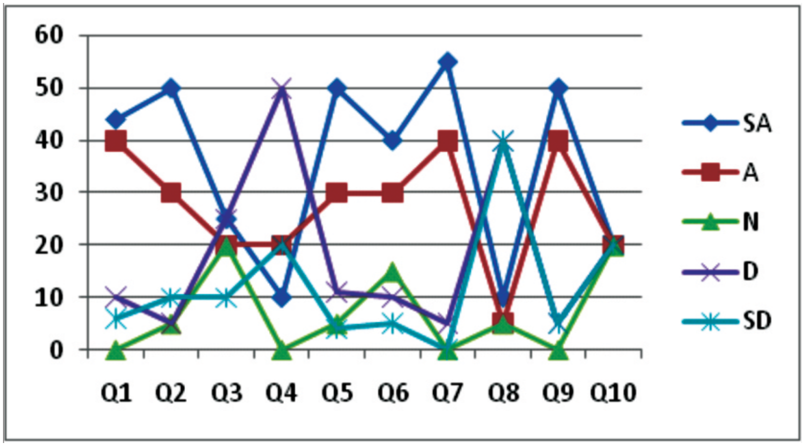
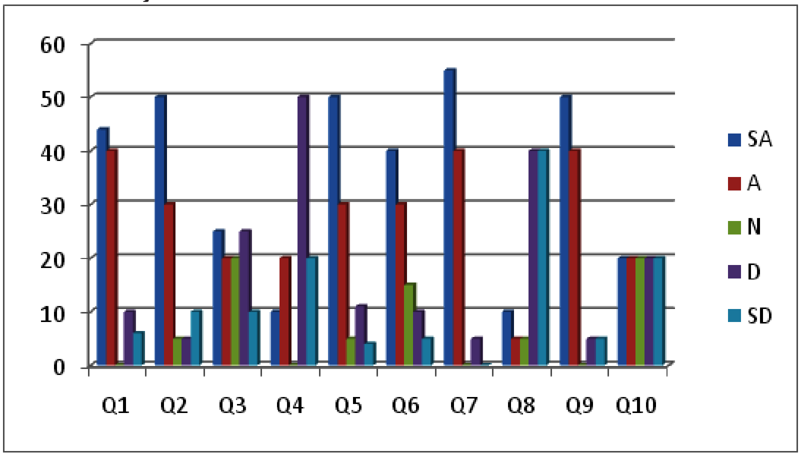


Table 8: Analysis based on column chart



Data Analysis

Numerical figures were awarded to each of the questionnaires as follows;

1. Strongly Agree (SA) = 4.5 – 5.0
2. Agree (A) = 3.5 – 4.5
3. Neutral (N) = 2.5 – 3.5
4. Disagree (D) = 1.5 – 2.5
5. Strongly Disagree (SD) = 1.0 – 1.5

The remark was deduced from the mean score calculated for each question on the questionnaire. A mean score of 3.5 and above will confirm "Agreement," while a score below 2.5 means "Disagree."

Discussion of Findings

From the analysis of the data above, almost all the respondents agreed that children should have access to ICT and that it is necessary for every family to have ICT gadgets. This finding shows that they know the importance of ICT. A larger percentage of them also agree to the fact that ICT has indeed limited interaction between family members. Children no longer talk face-to-face with their parents since they can chat using ICT gadgets. People sitting together still communicate with friends several miles away and ignore the ones beside them.

The lack of control over the use of ICT is another factor at which the respondents frown. Most of them disregard the inability of the policy makers to make rules guiding the use of the Internet.

Recommendations

1. Government and the Information Technology Industry must come up with policies to regulate and monitor the use of ICT.
2. Children should not be deprived of the knowledge of ICT and the use of ICT gadgets in schools and homes.
3. Government and stakeholders should address the security issues and challenges on the use of ICT.

Conclusion

This study looked at the benefits, negative impacts, and the security challenges of ICT infrastructure in the society. Simply put, the paper revealed the good, the bad and the ugly side of ICT. The good side of ICT should be embraced and explored very well. The bad side of ICT, which is seen as the mis-use of ICT should be checkmated, and the ugly side of ICT, as Fatin93 noted, that poses security challenges to the society should be addressed by the policy makers in the government and stakeholders.

