Relevant factors for the successful adoption of institutional solar cookers

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Abstract

Different types of solar cookers have been implemented around the world with varying levels of success. This study contributes to the literature with a study on the adoption of institutional solar cookers. The overall aim is to identify the relevant factors for the successful adoption of solar cooker. Interviews with public institutions in four different countries (Burkina Faso, Botswana, South Africa, India) show that in nine out of 24 institutions solar cooking systems were still in use.

The study shows that there are two cultural variables ('food characteristics' and 'schedule of daily routine'), which need to be considered by solar cooking promoters in form of assessing the local cooking situations and energy needs, and which determine the choice of the technology. In addition the study shows that in cases where solar cookers were not in use, changes in the management took place that led to differing levels of economic motivation. Thus, it is very important to analyze the organizational structures at institutions before implementing a solar cooking system. Solar cookers are more likely adopted if the local management can see the economic benefits of this technology.

In addition the study concludes that in order to enhance the use of solar cookers, solar cooking promoters should study their target groups, identify the local cultural preferences and find ways to integrate them into the design of solar cooking projects.

1. Introduction

In the year 2000 during the Millennium Summit in New York the leaders of the world's governments committed to a new global partnership to reduce poverty in form of 8 Millennium Development Goals (MDG), which should be achieved by 2015. These goals aim to (1.) eradicate extreme poverty and hunger; (2.) achieve universal primary education; (3.) promote gender equality and empower women; (4.) reduce child mortality; (5.) improve maternal health; (6.) combat HIV/AIDS, malaria and other diseases; (7.) ensure environmental sustainability; and (8.) develop a global partnership for development (UN, 2014). Surprisingly, they do not include energy but a reliable and affordable access to energy presents an important prerequisite for achieving these goals (Modi et al., 2006). Several studies have analyzed household energy use in developing countries and have shown that approximately 40 percent of the global population depend on biomass to satisfy their primary energy needs, which is unsustainable (IEA; 2011).

However, much less focus is given to public institutions in developing countries such as for example schools, health centers and religious institutions. With regards to the MDGs cooking becomes very relevant for an institutional level as well. Food processing activities such as cooking and baking at an institutional level can generate income for the employees and thus contribute to the achievement of several MDGs. One solution to the cooking crisis presents solar cookers, which make use of the solar thermal energy for cooking, since many of the countries that suffer from inadequate access to energy show also high levels of solar radiation.

Different types of solar cookers have been implemented around the world. However, the focus has been strongly on a household level. Nevertheless, several institutional types of solar cookers have been developed and implemented to improve the cooking situation at public institutions in the developing world. According to the IEA (2011) a lack of access to modern energy services goes along with a lack of provision of clean water, sanitation and healthcare. In this context the use of solar cookers at health institutions become very relevant

since the cookers could be also used for the sterilization of instruments and provision of clean water to their patients.

However, the success of solar cooking projects has been limited. Some studies claim that solar cookers are only successful in two different contexts. The first captures places where people do not have other alternatives for cooking such as refugee camps, which are often located in marginalized areas. The second is in areas such as the highlands of China and Tibet, where solar irradiation levels are high, cooking traditions corresponds to the use of a solar cooker, and biomass is not a real alternative for cooking (Klingshirn 2006, GTZ 2007, Tucker 1999).

However, these studies focus on a household level. This study contributes to the literature with a study on the adoption of institutional solar cookers. The paper presents a summary of my PhD thesis. The overall aim is to identify the relevant factors for the successful adoption of solar cookers. This summary focuses mainly on policy recommendations for solar cooking groups/organizations who work with the implementation of solar cooking projects. A detailed description of the study design and results can be found in my dissertation (Otte, 2014a).

The paper is structured as follows. Section 2 starts by presenting the contextual framework of the study. Section 3 describes the methodological approach applied in this study while section 4 presents and discuss the major results. Section 5 concludes the major findings by providing guidelines for future solar cooking projects.

2. Contextual framework

To develop the research design of this study I departed from a literature review, which is detailed discussed in one of my articles (Otte, 2013). The literature review showed that the list of variables is very complex and that the interaction of several factors influences the adoption of solar cookers. In total 18 variables were identified and for a better overview I divided the variables into six different categories: (1.) Economic, (2.) Cultural, (3.) Social, (4.) Political, (5.) Technical and (6.) Environmental factors. A full overview of the list of variables is presented in Figure 1.

We can see that the list of variables is long and that it will be difficult to test all these variables in a single study. By applying Roger's Innovation-Decision Process I was able to narrow down the list of variables to nine core variables[1].

[1] This process is detailed described in my paper Otte (2014b) "Warming up to solar cooking - A comparative study on motivations and the adoption of institutional solar cookers in the developing world" (in press) Energy Procedia.

