

## Empowering Rural Adult Women through Solar Energy Training for Sustainable Development: A Case Study

Dr. Lantana M. Usman<sup>1</sup>, PhD.

### Abstract

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Women in Sub-Sahara Africa are the sole providers of domestic wood energy, with half of the day invested and committed to sourcing firewood from forests and bushes. The experiences of these women are similar to other rural women in south developing countries, which led an Indian philanthropist to establish an energy unit at the Barefoot College of Tilonia, India. Through the government of India's international diplomacy, the college has extended the opportunity of training aged, unlettered and semi-illiterate rural women as solar energy experts across the world. Rural African women have, and still participate in the training, thereby making them solar energy 'experts' on return to their villages. The article is a research report that elucidates the impact of solar energy training on sample rural West African women in their communities. A qualitative educational research orientation and phenomenology design was conducted. Data was collected through face to face focus groups (FGs) interviews and participant observations, while data analysis engaged both hand data analysis (HDA) and computer data analysis (CDA) using NVivo computer qualitative software. Major findings revealed major dividend of the women's training in social and economic development for sustainability. The article concludes with suggestions that will further engage the women for innovative and sustainable solar energy training initiatives and dividend which are supported by local governments of their home countries.

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**Key Words:** Rural women; Africa; Training; Solar energy; Sustainable Learning; Development; Africa.

### Introduction

Traditionally, African rural women and their daughters are custodians of wood energy for domestic fuels (Hosken, n.d.; World Bank, 2000). The process of wood gathering is non-sustainable, as it gradually leads to deforestation and loss of soil fertility (Kongolo & Bamgose, 2002). Indeed, World Energy Council (1999) reiterated on rural energy, poverty and development by recommending alternative energies as solar energy, as part of saving the planet earth from vices of global warming amongst others.

African nations have taken the challenge on alternative energy, particularly solar energy, considering the abundance of sun energy in the continent. Indeed, their solar energy investments are on record, with countries as the kingdom of Morocco setting the pace in November 2009 by developing one of the world's largest solar energy projects costing about \$9 billion and with the aim of establishing 2,000MW of solar power by 2020 (Yansane, 2007). Ghana's investment on solar energy is expected to be the largest in Africa (McGrath, 2012), while Kenya is currently investing on solar energy with the assistance of the Chinese government (Kemeny, Munro, Schiavone, van der Horst, & Williams, 2014). Many African countries invest in solar energy in rural communities not only for the fact that sun energy is available and in abundance, but for its safety and alternatives to firewood energy (World Energy Council and Food and Agriculture Organization, 1999). Despite these progressive developments, the participation of women and girls in rural and urban African communities is limited, thereby marginalizing them in the micro management of solar energy (International Finance Corporation, n.d.).

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<sup>1</sup> Associate Professor, School of Education, College of Arts, Social and Health Sciences, University of Northern British Columbia, Prince George BC, V2N 4Z9, USA. Email: [lantana.usman@unbc.ca](mailto:lantana.usman@unbc.ca) Phone #: 1 250 960 5304  
Website: <http://www.unbc.ca/education/faculty>

The marginalization of women in solar technology in developing countries motivated an Indian philanthropist Surjit Bunker Roy to establish a solar energy curriculum at Barefoot College of Tilonia, India. African women from West African countries of the Gambia, Sierra Leone, Mali, Burkina Faso, Mauritania, Cameroon, Ivory Coast (Cote d'Ivoire) amongst others have been trained as solar engineers at the college. Since the inception of the college, and the return of the African women solar expert, no research has been conducted to evaluate the impact of their training in their communities, this motivated the outcome and report of this research article.

**1.1. Purpose of the Study.** Creswell (2015) stated that one of the purpose of research is to improve existing practice. The primary aim of my study assessed the impact of the learning outcome on solar energy on the lives of the women sampled in my study. The secondary aim explored how the women participants' sustained their learnt skills and knowledge as 'solar engineers' for sustainable living.