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Techno-Economic Viability Analysis of a Hybrid Renewable Energy System for Katsira Village

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Abstract

Off-Grid rural electrification with the help of Renewable Energy Sources (RES) has become a cost-effective and convenient option for areas where grid connection is neither available nor feasible in the near future. This paper focuses on creating a model for electricity generation from a mix of renewable energy resources to satisfy the electrical needs of an off-grid remote village of Katsira, located in north western state of Sokoto in Nigeria. The selected solution is based on the system cost and the availability of the renewable energy resource at the location. The monthly average daily global solar radiation for the village is about 5.919 kWh. With an estimated primary energy demand of 189KWh/day and 33kW peak load demand for the village, an economic feasibility and assessment of a proposed hybrid system to supply this requirement was carried out. The simulation using NREL's Homer software indicate that for the proposed hybrid system comprising of PV, Diesel and Small Hydro Power (SHP), the cost of generating energy (COE) is 0.045$/kWh. This cost is 40% lower than that of the public utility supply company in Nigeria. The optimized hybrid system realized has a Net Price Cost of $39,828.00 and no storage battery is necessary.

Keywords: *Small Hydro Power, Cost of Energy, Net Price Cost, Renewable Energy, hybrid system*

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Background to the Study

There exists abundant evidence that climate change (CC) is a severe threat to economic development and can substantially affect a nation's GDP, as it affects water, forest, sanitation, food security, industrial development, housing, energy , health and air we breathe. Fossil fuels have been a major cause of adverse environmental and social consequences such as climate change, air pollution and mining accidents. Up to date, fossil fuels (coal, oil and natural gas) have been the main source of energy, meeting three-quarters of total world energy needs. However, rising concerns about the security of energy supplies have led to a global search for alternative energy sources. Sustainability is a key factor influencing the long-term viability of any energy resource, and it comes as no surprise that it is at the forefront of the global campaign to abandon the use of fossil fuels (Lambert et al, 2005). In view of this, renewable energy sources are being increasingly exploited to meet the energy needs (Simon & Guido, 2011).

The World Commission on Environment and Development (WCED) called for renewable energy resources as the foundation of the global energy structure during the 21st century (WCED 1987)(John &Akinbami,2001) but the National Energy Policy acknowledges that despite the abundant energy resources available in Nigeria, they have not been properly managed to satisfy the nation's energy needs. The Nigerian economy is predominantly oil-driven, but the contribution of oil to the nation's GDP is very small indeed (Mustafa &Dilşad, 2012).

Reliable access to electricity is a basic precondition for improving people's lives in rural areas, for enhanced healthcare, education and for growth within local economies. At present, more than 1.5 billion people worldwide do not have access to electricity in their homes (Energy, 2011); in many cases, utility grid extension is impractical owing to dispersed population or rugged terrain (Simon & Guido,2011). An estimated 80% of these people live in rural areas; most have scant prospects of gaining access to electricity in the near future (Energy, 2011). By 2030 there will still be 1.2 billion people without access to electricity. The number of people without electricity will even rise in Sub-Saharan Africa.

In the rapidly growing economies of the developing countries the demand for electricity is constantly increasing. Electricity is one of the driving forces in a growing economy and increasing demand puts incredible pressure on the countries' energy infrastructure to match that demand (Mustafa &Dilşad, 2012). The generation of electrical energy through an alternative sources such as wind and solar, has become more attractive and is widely used for substituting fossil fuels in the process of electrical power energy since 1970s because of the crisis in oil. Nevertheless, such alternative energy sources have a slow development and the transition into a new phase of evolution in the electrical power generation sector appears to be a complex task (Nounietal, 2008).

Village electrification is a vital step for improving the socio-economic conditions of rural areas and crucial for the country's overall development. The villages' welfare is one of the main aims of the rural electrification program. Enormous benefits can be achieved in irrigation, food preservation, crop processing, agriculture and rural small-scale industries. It creates employment opportunities for the villages' youth and promotes a better standard of life (Kaundinya et al, 2009 & Nwosuet al, 2008). Therefore, availability of electricity removes poverty and helps economic development by fulfilling health, education, water supply (for drinking and irrigation) needs of the rural population (Chaureyet al, 2004).

