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The Effect Of Solar Energy Technology In Quality Education Development In Wolaita Zone Administration

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Abstract

This study aimed to investigate the effect of solar energy on quality education development in sampled school of Wolaita Zone Administration. Cross sectional descriptive statistics was instrumental as design of the research that is total quantitative approach. 120 Sample participants were selected to fill the survey questioners. Inferential statistics were the major part of analysis like ANOVA, Regression and Principal component analysis. The findings showed that independent variables were highly correlated with dependent variable at 0.005 level of significant level. Regression analysis of independent and dependent variables show R^2 = 0.783. This means that 78% of the variance in quality education development is due to solar energy electrification. It indicated that solar energy service qualities are an important dimension of the social context in improving quality education and academic achievement of students in schools. It was concluded that, the federal and well as regional state officials should exert more commitment for the expansion of solar energy at rural schools level who are not able to get sufficient electrification.

Introduction

Even though large-scale electricity networks have existed for more than a century, and hundreds of millions of people have received reliable and affordable access to electricity over the past few decades, many primary and secondary schools have no electricity whatsoever. About 90 percent of children in Sub-Saharan Africa go to primary schools that lack electricity, 27 percent of village schools in India lack electricity access, and fewer than half of Peruvian schools are electrified. Collectively, 188 million children attend schools not connected to any type of electricity supply. Put another way, almost one child out of every three goes to a school that lacks electricity. The other challenges are technical and economic, such as the high upfront cost of a grid connection or the expense of purchasing renewable energy technologies. As can be seen above, lack of electrification at primary and secondary schools therefore creates considerable obstacles towards escaping poverty, and correlates with many factors that contribute directly towards it.

Rural electrification programs have focused on connecting villages incrementally to the existing network, typically reaching schools in order of the least expensive. More than 1.7 billion people have been added to national electricity networks worldwide in the last two decades. “Well-planned, carefully targeted, and effectively implemented rural electrification programs provide enormous benefits to rural people as energy expert, Barnes has stated.” However, despite this progress, efforts to electrify schools have lagged behind, and left millions of children in the dark. A 2008 survey undertaken in 11 countries of 7,600 schools spread across Latin America, Asia and East Africa including Ethiopia noted that in general village schools lack electricity.[1] The result depicts only 27 % of village schools in India had electricity compared to 76 % of schools in towns and cities. In Sri Lanka, roughly one in five schools lacked access to electricity.

World Bank and International Energy Agency in 2013 compiled data on the electrification of African schools and noted that in at least twenty countries including Ethiopia, half or more public primary schools lacked access to electricity. One can see that, 90 million primary school students' in East and Sub Saharan Africa including Ethiopia, 94 million students in South Asia, and 4 million students in Latin America regularly attend schools without electricity. To sum, roughly 90 percent of children in East and Sub-Saharan Africa go to primary schools that lack electricity, and despite South Africa having the highest figures for grid electricity across the continent, some 3,544 schools are still without power.

Ethiopian Energy Sector Overview and Strategies

Ethiopia was consumed 1.3 EJ of energy in 2010 as indicated in national energy balance. This was emanated from various sources: biomass fuels (92 %), hydrocarbons (7 %), and electricity (1 %). Residential and service sectors were the major consumers of energy as indicated (93 %) and transport (5 %) with the remainder going for industrial and other applications respectively. Rapid economic growth has increased the pace of energy demand growth in Ethiopia: 6% for biomass fuels, 11% for electricity, and 11% for petroleum products.

One of the policy directive enacted by Ethiopian government was sectoral and cross-sectoral policies, strategies and plans to guide its actions. Some of these have been in place since the early 1990s while others have been very recent. The most important and recent of these include the Climate Resilient Green Economy Strategy (CRGE, 2011). The Growth and Transformation Plan (GTP, 2010), and Strategic Plan of the Ministry of Water and Energy (MWE, 2011). This initiative advocates expanding electricity generation from renewable sources of energy, and (d) .leapfrogging to modern and energy-efficient technologies (CRGE, 2011b).