**1.2. Theoretical Framework.** An African feminist theoretical framework on development is adopted. African feminism is a form of feminism that is innovated by African women and specifically addresses the conditions and needs of continental African women (African women who reside in Africa) (Orakwue, 2018). Specifically, the theory of Nego-feminism as the feminism of negotiation is the focus theory (Obioma, 2004). Nego-feminism stands for 'no ego' feminism and is structured by cultural imperatives and modulated by ever shifting local and global exigencies (Obioma, 2004). Nego-feminism is an African feminist variation theory that relates to the utilization of culture of negotiation [with the opposite gender] in order to deconstruct patriarchy for women's benefit in African societies (Obioma, 2004). Considering the cultural background of the women participants of my study, the theoretical framework fits into the narrative on how series of negotiations were made between the founder of the Barefoot College and my participants' spouses and male headed community leaders (Roy, n.d.).

## Research Procedures

An educational qualitative orientation, and phenomenology design (van Mannen, 2014) was undertaken. The advantages of the research design as participants' flexibility and 'friendly' researcher approach, as well as allowing researchers' to report objectively on the information gathered from the participants, and minimizing personal biases (van Mannen, 1988 cited by Creswell, 2015, p.439) justified the choice of the research design. Other research procedures for the study involved an exploratory thematic literature review related to the topic (Creswell, 2015).

Location/site of the study included rural villages of Kankurang and Kafenkeng in the Gambia, and Timbuktu in Mali, West Africa. The villages produced the first three (3) women that obtained training in solar energy at Barefoot College Tilonia, India (Gaye, 2006). Hence, the choice of the women participants was a purposeful sample considering their solar energy training, work experience and availability (Creswell, 2015). Additional six (6) women from each of the location were adopted as snowball sample. They were middle aged women, and trained by the original three pioneer graduates of Barefoot College in Tilonia.

**2.1 Data Collection Process.** The phenomenological process of collecting emic data or "information supplied by the participants in a study...emic refers to first-order concepts, such as local language, concepts and ways of expression by members in a cultural sharing group" (Swandt, 2001 cited by Creswell, 2015, p.445) was used. Unstructured interviews with the women participants were conducted in the local language. Using the latter allowed participants' flexibility and to express their candid opinions and experiences freely. Also, participant observation (PO) data was obtained from repairing, installation, and assembling solar product by the women solar engineers. Focus group interviews (FGIs) data obtained from the women participants and three (3) male heads of households of the women participants that obtained training from the college in India. Visual data method (VDM) as photographs were obtained to document and corroborate the observed activities of the women participants. The choices of photos are based on its advantages of telling the 'truth' as well as revealing the symbolic world of the participants views (Atkinson & Hammersley, 1994; Atkinson & Hammersley, 1994 cited by Dowling & Cooney, 2012).

Ethical consideration was addressed by obtaining written and verbal consent in the local language from all participants. The participants' patriarchal culture was respected by obtaining further permission or consent from their husbands. Anonymity of three (3) of the women could not be observed due to the fact that they were the pioneers at the Barefoot College in Tilonia, India, hence, their identities are known by their entire countries, and their achievements were celebrated on the nations' radio and television. This I consider a part of the limitation of the study, especially with reference to institutional ethics research board (Creswell, 2015).

**2.2. Data Analysis Procedure.** Focus group and unstructured interview data were transcribed from the local language to English language using hand data analysis (HDA), followed by computer qualitative data analysis (CQDAS) by using Nvivo software 8.0 for the purpose of research rigor in data management, categorization, generating nodes (codes) and themes (Creswell, 2015). Participant observational data was analyzed through the process of collaboration with the researchers' reflective field notes and comparing with the generated themes for similarities and confirming reliability of the findings (Creswell, 2015). Measures of validity involved qualitative method of member checking (MC) of transcribed interview data with a select participants for confirmation and clarity (Creswell, 2015). The preceding discussion provides a synopsis of the participation of rural African women at Barefoot College.

### **Rural African Women at Barefoot College of Tilonia**

Barefoot College of India formerly known as the Social Work and Research Centre (SWRC) founded by an educator, social activist, and entrepreneur Sarjit "Bunker" Roy on July 3, 1972 (Barefoot College, n.d; Jain, 2002; Elkington & Hartigan 2008). Roy's compassion for the rural poor in his native India, combined with his humanitarianism to help people out of poverty, fostering dignity and self-determination led to the founding of the college (Mortesen, 2010). On November 16, 1989 the college began using sun energy for solar electrification of the college, which became the pioneering development of solar engineering program (Barefoot College, n.d.). From December 1, 1997, the first female solar engineer from rural India was produced (Barefoot College, n.d.).