Rural electrification is relatively costly compared to electrification of urban areas. At any off-grid location, the delivered energy cost from the grid depends on four factors: -

a. Cost of energy (COE) generation from the central power plant.
b. Cost of transmission and distribution through the new network lines.
c. Transmission and distribution loss. (Technical and non-technical)
d. Load factor (Nwosuet al, 2008)

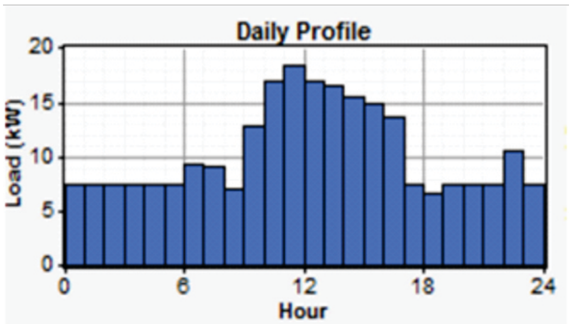
This study addresses those rural communities for whom off-grids are the most suitable solution and under-lines the benefits of using a mix of technologies based on renewable energies, battery storage, and fossil fuels. It focuses on rural communities isolated from public grids and without any prospect of connection in the next 15-20 years; having a certain load demand and serving a concentrated group of 15 or more households.

Study Area

The selected off-grid location for this paper is Katsira village in Goronyo local government of Sokoto State, in the north-west geo-political zone of Nigeria. The location of Goronyo on Latitude: 13° 45'N and Longitude:5° 41'E; the area of interest (i.e. Katsira village) is about 16km away from the main local government headquarter, Goronyo. Therefore, the daily radiation for Katsira is assumed to be the same as that of Goronyo due to their proximity. The village is nowhere near the national grid network and there no indication as to when it will be connected.

Electrical Loads

The demand for electricity in each area is different and therefore depends on numerous equipment factors, such as the price of equipment for electricity, the weather conditions, the time of day, the type of day and the season. Furthermore, even the level of affluence and lifestyle of the people in the community has an effect on the energy demand. The load profile describes the variation of the electricity demand with time. The hourly load profile provides crucial information on how electricity is used, and thus on where and what demand side management strategies could be potentially effective. Demand side management is the process of managing the consumption of energy to optimize available and planned generation resources (Nouniet al, 2008). Thus in this study the primary energy demand of Katsira village is 189Kwh/day and 33kw peak. Figs. 1a and 1bshow the daily profile and the seasonal profile of electricity demand for the village respectively.



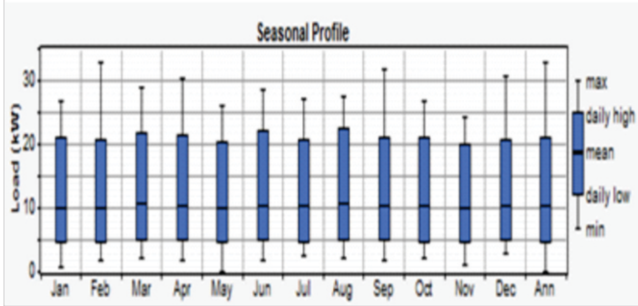


Fig.1a, Daily Profile of Electricity Demand

Fig.1b, Seasonal Profile of Electricity Demand

Methodology

Careful studies of different approaches were carried out for an optimal result. The methodology is based on the followings;

Hybrid Power System

A hybrid energy system generally consists of a primary renewable source working in parallel with a standby secondary non-renewable module or grid and storage units (Nouniet al, 2008). In this case the proposed system is comprised of PV modules, diesel generatorand small hydropower (SHP) system. Description of these components is given in the following sections. In the system also is included a storage battery and a DC/AC inverter.

Fig. 2 shows the hybrid system for the study.

