



The benefits of energy appliances in the off-grid energy sector based on seven off-grid initiatives in rural Uganda



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ABSTRACT

The aim of this paper is to build on the existing knowledge of the benefits of energy appliances for the off-grid energy market. Rural electrification schemes often focus on generating power for electric lighting and, more recently, phone charging. The purpose of this study, however, is to identify the benefits of an array of energy appliances (other than lighting) that rural electrification initiatives rarely take into account. From the literature review, and the user-perceived benefits identified through a 'User-Perceived Value Game' conducted in 119 interview settings, it is found that the top-ranked benefits pertaining to energy appliances are business opportunity, elimination of labour intensive tasks, preservation of health, protection from people posing a threat (personal security), operational expenditure, ability to acquire knowledge, feeling comfortable, food security, information access, time savings and productivity improvement. Of these, the benefits pertaining to energy appliances, as perceived by the beneficiaries whose values are often overlooked by the project implementers, are identified and include comfort, security and food security. Furthermore, the study gives a brief account of the user-perceived benefits of modern energy sources (e.g. solar home systems, solar lanterns and generators). Where possible, reference is made to the traditional energy alternatives (e.g. candles), revealing the reasons why villagers sometimes preferred traditional energy sources to more modern ones.

1. Introduction

For the global energy community, access to energy is seen as a key contributor to reducing poverty, improving the health of women and children and facilitating education [1,2]. Currently there are 1.06 billion people without access to energy services [3]. Despite increasing efforts to tackle this energy deficit, as well as large investment (estimated at US\$ 9.1 billion in 2009 and US\$ 13.1 billion in 2013 [4]), there has not been a significant change in the number of people without access to electricity, as seen in Fig. 1.

Electrification and development are often assumed to go hand in hand. The relationship between the two has been demonstrated by a comprehensive study that analysed 77 countries over a period of 25 years [6]. Although the researchers highlighted that this relationship is dependent on the interaction of multiple factors, electrification is seen as a key mechanism to improve living standards [7], to increase income through 'income-generating activities' [8] and to improve community services such as education and health services [9]. Despite said benefits, a rising population, a shortfall in sustainable energy projects [10,11] and partial uptake of modern energy sources has meant there has been slow progress in this sector. Regarding the latter problem,

statistics published in the 'Poor People Energy Outlook' suggest that two-thirds of the people who did have electricity continued to use traditional energy sources [12]. One reason for this is the unreliability of new electric power projects in rural areas. To date, the deployment of improved lighting has commonly been accepted as a minimum target for access to energy and is seen as a contributor to reducing poverty – because of the associated health, safety, environmental and financial benefits [13]. However, for the aforementioned benefits to hold true, beneficiaries have to move away from traditional energy sources as they are expensive and lead to, for example, respiratory diseases, early childhood death, indoor fires and air pollution [ibid]. Whilst simple energy solutions, such as indoor lighting, can marginally help to address these issues, they may not be seen as priorities for the affected community and this can influence the uptake and sustainability of a project. Without a holistic energy approach that includes cultural shifts regarding energy appliances, people are not going to get the full benefits of electrification.

Furthermore, the sustainability of energy projects can be linked to the availability of after-sales services [13] and the beneficiaries' acceptance of a development initiative [14]. Major improvements have been made in the availability of after-sales services; however, further

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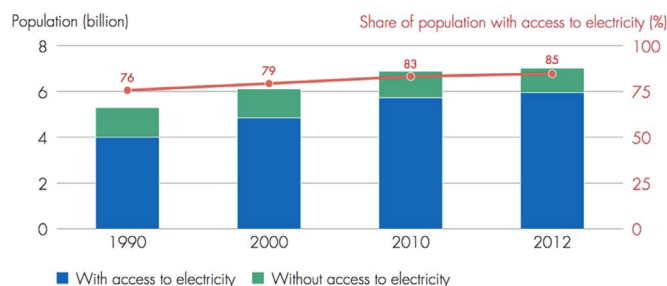


Fig. 1. Energy access timeline 1990–2012 [5].

improvements are required in communicating to end-users the benefits that sustainable energy initiatives can bring to their community. In this way projects are more likely to be willingly owned and maintained by the local end-users. This process is explained by a recent study: “*Understanding why something is important to the end-user will usually lead to an improved understanding of how a development initiative can be beneficial [...] and thus receive user acceptance because it is perceived to be of personal value to the customer. The customer will therefore care for the upkeep of the initiative, with the consequent outcome of sustainability achieved*” [15]. In line with this, the authors of this study argue that project developers need to consider more than simply implementing better quality lighting and mobile phone charging when creating sustainable energy projects in developing communities. Instead, they must additionally take into account the wider benefits that a range of energy appliances, such as televisions, street lighting or grain mills, can bring for rural communities. This is important as energy appliances can satisfy a wide array of the fundamental user-perceived values in rural households.