In 2006, Barefoot College founder and staff visited Timbuktu in Mali (West Africa) by launching an experiment of providing solar power to a select rural villages that had no hope of been connected to the conventional power grid (Barefoot College, n.d.). This initiative flagged the training of rural women from West African region in the college in India (Jain, 2002). To expand and sustain the initiative of training these rural women, in 2013, the founder (Roy) was honored with Clintons' Global Service Award, and also the Indian government authorized \$2.5 million to Barefoot College so as to launch five regional training centers in Sub-Sahara Africa, with Zanzibar as the first training center established in 2014 (Barefoot College, n.d.). The involvement of the Indian government with the college is considered an international Indian diplomacy towards rural development in Africa (Indian Diplomacy, 2013; Times of India, 2017), as well as part of Commonwealth Economic Partnership of member countries of Commonwealth countries.

At the third India-Africa summit held in New Delhi in October 2015, Barefoot College made further commitment to open Barefoot Women's Vocational Training Centers in Senegal, Liberia, Burkina Faso, South Sudan and Tanzania, similar to the one already existing in Zanzibar (Bhura, 2015). Barefoot College capacity initiative led to the establishment of sub campuses in the listed six (6) African countries and running the same curriculum and vocational skills as the mother Barefoot College (Times of India, 2016).

One of the most successful Barefoot college training and skills acquisition that gained worldwide recognition is the solar program, with the training of 450 illiterate and semi-illiterate rural African women over the last 10 years, thereby electrifying close to 50,000 households in 34 rural African countries as stated by Ruchita Beri a senior research associate at the Africa Centre of the Institute of Defence Studies and Analyses (IDSA). India is importing hydrocarbon resources from Africa in the oil and gas sector, investing in equities, etcetera. In return what is it giving back to the African countries? African countries do not want India to replicate the highly commercial experience of its other traditional partners. Barefoot College is a highly successful example of showing that India is essentially involved in capacity building and human resource development, how the country's engagement with Africa differs from China (Bhura, 2015, p.1). Within rural developmental paradigm, Barefoot College model is a partnership model and not a business model, and Africa has been its toughest testing ground says founder Roy (2015). If our model can work and be owned by a community in the middle of Africa, then this model is replicable and scalable anywhere--at the least cost. .... Barefoot model is the only college in the world where you teach an illiterate woman to become a solar engineer in six months-- with full support from the government of India (Bhura, 2015, p.1).

The core philosophy of training rural matured African women as 'solar engineers' or experts as commented by the founder is that "The women become solar grandmothers. The idea that grandmothers stay and give back to their community is the core philosophy that motivates the solar electrification program" (Bhura, 2015, p.2). This notion expanded the number of African rural women trained in Barefoot College, hence, in September 2015 additional batch of African solar trainees included rural women from Namibia, Zimbabwe, South Africa, Burkina Faso and Malawi. As noted by (Bhura, 2015) that:

“The trainees have never had access to any formal education or dropped out of school at the primary level. They are all mothers of young teenage children or grandmothers who sometimes have difficulty remembering the number of grandchildren they have. Most of them have never visited a new country, even with their own families; they have travelled a distance of more than 3,500 miles alone on a sheer leap of faith--buoyed by the strength of their conviction that they can have a better life back home after their India stint” (p.2).

Recruiting African rural women for solar training at Barefoot College involved dialogue between the founder, some of the teaching staff with spouses and male heads of households of the rural women in Africa (Bhura, 2015). The team visited and convinced/negotiated with village heads and husbands of the women in the communities to overcome their fundamental fears and allow the women to train as solar engineers in India (Bhura, 2015). As Roy added, “Sometimes a man has three wives there [in Africa]. Once in Gambia, a man threatened that he would marry another woman as soon as his wife leaves for India. The woman came to India anyway. After she finished her training and went back, she was given a hero's welcome. Her husband did not remarry” (Bhura, 2015, p.2). This narrative reinforces the role of patriarchy in defining the social personal space of women in the cultural context. African feminist theorist of Nego-feminism posits that knowing when, where, and how to detonate and go around patriarchal land mines and how to use culture of negotiation in order to deconstruct the patriarchy for the women's benefit (Obioma, 2004). The reason is most grounded on household decision on which gender access to education or training in most African cultures.