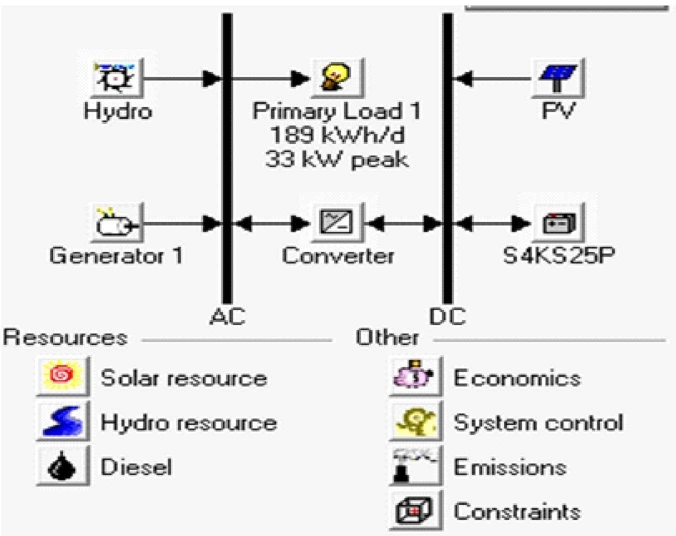


Fig. 2 Model of Hybrid Energy Systems (HOMER)

Solar Radiation Resource

Renewable energy sources are intermittent and naturally available.Due to these factors our first choice to meet the household electric energy demand will be solar energy. Weather data are important factor for pre-feasibility study of PV based hybrid energy system for any particular site (Kaldelliset al, 2000). For the selected location, the monthly average solar radiation, the global radiation and clearness index are indicated in fig.3.

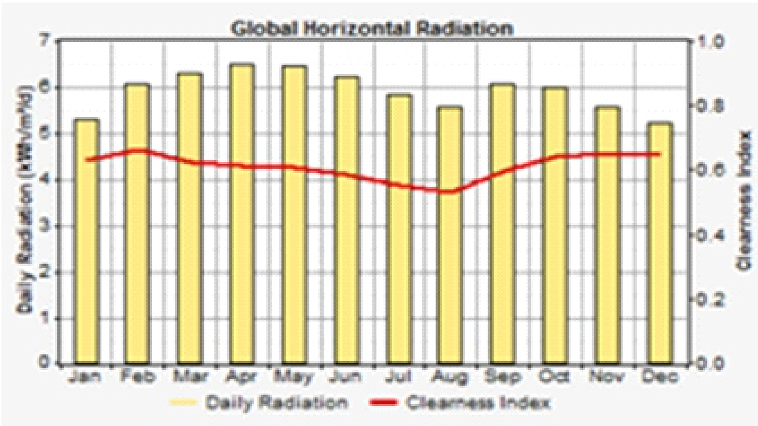


Fig. 3 Monthly average daily radiation, global radiation and clearness index of Katsira.

Diesel Generator

The off-grid diesel-based system is the most expensive solution over the whole lifetime of the project. The fuel costs of diesel, the running costs, and the replacement cost of the generating set every 3-4 years (25000 operating hours) offset the low initial investments. For the 20kW generator size considered, HOMER uses the following equation to determine fuel consumption:

$$F=F_0\,Y_{gen}+F_1\,P_{gen}$$

F_0 = is the fuel curve intercept coefficient
F_1 is the fuel curve slope
Y_{gen} is the Rated Capacity in kW
p_{gen} is the electric output in kW

It also uses the following equation to determine a generator's fixed cost of energy:

$$C_{fixed}=C_{O\&M}+\frac{C_{replacecost}}{lifetime\ (hrs)}+F_0\,Y_{gen}\,C_{fuel}$$

$C_{O\&M}$, and C_{fuel} are the operation and maintenance cost and fuel price in U.S. Dollars, respectively

F_0= is the fuel curve intercept coefficient
Y_{gen} is the rated capacity in kW

In terms of the fuel price and the fuel curve slope, HOMER determines a generator's marginal cost; an additional cost for every KWh generator produces using the following expression

$$C_{marginal} = F_1 \ C_{fuel}$$

Small-Hydro Power

The electrical power generated by the small-hydro unit is given by:

$$P_h = \eta_{hyd} \rho_{water} . g . H_{net} . Q$$

Where η_{hyd} is the hydro efficiency as obtained from the quadratic fit to the manufacturers' data, ρ_{water} is the density of water, *g* is the acceleration due to gravity, H_{net} is the effective head, and Q is the flow rate (Chaureyet al, 2004). Figs.4a and 4b show the average discharge of Goronyo dam from 1996-2005 and the cumulative average discharge of Goronyo dam from 1996-2005 respectively (Umar, 2005).