More than 70% of Ethiopians depend on fuel-based lighting including fossil and solid biomass fuels (CSA, 2012b) and a relatively small segment of the population uses fuel based electricity generators. This contributes to greenhouse gas emissions, air pollution, and local environmental degradation. The green growth strategy seeks to displace fossil and solid biomass fuel use for lighting and other applications by renewable sources of energy including hydro, wind and solar. Development of infrastructure and in particular expansion of energy infrastructure features prominently in the GTP where it accounts for 40% of the total investment allocated for the period (MOFED, 2010). Despite such a huge investment to the energy sector, still majority rural communities (80 %) and their school kids were living under dark without electrification.

The energy sector strategic plan (2011-2015) specifies the energy sector vision and goals for the period. The plan puts in detail the goals stated in the GTP; quantitative targets are provided for both grid and off grid electricity as well as for other energy applications. Solar electricity appears to be the principal choice for off-grid electrification according to the Strategic Plan where the target is to distribute more than 3 million solar home systems by 2015 (MWE, 2010b).

The first PV systems were installed in Ethiopia in the mid-1980s - these systems were installed for rural home lighting and for school lighting. The largest of these was a 10.5kWp system installed in 1985 in Central Ethiopia, which served 300 rural households and their school kids through a micro grid in the village. This system was later upgraded to 30KWp in 1989 to provide power for the village water pump and schooling. It is estimated that a total of some 5.3MWp of PV is now in use in Ethiopia. The main area of application for PV is now off-grid telecom systems (particularly for mobile and landline network stations) which account for 87% of total installations.

PV systems are also used in social institutions including health stations and schools and for water pumping. Some thirty thousand residential customers are also electrified with PV in rural areas. In Ethiopia, only 270 rural schools in off-grid areas got access to electricity using solar PV systems recently in 2011. Which is insignificant a country with 80 % population lack electrification. Application in this sector is expected to increase rapidly due to the near universal access to the mobile network planned by the government by 2015, nonetheless, ignored the education sector service for rural communities and school children.

PVS installations in the early days were mainly project-based government and NGO action and systems were provided as grant to users. Project based installations are still important, particularly for institutional systems (schools, health centers, and water pumps). However, government now realizes that university community-service interventions program will enable wider dissemination, sustainability and capacity development. In this regard, WSU intended to share the burden of the government in electrifying the rural schools to improve student academic achievement and quality education. The following sections describe the target beneficiaries (direct and indirect) of the project, objectives (developmental and immediate), output, activities, time schedule, and others.

As UNESCO reports of 2014, from 46 countries in East and Sub-Saharan Africa showed that “the vast majority of schools report having no electricity in nearly all countries.” In more than half of all countries surveyed, 4 in 5 primary schools have no electricity. Despite such challenges and very limited power of electricity, the schools even with limited electrification have various educational benefits. It enables the use of modern mass media tools in the classroom such as the internet and televisions; electrified schools have better staff retention, outperform non-electrified schools on key educational indicators, and can enable broader social and economic development of communities. Furthermore, the following section more elaborates the benefits of access to school electrification from education points of view.

Since energy at the household level has a positive impact on children’s education, it is not surprising that energy at schools and vocational institutions is associated not only with a better experience for pupils, but also with great benefits for future employment options and income generation (Practical Action, 2013). Again, lighting is an important factor, which allows for extended operating hours of schools after sunset, which may be used by pupils for studying, teachers for preparing, or to facilitate trainings for community members. Lighting also has an influence on school attendance, specifically in areas such as the rainforest where penetration of sunlight is poor and lighting required during the day. As qualitative research in Bangladesh shows, teachers consider it almost impossible to teach under conditions of low light (The World Bank, 2013)

The same is true for heating of classrooms, which is required in colder regions to prevent disease. Again, applying sustainable energy solutions prevents this problem. Specifically in schools, energy is also needed for cooling: for both students and teachers it is hard to stay focused during hot summer months without any form of cooling, as evidence from Bangladesh confirms (Practical Action, 2013).

Problem Statement: The Educational Challenges of Electricity Access

With so many benefits to the electrification of schools that encompassing extended studying, access to computers and mass media, better staff retention and school performance, and community co-benefits such as health and gender empowerment. Why do so many remain without power? This section of the report discusses at list four interrelated barriers that offer a likely explanation.