### **3.1. Objective of Training African Rural Women as Solar Experts**

The educational objective of training rural women, especially African women as solar experts is to empower them for self-reliance, removing or minimizing them from abject poverty, and improving their quality of life (Roy, 2014). This notion is supported by Gandhi's philosophy of empowering the poor through literacy (Gutek, 2013). When selecting two rural women trainees from Kafenkeng and Kankurang Village in Bondali District of the Gambia the founder of Barefoot College stated that,

These two women do not know how to read neither to write. The two women would be trained as solar engineers within 6 months, and after the training, they would be able to install solar units, fabricate charge controllers and inventors in their villages as well as carryout repairs on the spot. Kankurang and Kafenkeng would be the first two solar electrified villages in the Gambia that would be technically and financially self-sufficient (Roy, 2014, p.1).

The above quote tallies with one of United Nations Sustainable Development Goals (SDGs) on poverty eradication for sustainable development with women (Griggs, 2013; Kates, Parris, & Leiserowitz, 2005; UN, 2015). Additionally, the objective matches with the micro level of human development index (HDI) of bottom-top model, as this developmental paradigm is more grassroot based and often successful in the developing countries (World Bank, 2004). Haven't reiterated the objectives of training rural African women as solar energy experts, the preceding discussion will explore the characteristics/back ground and training duration of rural African women at Barefoot College.

### **Characteristics of rural women learners and training duration at Barefoot College**

Women trainees or students at the Barefoot College (BC) are described by Roy (2004) as grandmothers and illiterates, others in minority are semi illiterates and early elementary drop outs. Arriving at the college with this educational background is not only challenging as stated by the founder (Roy, 2004), but that their educational backgrounds defines the nature of curriculum delivery in the college as well as types of teachers that engage the women trainees. The training duration is over a period of three (3) to six (6) months in the installation and maintenance of solar lighting systems and allied tasks by the college (Ashden, n.d).The duration training is part of the school policy so as to graduate the women as fast as possible and to enable them return home to Africa to their families and communities. Secondly, keeping to the six month duration of training the women enables the college to keep to their word to the students, host communities, and their spouses, thereby ensuring and promoting trust on both sides.

## Discussion of Findings

The interview major findings resulted into three major themes as economic, social, health and literacy dividend of training rural African women as solar energy experts. These themes corroborate with my observational notes and photographs of the women's activities with solar appliances in their communities.

Major dividend of the women's training in solar products noted the general provision of essential labor services to households, which generates income to the women. Services as installation of small roof panels and house electrification are highly patronized in the village communities. They also assemble solar lanterns, solar stoves, and solar re-charge batteries for recharging cell phones. These solar products not only create a manageable labor force for women in the communities, but create opportunities for them to generate earnings that are sustainable. As the women added

Even though we charge between 5-10 dollars for installation and repairs of solar panels and appliances, the money is of great help, as we recycle the earnings in supporting our home needs, especially buying food stuff and supporting our husbands responsibilities as buying fertilizers for their farms and payment of children school needs as books, pens etc. (Focus Group Transcript #5:1)

The above comments resonate with grassroots financial empowerment of the women. It also reinforces their purchasing power due to their earnings. Considering the low charges of their labor, the cost of imported solar spare parts from India is subsidized by Barefoot College. The solar parts are duty free and are directly shipped to the women in their communities. This is to ensure that the women's work is sustainable in the communities. The delivery process relieves the women from unnecessary cost that will reduce their earning powers. As one woman leader hired in the retraining of other women in solar repairs by the local government added

The government has to step in to assure the college that it will contribute in the transfer of the solar spare parts at least to cut down cost for the women. This arrangement has built assurance and trust with the college and the host countries in Africa. Indeed, the initiative is sustainable thereby keeping the rural women in business as well as sustaining their income earnings. (Focus Group Transcript #4:2).

Other economic dividend for the women participants' is their formation of group funding (asusu) and cooperative societies. These low level income generating self-help initiatives are aimed at assisting co-women in time of family needs or emergencies as family health, child birth etc. These are generated from the building of solar stoves, house electrification which are often a group of women activities. These stoves and allied solar products are sold on market days, and the earnings are saved in the grassroots financial coops managed by the women.

