Energy Policy 63 (2013) 375–381

Contents lists available at ScienceDirect

Energy Policy

journal homepage: www.elsevier.com/locate/enpol

Solar cookers in developing countries—What is their key to success?

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HIGHLIGHTS

- The paper elaborates a list of variables influencing the adoption of solar cookers.
- The interrelations of the variables are illustrated in a flow chart.
- Environmental factors are easiest to control for by solar cooking organizations.
- Technical, social and cultural variables can be captured through a needs assessment.

ARTICLE INFO

Article history:
Received 14 September 2012
Accepted 20 August 2013
Available online 7 September 2013

Keywords:
Solar cooking
Developing countries
Social adoption

ABSTRACT

In developing countries households and institutions heavily rely on biomass to satisfy their energy needs. The unsustainable use of biomass is accompanied by several negative health and environmental impacts. As a clean energy source, solar cooking presents one alternative solution. In spite of its multiple benefits; however, solar cookers have experienced little success. Curiously, there has been little discussion about this in academic circles. Most research concerns technical improvements of solar cookers, rather than on the reasons why these cookers are not actually adopted in the field. This paper fills the gap by developing a comprehensive list of variables that influence the adoption of solar cooking: (1) economic, (2) social, (3) cultural, (4) environmental, (5) political and (6) technical. Furthermore, we can see that some solar cooking promoters are able to control for some of the variables (e.g., environmental factors), but not others (e.g. technical, social and cultural factors). The latter can only be captured through a needs assessment of the target group. This sort of assessment is a demanding but necessary step for the successful outcome of a solar cooking project.

1. Introduction

In developing countries, homes and institutions rely heavily on biomass to satisfy their energy needs. It is estimated that around 2.5 billion people around the world make use of biomass. At the household level, biomass accounts for 90% of the primary energy consumption, which mainly includes cooking (IEA, 2006).

The unsustainable use of biomass is accompanied by several negative health and environmental impacts. Many people in developing countries make use of a so-called “three stone fire” for cooking. Such fires are inefficient and produce smoke that can cause respiratory diseases, particularly among women, who are often in charge of the cooking process. According to the Global Burden of Disease Study (GBD, 2010), household air pollution from solid fuels causes about 3.5 million deaths in developing countries each year.

Furthermore, the unsustainable use of biomass has negative impacts on the environment. In general, the use of biomass for cooking is acceptable if harvested in a sustainable way. However, population growth in those countries leads to increased pressure on forests. A report by the FAO (2010) shows that between 1990 and 2010 the global biomass stock decreased by 3.6% globally, while the largest declines were found in South America and on the African continent.

Solar cooking presents an attractive alternative to the various problems caused by the unsustainable use of biomass. It is regarded as a clean way of cooking because it makes use of the sun as fuel and it is does not produce smoke. In solar cooking, sunlight is converted to heat energy, which is retained for cooking. Solar cooking is not a new idea. First designs of solar cookers can be traced back to the 18th century, when Nicholas de Saussure (1740–1799) built a black insulated solar cooker (Kimambo, 2007). Over the years, several types of solar cookers have been developed for homes and institutions all around the world.

In spite of its multiple benefits, solar cookers have not enjoyed widespread success, with low levels of successful implementation

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http://dx.doi.org/10.1016/j.enpol.2013.08.075

(GTZ, 2007). In the academic literature, this issue has received only limited attention. Most research is related to the technical improvements of solar cookers (see: Schwarzer and Vieeira da Silva, 2003, Nahar et al., 1993, Nahar, 2003, Hussein et al., 2008, Lahkar and Samdarshi, 2010, Rao and Subramanyam, 2005). While there are a few studies which address particularly relevant social issues, we lack a comprehensive study of the various factors that can influence the use of solar cookers (see: Ahmad, 2001, Bremm-Gerhards, 1991). A first task in this regard must be the assembly of a list of all relevant variables that can affect the successful implementation of solar cookers.

This paper aims to fill that gap by providing such a list. In the second part of the paper, the interactions of these variables are analyzed and illustrated in a flow chart that can serve as a guideline for future solar cooking projects.