Capital cost and limited financing: Perhaps the most obvious challenge is the fact that electrification of schools—through the grid, or through off-grid or micro-grid systems including renewable energy—is expensive. Schools may not be able to afford high initial connection fees. There can be long waiting times for connections and some rural schools may never be cost-effective to connect. Moreover, building centralized electricity grids is capital intensive. Such electrification efforts have connected hundreds of millions of people to the grid, but have also been expensive, with incremental transmission expansion costs ranging from $29 to $2,000 for every newly installed KW serving new power plants.

Thus, rural electrification programs in Chile, China, Honduras, Mexico, the Philippines, and Tunisia all depended on massive subsidies; they each funded their grid electrification efforts by using taxpayer dollars to finance 70 percent or more of total costs.[2] These heavily subsidized programs have occasionally "drained" the resources of state-owned electricity companies, with highly damaging effects on their overall performance and quality of service. The result is widespread brownouts and blackouts for all of their existing customers, and a reluctance of the power companies to reach out and provide electricity service to the poor.

Even then, when electricity access is provided, many schools cannot afford to pay for it or maintain it. For instance, in South America, although electricity supplies only 10 percent or so of the total energy used in schools, it accounts for more than 50 percent of its total cost, leading one study to note, "It is a very expensive source of energy for the region."[3] Some teachers and principals admit that they believe scarce school revenue can be spent on other things such as books or more teachers. In South Africa, two-thirds of school staff interviewed said they would have liked the money spent on electrification to be spent on other things such as accommodation for students or extra classrooms.

Papua New Guinea program called Solar Lighting for Rural Schools distributed almost 1,700 solar PV kits spread across 2,400 classrooms at 320 primary schools, but failed completely when neither teachers nor school boards could afford to invest in maintenance. Only a handful of units remained operational a mere five years after the program ended.

The sheer cost of electrification means schools and other major actors need appropriate mechanisms to finance it. However, this financing is unlikely to materialize without significant changes. The most recent projections from the International Energy Agency (IEA) subtly, but clearly, underscore that many of the poor are not likely to receive electricity access soon. In projecting the future, the IEA estimated that almost 1 billion people would still be without electricity by 2030. The IEA also estimated that about $1 trillion would be needed for universal access to energy and electricity between 2010 and 2030, an average of $50 billion per year. As of 2009-2010, however, only 3 percent of this needed investment has been committed. On a yearly basis, investments in financing electrification need to be ramped up by more than five times. Therefore, since one of the strategic pillars of university is community service, WSU planned to share the burden of state and community through establishing solar energy in secondary school to minimize the challenges of rural school students.

Lack of household energy access: School electrification programs provide access to schools, but rarely to households—meaning students' and teachers' homes remain without access (except in the cases in which teachers live in the schools). This result in two obvious drawbacks: they are unable to capture the educational benefits of household electrification, and do little to address the human health issues arising from dependence on solid fuels for cooking (except for schools that provide breakfasts and lunches for students and teachers). Multiple studies have confirmed the positive link between household access to electricity and various improved educational outcomes.

In Zimbabwe, children in a household with access to solar energy spend more time doing homework compared to households without access. In Bangladesh, duration of school attendance by children corresponds with the duration of household access to electricity. In the Philippines, homes with access to electricity on average have children that attend school for two years longer than those from homes lacking it. In Vietnam, another report concludes, "children from grid connected households tend to stay in school more than those from ones without grid electricity." In India, students whose households are electrified are more likely to complete grade appropriate tests successfully as compared to their counterparts whose households are not electrified; electrified households also have higher literacy rates. Another study of India found that household electrification increases school enrollment by about 6 percent for boys and 7.4 percent for girls; as the authors' note, household electricity access, in conjunction with service reliability "is what matters in improving household welfare in rural India." Thus, this study mainly targeted to investigate "the Impact of Solar Energy Technology in Quality Education Development in Ethiopia and guided by the following major research questions?

1. Is there significant relationship between Solar Energy technology and Quality Education Development at school level rural Ethiopia?
2. To what extent solar energy technology influences the development of quality education?