A significant social benefit enjoyed by the women participants is autonomy. This is attributed to the general advantages of education and training of African women in various literatures thus, "The relation between education and autonomy is mediated by the cultural relations of patriarchy. In many highly patriarchal settings woman's autonomy increases only if she has a secondary or higher education (Brock-Utne, 2000, p.13). Labor autonomy of the rural women as solar experts has elevated their status in the village communities. They are respected and their labor is appreciated and rated as essential service. As one woman added

Yes, we are highly appreciated and respected in the village now than before. My husband calls me 'engineer' (she laughs!!!). My in-laws call me the engineer as well, no more quarrels as before at the extended family levels. I think because they (my in-laws) now see I bring money to my husband and the family. In our village, money or income is associated with respect!! [all the women in the focus group chorused yes!!! To her statement] (Focus Group Transcript #6:1)

The above interview excerpt relates to areas of not only social empowerment of the women, but improving healthy social communication at the family level. Within African culture of patriarchy, the man as head of household has dominance of opinion and decision making, especially in the rural areas. However, women participants of my study as observed in their household dynamics seem to earn recognition at the family social space with their opinions considered by their spouses and other family male significant others, and this is simply due to their 'earning power and status' thereby earning them more 'financial and social respect'. As reported from an observed classroom discourse between a teacher and an African female student at Barefoot college retorts "Now my husband at home will do the cooking, cleaning, washing. I sleep." Madan stares at her incredulously, "You sleep?" And Pat comes Rosaline's triumphant response, "Yes, I am a solar engineer."

The women around them burst out laughing (Bhura, 2015, p.1). The comments of the student demonstrates the anticipated 'liberation' of women from the traditionally define domestic chores of women in Africa, which are often engrained in the confines of patriarchy. The expression may be a wishful desire of the woman and indeed all rural women across the continent, but in reality, it may not be feasible due to customs and traditional systems enrooted at the family, community, and ethnic and to some extent religious practices.

Additionally, earnings of the women as solar experts support family health needs. Solar grandmother engineers fund their children and grandchildren health needs as well as their health needs. These are feasible in health crisis as malaria health care, typhoid fever and other common health challenges related to immunization/vaccination. For the younger women retrained in solar energy work, they are able to attend to the cost of their ante-natal and post-natal health care without their husbands financial support. As one young woman added

In case of health emergency in my family, when my savings are insufficient, I seek 'soft loan' from our cooperative society, and sometimes from our crowd funding source. For the most, the funds come very handy and solve the problems immediately, which is good. (Focus Group Transcript #6:3)

The above comment display women's independence and self-reliance. This is progressive empowerment, and a departure from the orthodoxy of dependence of rural women due to the define spaces of patriarchy in African rural villages (Ogundipe, 2005).

The health empowerment of the women solar experts of my study extended to sustainable water hygiene they learnt from Barefoot College (Barefoot College, n.d.). This water sanitation approach of the women is conducted through rain water harvest, one of the five (5) approaches or principles of Barefoot College. This initiative is one of UN Sustainable Development Goal (SDG) 6 "Clean water and sanitation" (UN Sustainable Goals, 2015). As I observed the replacement of solar panels on the roof by the women solar engineers, they in addition position the solar panels away from the eaves of the roof that allows the flow of rain water on the roof. The women also mend and repair broken eaves at the roof top to aid the flow of rain water into plastic reservoirs on the ground of the houses. Collecting or harvesting the rain water in large plastic reservoirs in the village houses by the women promotes water hygiene and free from contamination. As observed, the rural women further keep the water clean by dropping Moringa seeds (obtained from Moringa Oleifera) (Deleegn, Sahile, & Husen, 2018; Sotheeswaran, Nand, Maata& Kanayathu, 2011) in the collected water plastic reservoirs. This traditional and cost effective or cheap water sanitation method is popular in developing countries and certified effective and less expensive (Deleegn, Sahile, & Husen, 2018; Sotheeswaran, Nand, Maata& Kanayathu, 2011).