The aim of this study is threefold. Firstly, the study will provide a review of the benefits of electric appliances for the off-grid energy market. This is done by compiling existing literature on the benefits of electric appliances in relation to household energy use, community services and productive use. To add to this existing knowledge, this research paper then investigates the benefits of rural electrification initiatives as perceived by the end-user of electrification projects in seven villages across rural Uganda. As a result of this investigation, coupled with the literature review, it was possible to identify the principal benefits associated with off-grid energy appliances. Secondly, this research investigates the benefits of energy appliances which are considered important to end-users but not currently considered to be of significance by professionals involved in the delivery of off-grid solutions. Finally, the study concludes with a brief account of the user-perceived benefits of modern energy sources (e.g. solar home systems, solar lanterns and generators). Where possible, reference is made to the traditional energy alternatives (e.g. candles), revealing the reasons why villagers have frequently been found to prefer traditional energy sources to more modern options.

2. Literature review

The purpose of this section is to explore the benefits of energy access for household use, community services (including health care and education) and productive use, as described by literature.

As discussed above, the majority of off-grid rural electrification initiatives focus on the provision of electric light and mobile phone charging, often through solar products at a household level as this is the simplest means of providing modern energy services to rural areas [11]. Nonetheless, other energy appliances also have an important role to play in improving rural livelihoods as they can deliver a wider range of benefits than most rural electrification initiatives. To date, little attention has been placed on identifying the benefits of energy appliances beyond electric lighting and mobile phone charging. Discussed below are the potential benefits of off-grid energy access

for household energy use, community services (education and health care) and productive use. This is important in order to later understand UPVs of electrification projects.

2.1. Household energy use

Research shows that the majority (> 80%) of the energy consumed from traditional sources of energy in rural areas is for household activities such as cooking, water heating, lighting and space heating [16,17]. Based on the literature review, listed below are the most common electrical appliances used in rural households and their associated benefits [8,11,18–34].

- 1. Television:** Improved access to information, access to modern communication channels, entertainment, awareness creation.
- 2. Electric cooker:** Reduced operational expenditure, environmentally sustainable fuel, labour-saving for women through reduced need to collect fuel.
- 3. Electric light:** Brighter light at night time, additional hours to study, health benefits from reduced use of kerosene, labour-saving for women through reduced need to collect fuel, reduced operational expenditure, extending the working day, providing extra hours for study.
- 4. Radio:** Improved access to information, access to modern communication channels, entertainment, access to knowledge (awareness raising campaigns).
- 5. Mobile phone charging:** Reduction of communication costs, mitigation of transport costs connected with mobile phone charging, banking access, improved literacy.
- 6. Fridge:** Reduced chance of food poisoning, increased variety and quality of the diet through improved micronutrient intake.
- 7. Washer/Dryer:** Labour-saving (generally for women).
- 8. Street lighting:** Improved security and increased comfort in rural settlements at night (particularly for women).

2.2. Community services

The availability of electricity is seen as crucial to improving access to community services like health care and education [12,35,36]. Moreover, energy access in rural areas can help to attract and retain skilled workers such as teachers [28] and healthcare workers [29]. Listed below are the benefits of electric appliances related to education and health care.

2.2.1. Education

To date, globally there are approximately 200 million children attending primary and secondary schools which are not connected to energy services [28]. Inclusive and quality education is a key driver for sustainable development, as described by Sovacool and Ryan: “*Education is also widely recognised as one of the most essential components for poverty reduction*” [28]. According to UNESCO’s ‘Education for All’, 58 million children worldwide do not attend school and 100 million do not complete their primary education [25]. The majority of those not receiving adequate opportunities for education are girls [ibid]. Reasons for the gender inequality include the time intensive daily chores conducted by girls, such as the collection of firewood, and inadequate hygiene facilities: “*Adolescent girls’ concerns over privacy, particularly during menstruation, influence their education decisions and can act as an obstacle to school attendance*” [37]. Improving the infrastructure of schools, such as energy access, can be vital for improving rural livelihoods. It helps to shift the imbalance between rural and urban communities by making rural dwellers more competitive, such as in their ability to receive higher levels of education. Summarised below are the findings pertaining to the benefits of energy technologies and facility support functions at school of the following studies [25,28,30].

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