Objective: The major objective of the study was to investigate the effect of Solar Energy Technology in quality education development in rural Ethiopia

Method and Materials

Research Design

Descriptive survey design of cross-sectional nature was used to study at hand. The design helps to study issues pertaining to the problems under the current research over wide areas within a confined current period. It is more advantageous to test objectives and answer about group's beliefs, attitudes, behavior, and demographic composition (Gay et al., 2009).

Sources of Data

Multiple sources of evidence were used to triangulate the data, thereby increasing the credibility of the results of the study. Consequently, relevant information was generated from both primary and secondary roots. Primary data were solicited from teachers, students, principals, supervisors, educational officers. National education proclamations, Solar

Energy Policy, 2008, Education and Training Policy, 1994), General Education Quality Improvement Program (GEQIP), Quality Education Strategic Support Program (QESSP), EFA documents, Education Sector Development Program VI & V (ESDP1-5), education reform documents, guidelines utilized as secondary sources.

Sample and sampling technique

For the purpose of this study, the sample size was determined using the standard tables for sampling, using the confidence level of 95% and 5% confidence interval. To minimize the error, a 10% of the total population was added to each sample. For this study 640 population including students, teacher and department heads and all vice principals, and principals were selected randomly from ten sample secondary schools. The sample size was computed using the sample size determination formula that was adopted by (Gay et al., 2009) .He provides a simplified formula to calculate sample sizes. This formula was used to calculate the sample sizes of respondents.

$$n = \frac{N}{1+N(e)^2} = \frac{540}{1+640(0.05)^2} = \frac{540}{1+4.624} = 110.79 \approx 110+10\ \%\ 120$$

Where, **n** is the sample size, **N** is total sample frame (640), and **e** is acceptable level of error (0.05).

Therefore, using this formula, 120 sample respondents (Students, Teachers and department head, principals) was selected as a sample size. In order to draw sample respondents from total population the study was intended to utilize simple random sampling techniques. The study used simple random sampling technique to select participants. This is because it offers each and every element in the total population equal and independent chance of being selected and avoids personal (researcher's) bias in the process of taking sample from among the total population.

Instruments

Relevant data was generated from the study participants through self-developed survey questionnaires. Data was collected from teachers and academic leaders. The questionnaires prepared for both group differently on the same issues. Two sets of questionnaires comprising both open ended and closed-ended questions items were prepared.

Materials

In the course of data collection progression, SPSS version 20 and STATA version 13 were used to analyze the quantitative data. Image analysis software like Arc-GIS version 10.1 was instrumental to mapping the study area. Vensim software also were used to sketch the conceptual framework figure of the study.

Procedures

The procedure section describes all the steps in collecting the data, from beginning to end, in the order in which they occurred. Accordingly, it comprises of description of the technique to be used to select study participants, instrument development, and instrument validation, gaining entry to research, data collection, data validation and data integration. Then questionnaires prepared for research participants, and sample questionnaires were distributed to a limited number of respondents within each group of pilot testing. Subsequent to the preparation and validation of instruments completion, all questionnaires have cover letters to make a request for the cooperation, assured that their information was used only for research purposes, and keep strictly confidential, and then the data collection from respective education offices were begin as per the research schedule. In this process some date may converge and others may complement each other, ultimately enhancing the validity of the study.

Data Analysis

2.6.1

Under this section, the process by which outputs were generated through three steps: preparing data for analysis, analyzing the data, and interpreting the output data, and drawing valid inferences. The quantitative data analysis is predominantly inferential as its aim is to examine the Effect of Solar Energy Technology in Quality Education Development in Wolaita Zone Administrationin light of policies and practices. The quantitative data analysis was follow three phases:

Ensuring data integrity by testing whether the response furnished by the participants was applicable. This was involve checking the reliability and validity of data to see if there is any inconsistencies across responses in the dataset, to detect erroneous entries introduced in data collection or capturing stages and account for missing responses. This was done through, manually and using SPSS and STATA software packages.

Inferential statistics: To analyze the relationship between a set of predictor variables and dependent variables, correlation (Pearson correlations) was employed. The study was utilizing the logistic regression analysis with the support of statistical package for social science (SPSS) version 20 software and STATA version 12. Logistic regression because of the nature of the measurement scale was continuous, it vital to see the impact of independent variable on dependent variable.