The strategy of harvesting rain water is one of the skills the trained women solar experts of my study received at the Barefoot College. The advantages of rainwater harvesting/collection as clean water supply by the women saves time and labor of women and girls sourcing water from rivers and streams, which often is labor intensive and time consuming. Harvesting rain water by the women eliminates the retention of stagnant water in gutters, which encourage the gestation of mosquito larva and mosquitos, a major carrier of malaria across Africa. Further health benefits include the reduction of water borne diseases as typhoid and cholera in the family and community, thereby reducing the cost or finances in managing these diseases in hospitals and local pharmacies. As the women added:

The water we collect in the huge plastic reservoirs are not only clean and safe to drink and cook, we also notice that our family members have less or no attacks of typhoid fever in particular. To sustain this, we have contributed to buy more plastic cans and place them in public buildings as village halls, and schools, so that the public can access clean water when visiting the area. (Focus Group Transcript #6:4)

To corroborate the women's statements while visiting some of the public areas mentioned, I noticed public elementary schools had small and few solar panels and electrification done by the women solar experts as part of community village initiatives. This was organized by the chiefs of the villages and community funding, supported by the local council/government to pay the service of the women. The partnerships with the local government not only recognize the women skills and labor, but support their initiative as well as sustain their workforce in the villages. These steps has a wider impact in promoting women workforce in the villages, which most African local governments and ministries of women affairs can consider as policy initiative.

Most of the personal and financial economic earnings of my women participants come from assembling and repairs of solar powered stoves. Historically, solar powered stoves are not alien to Africa. Wenzel & Puris (2007) traced the history of solar stoves usage in Africa to a French scientist August Mouchot who designed and built solar cookers for French soldiers in Africa in 1877, and in 1878 he exhibited a solar concentrator at the Paris exhibit (p.6).

The rural women solar experts of my study assembled parabolic solar stoves and repair them for maintenance and sustainability. These major domestic appliances facilitate the nexus of their major earnings and distribution to most households, with women as their target customers. Targeting women buyers across villages is a demonstration of their marketing strategy otherwise described as ‘demographic and benefit marketing segmentation’ in business studies (GKToday, 2016). The two types of marketing segmentation adopted by the rural women solar energy experts in distributing not only parabolic stoves but other products as lanterns etc. has provided the women decision criteria as small businesses targeting a particular gender (women) and behavioral marketing segmentation usage rate benefit and purchase decision (of the products) (Bhasin, 2018; Thomas, 2016).

Most important dividend of the women’s marketing segmentation is the geographic spread of their clientele in rural and even urban area markets, thereby sustaining self-employment and earnings for the rural women solar energy experts. Introducing and using solar parabolic stoves in the family households has many advantages as liberating rural women from intensive labor of sourcing firewood fuel for cooking, saves cooking time and process, and above all reducing the health hazards of smoke inhalation from firewood fuels, and smell from kerosene stoves and gas, thereby reducing respiratory related diseases as asthma, lung cancer amongst others. As one woman commented

Using solar stoves is cheap and safer compared to firewood. The stoves can stay heated till the next day. It is easier to make tea (common in the Sahel), as well as warm food whenever needed, which we are unable to do with firewood. Also, those of using kerosene stoves and gas have compared the solar stoves to be cheaper and smell free when compared to smell of kerosene and gas (Focus Group Transcript #7:4)

The above comment is supported by empirical studies on the dividend of solar cookers which include monetary and time savings, and lack of smoked black cooking pots (Wentzel & Pouris, 2007, p.6-8). Other solar products as lamps and their repairs for domestic use in homes by the women solar experts have decreased incidences of fire outbreaks caused by local oil/kerosene lamps and stoves. Additionally, the women’s assembled solar lamps assists school attending children to undertake their homework at night, thereby improving their learning success and reducing the risk of eye problems while using kerosene lamps. This initiative is further corroborated with the innovations of solar bags for school attending students in South Africa (Brand South Africa, 2014; Said-Moorhouse, 2014).

Indeed, the above findings reveal change in quality of lives of the women participants of my study. They may be seen as few changes, but to the women, they are great changes that have shaped their rural status as providers at the family unit and to the community.