The structure of the article is as followed: Section 2 begins with the collection of variables[1]. This list is drawn from a literature review, including articles written by both practitioners and academics about their experiences with the implementation of solar cookers. Since the existing literature on the use of solar cookers is very limited, I also include information from qualitative interviews with solar cooker practitioners (conducted between June 2010 and July 2011)[2]. Last but not least, I step a little bit out of the field of solar cooking to find inspiration for additional variables to consider, including articles on the adoption of other (solar) energy technologies. The interactions of the relevant variables and their meaning for the implementation of solar cooking projects are discussed in Section 3. This section will show that the model presented in the flow chart is difficult to realize in solar cooking projects, given time and resource constraints. Therefore, focus is directed towards the inclusion of some key variables for the adoption of solar cooking. In short, certain types of (environmental) factors can be easily controlled for by solar cooking promoters, while other (technical, social and cultural) factors are more difficult to control. The latter variables can only be captured by conducting a needs assessment of the target group—a demanding, but necessary, step for the successful implementation of a solar cooking project. Section 4 summarizes the major findings and recommendations for future solar cooking projects.

2. Relevant variables for the use of solar cookers

The number of variables which are assumed to influence the adoption of solar cooking is overwhelming. In order to gain a better overview, I divided the variables into six categories: (1) economic, (2) social, (3) cultural, (4) environmental, (5) political and (6) technical. In the following I will describe each of these six different categories and their component variables.

2.1. Economic factors

The most important economic factor to influence the adoption of a solar cooker is its *price* (Carmody and Sarkar, 1997). Affordable solar cookers are assumed to be more acceptable to users. In general, solar energy technologies in developing countries, including solar cookers, suffer from a high initial price, due to an underdeveloped market. Even though people can save money over the years by using a solar cooker, if the initial price is too high, this will discourage many people from obtaining a solar cooker.

2.2. Social factors

Among the social factors, there are four variables to consider. The first variable is *motivation*. Questions of motivation appear at several levels, including the type of motivation (e.g., economic, environmental, health) and differences in the type of motivation between different actors on different levels (e.g., purchaser, cook). In addition to motivation, other social factors include: (2) *the use of solar cookers by its disseminators*, (3) *existing power and gender relations* and (4) *supplier characteristics*. In the following, I will describe the different social factors in more detail.

2.2.1. Motivation

Kaplan (1999) argues that *motivation* is contextual. In the context of adopting solar PV systems, he identifies two types of motivational factors: the economic benefit of solar PV systems and an increased level of autonomy (due to a higher level of freedom from national electricity providers). Peter et al. (2002) add environmental protection as an additional motivational factor to Kaplan's model.

Applying this knowledge to the context of solar cooking, we can distinguish between **economic** and **environmental** types of motivation. Potential users might be motivated by the possibility of saving energy costs, or by the promise of protecting the environment. After all, and compared to fossil fuels, solar energy is a renewable energy source which does not harm the environment. In addition, future users might be motivated by potential **health** benefits. The use of conventional fuels (e.g. charcoal or biomass) produces smoke that can lead to respiratory diseases among cooks. Solar cookers are free of smoke.

With these three relevant motivational factors identified, we need to consider potential differences in the importance of those factors across different groups. Solar cooker promoters often emphasize the environmental and health benefits. From a user's perspective, however, the assumed economic gain of using solar energy (instead of using conventional fuels) might be regarded as the main motivational factor. In previous research on the use of solar cookers in Tanzania, I found people were more willing to use a solar cooker if it can lead to additional income-generating activities besides cooking (Otte, 2009). One of the projects I visited, on Zanzibar, used a solar cooker to boil the color for baskets that were produced by local women and sold to tourists. Women were very interested in solar cookers because they gave them an additional source of income. Furthermore, the solar cookers were well maintained, due to their economic value. This suggests that the chance of a successful adoption is higher if the solar cooker is perceived by its users to generate an additional economic benefit. This example came from the household level, but the economic motivational factor can also be transferred to the institutional level. Larger institutions, preparing food for many people, might see the economic benefits of using a solar cooker as it will cut their current energy costs.

At the household level, there may be differences separating the motivation of men and women. A study by Bremm-Gerhards (1991) showed that solar cooking is viewed positively by men and women if it leads to an improvement of their current conditions. However, men and women focus on different types of benefits: women appreciated the gain of time when using a solar cooker, men focused on the economic benefits of the solar cooker.

At the institutional level, types of motivation may differ between the decision-makers and the cooks that use the solar

[1] The presented list is not assumed to be exhaustive.

[2] Interviews were conducted with the NGO Solare Brücke e.V which promotes Scheffler reflectors, a solar cooking system implemented in different countries around the world. In addition, I include information from a visit to a solar farm in South Africa working with the improvement and development of solar box cookers and one interview conducted with KOZON, a Dutch NGO implementing the CooKit solar cooker in refugee camps in western Africa.