Month	Stream Flow (L/s)
January	269,300.0
February	273,960.0
March	297,850.0
April	358,400.0
May	328,400.0
June	742,600.0
July	1,471,100.0
August	444,880.0
September	616,970.0
October	110,980.0
November	355,250.0
December	284,550.0

Annual average: 163,826.9

Scaled annual average (L/s) 463827

Fig. 4a Average Discharge of Goronyo Dam1996-2005(Umar,2005).

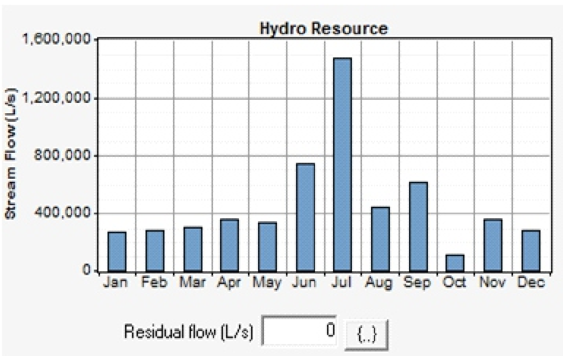


Fig. 4b, Cumulative average discharge of Goronyo Dam 1996-2005 (Umar,2005)

Converter

A converter is an electronic power device that is required in a hybrid system to maintain the energy flow between AC and DC electrical components. It has an inverter and a rectifier to do the conversions from DC to AC and vice versa (Chaureyet al, 2004).

Battery Power

Battery is used as a backup system which maintains constant voltage across the load during peak loads or a shortfall in generation capacity (Nouniet al, 2008). The state of charge of battery can be calculated from the following equations:

A. Battery discharging

$$P_b(t)=P_b(t-1)(1-\sigma)-\left[\frac{P_h(t)}{\eta_i}-P_i(t)\right]$$

B. Battery charging

$$P_b(t)=P_b(t-1)(1-\sigma)+\left[\frac{P_h(t)-P_l(t)}{\eta_i}\right]$$

Where $P_b(t-1)$ and $P_b(t)$ are the battery energy at the beginning and the end of interval t, respectively, $P_l(t)$ is the load demand at the time t, $P_h(t)$ is the total energy generated by micro-hydro unit and wind generators at the time t, σ is the self-discharge factor and ηb and ηi are the battery and inverter efficiency, respectively, as obtained from the manufacturers' data (Chaureyet al, 2004).

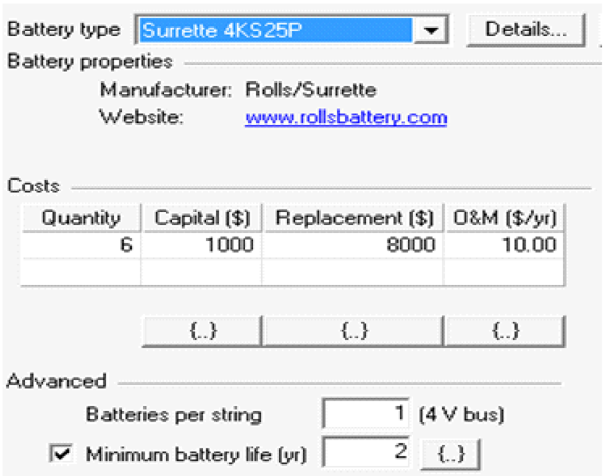
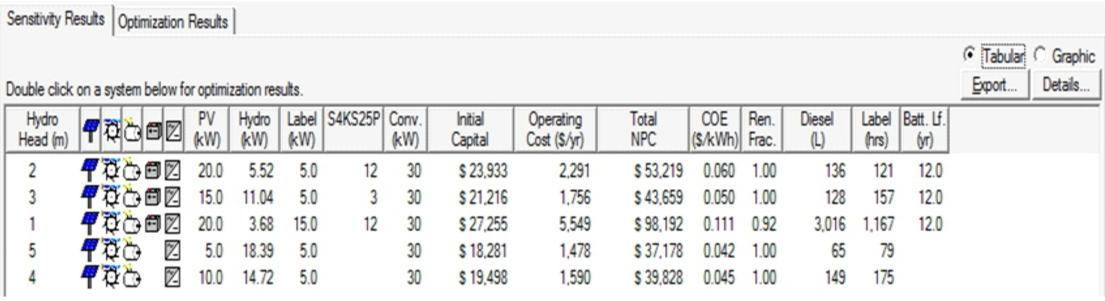