### **Learning outcome of rural women solar experts**

The learning outcomes are measurable within their communities, as well as supported by literature. They include the following:

**4.1. Increased self-confidence.** Many of the solar trained women and those retrained in the local rural communities or villages are described to possess increased self-confidence. As noted from the experience of the founder on one of the women from the Gambia who returned home haven’t been trained as solar expert, it was reported that:

Rejecting two women whom a village community in Gambia proposed to him for solar energy training, Roy selected another grandmother, whose body language he liked. The village community demurred: *"difficult husband, not possible."* However, with a little difficulty Roy persuaded the husband to let his wife go to India for the training. *"She went like a grandmother and came back like a tiger. She walked out of the plane and spoke to the whole press as if she was a veteran. She handled the national press and she was a star. And when I went back six months later and said where your husband is, she replied; 'Oh somewhere, it doesn't matter, it doesn't matter'. Success story"* (Roy, 2011,)

The Gambian success story is an illustration of self-confidence and empowerment. In another narrative with UNESCO Director General, founder of Barefoot College Roy added:

You see the change scene in front of your eyes. You see her confidence growing in front of you eyes; you see someone insecure, uncertain, and not confident about herself, becoming an engineer who knows more about solar engineering than any university graduate after five years. So she is an extraordinary woman within six months. (Barefoot College/UNESCO Partnership, 2012, p.1).

The role of self-confidence in humans is associated with psychological behavior (Bandura, 1971); the author further explained that adults experiencing self-confidence tend to gravitate toward self-efficacy, thereby making good decisions amongst alternatives related to their learning, life decisions and carriers. The authors' principles are noted with the rural women solar experts of my study. Their acquired self-confidence not only empowers them to positive decision making issues on their business investments and strategy on solar products, but assisted them in group think social responsibilities communication (Katopol, 2015; Kramer & Dougherty, 2013) with members of their cooperative societies and crowd funding associations in the rural villages.

**4.2. Solar rural women experts as agents of change.** The UNESCO Director-General asked Bunker Roy the founder of Barefoot College what motivated him to train rural African women. He responded thus:

The Barefoot College had tried to use men as change agents for many years, without any success. Roy declared that men are "*untrainable*" and explained why he thought so. He stated that the college invests only in women, as change agents and that "*women are the answer to the future problems of the world*", adding that the Barefoot College has trained 300 grandmothers from 29 African countries as solar engineers. "*They are the only solar engineers of Africa.*" Illustrating how an African grandmother is empowered and personally transformed by the training she receives at the Barefoot College. (Barefoot College/UNESCO Partnership, 2012, p.1).

The above quote can be associated with the principles of African feminism of *Stivanism* (Social Transformation in Africa Including Women) which elucidates African women experiences and realities they face. By implications, *Stivanism* reiterate positive change for African women through various social-economic transformation (Ogundipe-Leslie, 1994). Most of the realities and experiences rural African women face are broad but with poverty and poor social and economic development as the most prominent of all the challenges. Overcoming the economic constrain of women in development in Africa will require engaging the women directly (Bradshaw, Castellino and Diop (2013); this is evident in the approach of Barefoot College, as it involves rural women directly to change their economic wellbeing through the acquisition of skills and knowledge as solar energy experts. In labor economics, Bradshaw, Castellino and Diop (2013) added that "Identification of women as being a reliable, productive and cheap labor force makes them the preferred work force" (p.5).

Invariably, the learning outcome of the rural women solar experts not only transform their low social and economic status, but change their quality of living and self-worth, thereby making them as agents of change.

**4.3. Sustainable and effective household energy.** The Barefoot College's training of rural women fabricating solar cookers and allied solar products for domestic use is promoting the use of cleaner and more efficient energy technologies and alternative energy sources...in households, more completely, more effectively, and much more cheaply (Roy, 2012). Through solar energy initiatives the rural African women are exposed and included in current technologies as mobile (cell phones) in rural and remote villages across Africa thus, "the materiality of mobile phones, seasonal changes, and other factors must be considered when developing technological interventions in rural areas" (Wyche & Olson, 2018, p.1). Through these mobile phones, the women are able to access solar made batteries, repair them and recycle them for longer local use.

In sum, the involvement of the rural African women to soft technologies as mobile phones can be associated with gender equality that empowers the women in the area of communication and facilitating their solar energy businesses.

**4.4. Further literacy in solar technology.** Becoming solar experts has enabled the women to learn and understand some basic language of technology related to solar energy. Learning the names of wires and tools used to assemble solar products is empowering and may trigger the younger women retrained by the Barefoot College trained 'grandmothers' to pursue further education as adult learners in and outside the village communities.