Reliability

Reliability (α) of an instrument means that if the same instrument is used at different times or administered to different subject from the same population, therefor the findings should be the same. In other words, reliability is the extent to which a measuring instrument is repeatable and consistence (Smith & Combs 2008). To ensure reliability of the study, the author has used a combination of survey questionnaires and their Alpha values of all variables were greater than 0.7. It shows that the data was best fit to the study at hand. The overall reliability of the variables was α=.866.

Table 1. Coefficients of Internal Consistency Using Cronbach's Alpha Methodology.

No	Items	No of items	Cronbach's Alpha (α)
1	Lighting services	4	.885
2	Facilitation of ICT	6	.894
3	Staff retention	8	.883
4	Better teacher training	5	.894
5	Laboratory practices	4	.888
6	Better school Performance	5	.922
7	Enablement of community –co-benefit	6	.871
8	Information access	7	.833
9	Better academic achievement	5	.899
10	Quality education development	6	.911

Source: Survey Data -2021

Inferential statistics

Inter Image Correlation

Principal Component Analysis

Principal component analysis requires that the Kaiser-Meyer-Olkin Measure of Sampling Adequacy be greater than 0.50 for each individual variable as well as the set of variables. On iteration 1, the Measure of Sampling Adequacy for all of the individual variables included in the analysis was above 0.5 which is color plotted on the above table, supporting their retention in the analysis

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Table 2. Anti-Image Correlation Matrix for appropriateness of factor analysis to Measure of sample adequacy

Anti-Image Correlation Matrix	1	2	3	4	5	6	7	8	
Lighting services	**.758**	-.535	-.225	-.108	-.139	-.150	-.128	.060	
Facilitation of ICT	-.535	**.870**	-.105	-.036	-.131	.182	-.193	-.460	
Staff retention	-.225	-.105	**.896**	-.064	-.301	-.347	.007	.141	
Better teacher training	-.108	-.036	-.064	**.787**	-.516	-.081	-.122	.075	
Laboratory practices	-.139	-.131	-.301	-.516	**.962**	.000	-.194	-.150	
Better school Performance	-.150	-.182	-.347	-.081	.000	**.725**	-.428	-.181	
Enablement of community –co-benefit	-.128	-.193	-.007	-.122	-.194	-.428	**.805**	-.114	
Information access	-.060	-.460	-.141	.075	-.150	-.181	-.114	**.739**	
Better academic achievement	.543	.761	-223	.324	.223	.122	.115	**.311**	**0.876**
Extraction: Principal Component Analysis									

Source: Field Data-201

Table 3. KMO and Bartlett's Test for Appropriateness of Factor Analysis and for MSA

Kaiser-Meyer - Olkin Measure of Sampling Adequacy (MSA):		.887
Bartlett's Test of Sphercity	Approx. Chi-Square	599.94
Df 45		
Sig.	0.000***	

Source: Field Data -2017, Extraction Method: PCA

As we can see from the table above regarding the sampling adequacy for a set of solar energy variables, the overall MSA for a set of variables included in the analysis was .887 which exceeds the minimum requirements of 0.50 for the overall measure of sampling adequacy. Principal component analysis requires that the probability associated with Bartlett's Test of

Sphercity be less than the level of significance. Thus, the probability associated Bartlett's test <0.001, which highly satisfies this requirement.

Our initial factor solution was based on the extraction of 2 components. Using the output from iteration 1, there were 2 eigenvalues greater than 1.0. The latent root criterion for number of factors to derive would indicate that there were 2 components to be extracted for these variables. In addition, the cumulative proportion of variance criteria can be met with 2 components to satisfy the criterion of explaining 60 % or more of the total variance. Thus, as principal component analysis depicts, a 2 components solution would explain 78.32 % of the total variance.

Regression Analysis

1. **What is the effect of solar energy on quality education development in sampled secondary schools?**

This section demonstrates how independent variable influences the dependent variable. Accordingly, Table 3 provides the results of regression analysis with solar energy as the independent variable and quality education development as the dependent variable. Regression analysis of independent and dependent variables show $R^2 = 0.783$. This means that 78% of the variance in quality education development is due to solar energy electrification.