Fig.5, Surrette Battery's technical & cost parameters

The battery chosen for this study is Surrette 4KS25P as shown in fig 5. It is a 4V battery with a nominal capacity of 1,900Ah. It has a lifetime throughput of 10,569 kWh. The capital cost, replacement cost and O&M costs for one unit of this battery were considered as $1000, $800, and $10/year respectively.



Sensitivity Results | Optimization Results

Tabular | Graphic

Export... | Details...

Double click on a system below for optimization results.

Hydro Head (m)	PV (kW)	Hydro (kW)	Label (kW)	S4KS25P	Conv. (kW)	Initial Capital	Operating Cost ($/yr)	Total NPC	COE ($/kWh)	Ren. Frac.	Diesel (L)	Label (hrs)	Batt. Lf. (yr)
2	20.0	5.52	5.0	12	30	$ 23,933	2,291	$ 53,219	0.060	1.00	136	121	12.0
3	15.0	11.04	5.0	3	30	$ 21,216	1,756	$ 43,659	0.050	1.00	128	157	12.0
1	20.0	3.68	15.0	12	30	$ 27,255	5,549	$ 98,192	0.111	0.92	3,016	1,167	12.0
5	5.0	18.39	5.0		30	$ 18,281	1,478	$ 37,178	0.042	1.00	65	79	
4	10.0	14.72	5.0		30	$ 19,498	1,590	$ 39,828	0.045	1.00	149	175	

Fig 6, Sensitivity Analysis Details

Simulation

Simulations were conducted using HOMER software; a product of National Renewable Energy Lab, a division of the U.S. Department of Energy (Bernal & Dufo, 2009)&(John & Akinbami, 2001). HOMER specializes in modeling and comparing different power generation systems based on electric and/or thermal loads. HOMER facilitates finding the optimum solution in terms of a system's installation and recurrent costs over a specific life span. The software executes three major tasks; simulation, optimization, and sensitivity analysis. A model is simulated at every hour of the year to assess its efficiency, viability, and cost effectiveness. Optimization analyzes different system's combination in search for the most cost-effective solution while meeting technical feasibility. Sensitivity analysis analyzes the effect of different input assumptions (such as cost of fuel and average wind speed) on a system (Shaahid & El-Amin, 2008). Figure 1 represents HOMER's schematic representation of the hybrid system.

Results and Discussion

HOMER performs the simulation for a number of prospective designed configurations. After examining every design, it selects the best that meets the load with the system constraints at the least LCC. HOMER performs its optimization and sensitivity analysis across all mentioned components and their resources, technical and cost parameters, system constraints and sensitivity data over a range of exogenous variables. Results for the hybrid system options are compared regarding the least-cost scenario (Okbaet al, 2012).