Such pursuit of further education in solar energy when successful will be able to expose them to more urban workforce in the area of larger installation of solar panels for government and corporate buildings, and working with men side by side. This notion was expressed by some of the younger solar women participant experts of my study.

In addition, Bhura (2015) noted that Barefoot College became the first voluntary organization in the world to forge a tie-up with Apple to develop iPads for facilitating a smoother learning experience for solar trainees in Tilonia. This partnership will definitely extend to rural African women involved with the college curriculum in Africa's Barefoot College campuses. By implication, the opportunity for the rural women to access higher technology and be trained in the repairs of apple products in the future.

**4.5. Sustainable learning cooperation of solar energy women trainees across rural Africa.** There exists cooperation and sense of team work amongst solar energy women experts across their regions in Africa. This was noted thus,

“Once women in Benin [West Africa] failed to set up the solar power equipment. Then Barefoot solar mamas from Mauritania [West Africa] came down to help set it up for them. It is then that I am suddenly reminded of something Bunker Roy said in the course of our interview, "The best part of being illiterate is that you don't forget."(Bhura, 2015, p. 2). The camaraderie existing amongst the rural women solar experts fosters and enables them to retain their knowledge and skills so as to support each other regardless of geographic location.

## **Conclusion**

The article is a report of an educational qualitative research and an exploratory literature review of a sample of rural West African women trained as solar energy experts. Synopsis of the research procedures are presented with major findings of the study presented as thematic headings on the dividend of their knowledge and skills in the areas of economic, social, health and literacy. The paper concludes with the major learning outcomes of the women, and supported by pertinent literature.

In sum, the author acknowledges the limitation of the research due to the small sample and fewer geographic coverage of two West African countries, thereby limiting generalization. It is my hope that further studies on the impact of Barefoot College satellite campuses in African countries as Tanzania, Kenya, Madagascar, and other east African countries will be evaluated so as to provide further impact of the women solar engineers in those countries.

Conclusively, the focus on rural African women gaining knowledge and skills as solar engineers/experts is a breakthrough in grassroot development. Indeed, past literature on rural African women's contributions to development have always been in agricultural labor sector, especially with the publication of Boserup (1997) and her research experiences with Senegalese women in agricultural informal sector while resident in the country in the newly established UN Africa Institute of Economic Planning. Becoming solar engineers or experts is a shift for rural African women gaining access to 'soft' friendly and cheap technology at the grassroot level. The inclusion and participation of the rural women means they are not left behind in the global initiative of sourcing and using alternative energy. Additionally, the grassroot initiative of Barefoot College is not only people to people development but an investment on the rural poor regardless of geographic boundaries, race or nationality. The founders' focus on rural illiterate and aged women is worth commending as this policy initiative and implementation challenges modern educational conventions and skeptics that learning and skills acquisition can take place regardless of age, and that training and learning knows no boundaries. The Barefoot College aim of learning solar energy skills so as to change the face of poverty amongst the rural poor women is indeed a winner in grassroot micro development. It is the hope that solar energy curriculum run by Barefoot College in its African campuses will expand the curriculum by training rural women in other solar innovations as solar school bags for rural school attending students as pioneered by women entrepreneurs in South Africa (Brand South Africa, (2014) and Ivory Coast (Africa.com Contributor, n.d.; Said-Moorhouse, 2014). The innovation will serve as capacity building for the rural women across the African continent.

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### Authors' Biography

Dr. Lantana M. Usman is currently a tenured Associate Professor and a past coordinator of graduate degree programs at the School of Education, University of Northern British Columbia, Prince George, Canada. Prior to her current position, she was an instructor and a researcher at the Department of Educational Policy Studies, University of Alberta, Edmonton, Canada, where she earned her Doctor of Philosophy degree in Educational Administration, Leadership and Policy Studies. Her area of teaching and research interests include (but not limited to) Educational Policy Studies, Educational Leadership/Management and Administration, Comparative International Education, International Education and Development, Economics of Education, Sociocultural Education, Women Studies, Girls Education, Gender Education and Development, Multicultural Education, Inclusive Education, Refugee and Immigrants' Education, Conflict and Peace Education amongst others. Lantana can be contacted at [lantana.usman@unbc.ca](mailto:lantana.usman@unbc.ca)