Table 4.10: Model Summary or Regression Analysis

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.878[a]	.783	.764	.448

[a] Predictors: (Constant), lighting, ICT facilitation. Staff retention, teacher training, better school performance. Community co-benefits. Information access, academic achievement

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	71.444	3	23.815	118.813	.000[b]
	Residual	21.247	106	.200		
	Total	92.691	109			

a. Dependent Variable: Teachers' Commitment

[a] Predictors: (Constant), lighting, ICT facilitation. Staff retention, teacher training, better school performance. Community co-benefits. Information access, academic achievement

Table 4. Coefficients

Model Predictors	Unstandardized Coeff.		Standardized Coeff.	t	Sig.
	B	Std. Error	Beta		

(Constant)	2.238	.654		3.422	.001
Lighting services	.459	.088	.554	5.217	.000
Facilitation of ICT	.332	.090	.130	1.463	.001
Staff retention	-.208	.103	-.230	-2.030	.045
Better teacher training	.443	.083	.633	3.21	.002
Laboratory practices	.511	.101	.571	2.412	.001
Better school Performance	.621	.911	.459	4.121	.0001
Enablement of community –co-benefit	.611	.075	.623	2.012	.003
Information access	.455	.111	.541	3.121	.031

a. Dependent Variable: Quality Education Development

Source: Survey Data-2021

Table 4 shows the results of regression coefficients (β) of the eight independent variables. Regression coefficient of lighting services is (β = 0.459) which indicates that one unit change of solar energy service in the school level will cause 0.55 unit changes in lighting service in particular and quality education development in general in a positive direction. Similarly, regression coefficient of Facilitation of ICT is (β = 0.332) and significant. This implies that one unit change in solar energy service at school level will cause 0.332 unit change in ICT facilitation in particular and quality education development in general at positive direction. Regression coefficient for Staff Retention is (β = 0.230) and significant, meaning one unit change in solar energy service at school level will cause 0.230 unit change in staff retention in particular and education quality in general. Regression coefficient of better teacher training is (β = 0.443) which indicates that one unit change of better solar energy services at school level will cause 0.443unit changes in better teacher training in particular and quality education development in general in a positive direction. Regression coefficient of havening laboratory practices is (β = 0.511) which indicates that one unit change of solar energy lighting services at school level will cause 0.511 unit changes in laboratory practices in particular and quality education development in general in a positive direction. Similarly, regression coefficient of better school performance is (β = 0.612) and significant. This implies that one unit change in solar energy at school level will cause 0.332 unit change in school performance and quality education development in general. Regression coefficient enablement of community co-benefits is (β = 0.611) which indicates that one unit change of solar energy lighting services at community level by renting from school will cause 0.611 unit changes in enablement of community co benefits in particular and community support and education development in general in a positive direction. Similarly, regression coefficient of access to up to dated information is (β = 0.455) and significant. This implies that one unit change in solar energy service at school level will cause 0.455 unit change in access to information in particular and quality education development in general at positive direction. Thus, all the regression results show that solar energy has significant effect on quality education development in sampled school level in a positive direction.

Conclusion

As indicated in the above findings, the following conclusions were drawn.

The findings showed that independent variables were highly correlated dependent variable. It indicated that solar energy service qualities are an important dimension of the social context in improving quality education and academic achievement of students in schools. It was concluded that, the federal and well as regional state officials cause more commitment for the expansion of solar energy at rural schools level who are not able to get sufficient electrification. A combination of both lighting, ICT facilitation. Staff retention, teacher training, better school performance. Community co-benefits. Information access, better academic achievement attributes may bring out a positive influence on commitment among teachers to work hard in sampled government secondary schools.

To sum, significant positive relationship was found between independent variables and dependent variable in sampled secondary school. This can infer that teachers want leaders who are honest, competent, forward–looking and inspiring which implies that teachers identify with the schools and teaching and feeling obliged to continue serving because of sufficient electrification services offering at school level.

The regression model result revealed that the adoption of solar energy in the in sampled school level is influenced by lighting, ICT facilitation. Staff retention, teacher training, better school performance, Community co-benefits, Information access, better academic achievement factors. More specifically, the adoption decision is positively affected by all independent variables and all these variables are found to be significant.

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