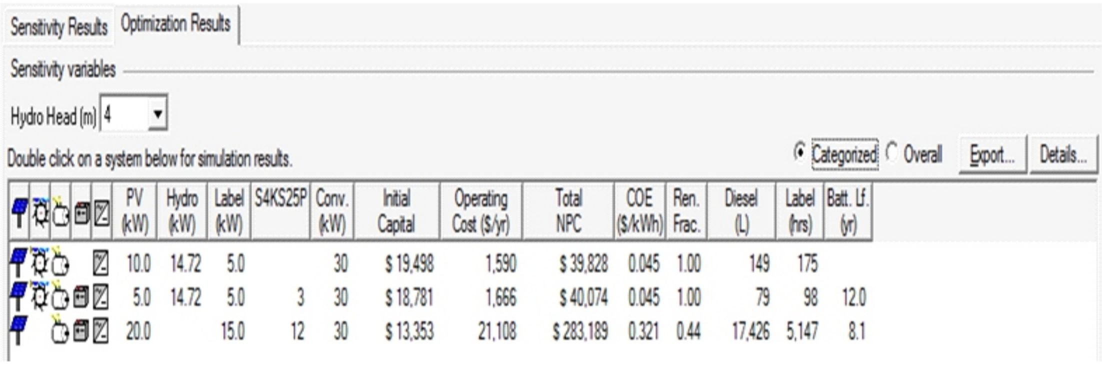
Sensitivity Result

Sensitivity analysis eliminates all infeasible combinations and ranks the feasible combinations taking into account uncertainty parameters. HOMER allows taking into account future developments, such as increasing or decreasing load demand as well as changes regarding the resources, for example fluctuations in the river's water flow rate, wind speed variations or the biodiesel prices (Okbaet al, 2012). Here, the various sensitive variables are considered to select the best suited combination for the hybrid system to serve the load demand of Katsira village. Fig. 6 below shows the sensitivity analysis detail.

It can be observed that with change in the sensitive variables, the configuration of the system changes. Even in this analysis, HOMER ranks the configurations in descending order of their total NPC.

Optimization Results

For the off-grid electrification of Katsira, various combinations have been obtained for hybrid systems with SPV, SHP, Diesel plant batteries and converters from the HOMER Optimization simulation. This is shown in fig.7.



Sensitivity Results | Optimization Results

Sensitivity variables

Hydro Head (m) 4

Double click on a system below for simulation results.

Categorized / Overall / Export... / Details...

PV (kW)	Hydro (kW)	Label (kW)	S4KS25P	Conv. (kW)	Initial Capital	Operating Cost ($/yr)	Total NPC	COE ($/kWh)	Ren. Frac.	Diesel (L)	Label (hrs)	Batt. Lf. (yr)
10.0	14.72	5.0		30	$ 19,498	1,590	$ 39,828	0.045	1.00	149	175	
5.0	14.72	5.0	3	30	$ 18,781	1,666	$ 40,074	0.045	1.00	79	98	12.0
20.0		15.0	12	30	$ 13,353	21,108	$ 283,189	0.321	0.44	17,426	5,147	8.1

Fig. 7 Optimization Result Details

According to the optimization results, the optimal combination of RET system components are a10kW PV-Array, 14.72kW SHP, 5kW diesel plant, 30kW Inverter. By this result it can be seen that there is no need for storage batteries. The implication of this is that when there is no energy supplied from the PV system (i.e. in the night), the load requirement will be met by the combination of SHP and the diesel generating set. Detail optimization results are shown in fig.7. The total Net Present Cost (NPC) was found to be $39,828, Capital cost as $19,498 and Cost of Energy (COE) as $0.045. As per the results obtained, the COE of $0.045/kWh from this hybrid system is cheaper than that of $0.075/kWh obtainable from PHCN. Assuming exchange rate of $1 to N160, the COE will translate to N7.20/unit which is less than N12.00/unit charged by PHCN. Thus, the optimized system is 40% cheaper than that of PHCN. Therefore there is no need for a grid extension to meet up the village load. But, if the cost of electricity from the PHCN falls below $0.045/kWh, grid extension becomes viable. It should be noted that, the second and third optimized options have far less capital outlay when compared with the first option. However, but their operating costs are $1,666; $21,108 and total NPC are $40, 07; $283,189 respectively are higher than the corresponding values for the first optimum choice.

Conclusion and Recommendation

The analysis presented in this paper validates the possibility of guaranteeing continuous availability feature of firm power at Katsira village by means of hybrid power option consisting of SPV, SHP, Diesel plant, Surrette Batteries and inverter. This combination has been identified as the cheapest and most dependable solution with a COE of $0.045/kWh; total NPC of $39.828 and initial cost of $19.498.The simulation results obtained indicate that, the COE of $0.045/kWh from this hybrid system is cheaper than that of $0.075/kWh obtainable from PHCN, thus it is by 40% cheaper than that of PHCN.

The observations of this study can be employed as a benchmark in designing hybrid systems for other locations having similar climatic and load conditions so as to avoid over dependence on fossil which has detrimental impact on human life and climate. In other to achieve this, the government, cooperate bodies, and cooperative societies will avail themselves of this opportunity to generate "all-green" power and save our environment from the global warming caused by greenhouse gases.

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