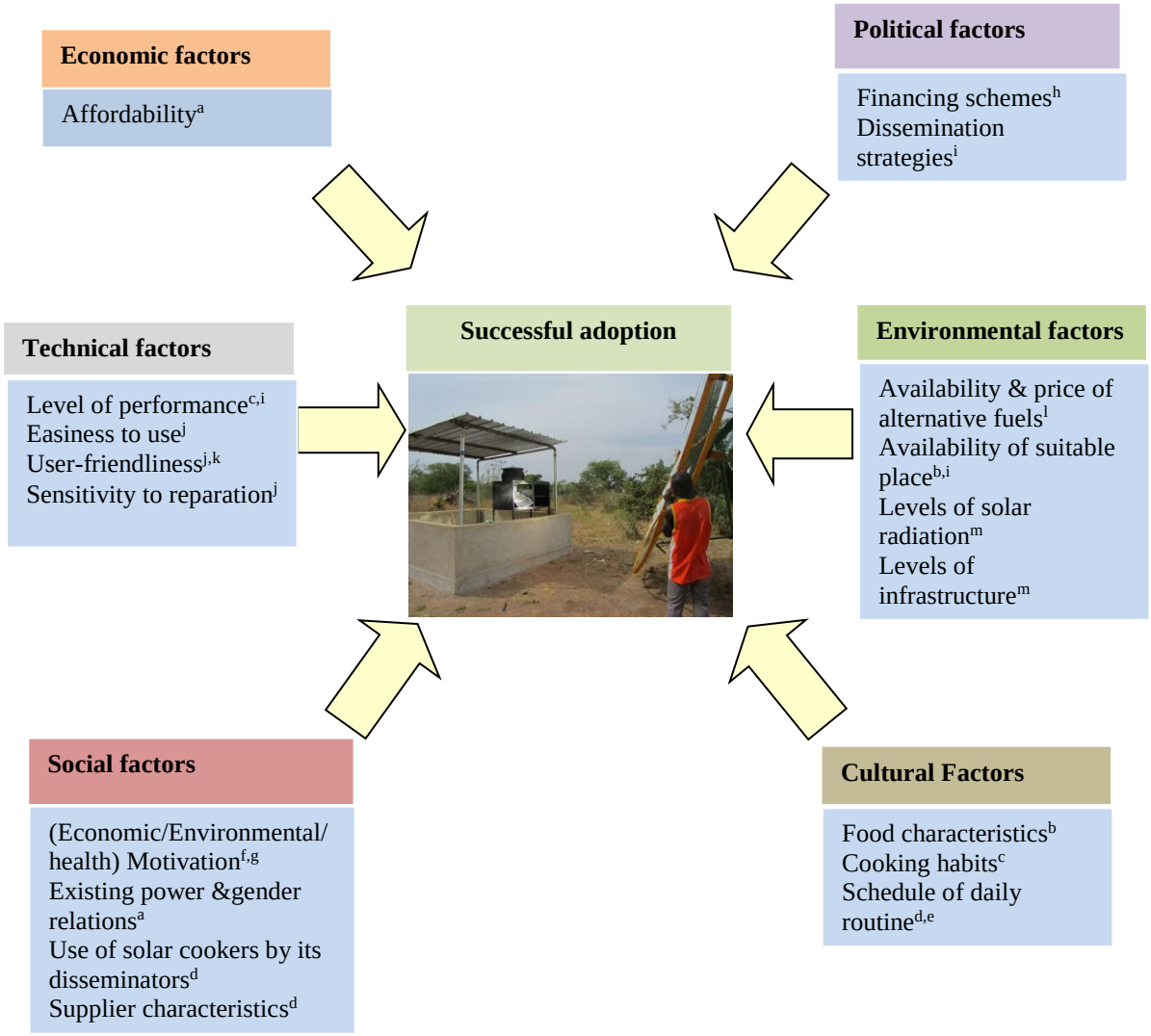

Figure 1 Variables relevant for the successful adoption of solar cookers

Sources: [a](Carmody and Sarkar, 1997); [b](Ahmad, 2001); [c](GTZ, 1999); [d] Narayanaswamy (2001); [e](Prasanna and Umanand, 2011); [f](Kaplan, 1999); [g](Peter et al., 2002); [h](Barnes et al., 1994); [i] (Hafner et al., 2002); [j](Bremm-Gerhards, 1991); [k](Murty et al., 2007); [l](GTZ, 2007) and [m](Otte, 2009).

This study focuses on institutional solar cookers and compares the use Scheffler reflectors in form of direct and steam kitchens in four different countries (Burkina Faso, Botswana, South Africa and India)[2]. In total 24 institutions were interviewed to identify levels of use and information related to the nine variables that were identified in the theoretical framework. Most of the institutions were located in India. In total 16 cases are from India, five from Burkina Faso, two cases from Botswana and one case from South Africa. More cases are included in India since more Scheffler reflectors had been installed there (Hoedt, 2009). The tracing of the cases on the African continent was not always an easy task since some of the systems had been installed in the early 1990s. In India, the institutions included in this study capture mainly religious institutions either in form of retreat centers, temples or boarding schools that are run by religious groups. On the African continent solar kitchens were installed in form of bakeries, shea nut butter production or for cooking at boarding schools.

3. Methods

Qualitative Comparative Analysis (QCA) was applied for analyzing the data. QCA allows for multiple conjunctural causation (Schneider and Wagemann, 2012) and presents a suitable tool for complex studies where

[2] The Scheffler reflectors were chosen based on an earlier mapping of different solar cookers, which is described in another paper presented at the Solar Cooking Convention 2014 entitled “Mapping global impact data for solar cooking: A case study”.

a complex number of variables can be identified that influence a certain outcome and we do not assume that a single variable leads to a certain outcome.
QCA is based on the logic of Boolean algebra and helps us to identify the necessary and sufficient conditions (variables) that influence the adoption of solar cookers. I applied a crispest QCA, which means that I coded my interview data in 1 and 0 values where [1] captures the presence of a condition while [0] captures the absence of a condition. The interview questions were "yes" and "no" questions. This means that all nine variables and the outcome (successful adoption) were calibrated into dichotomous values. If we for example look at the variable "user-friendliness", [1] would indicate that institutions considered the system user friendly, while [0] would indicate that they consider the system as not user-friendly.

4. Results and discussion

The interviews with the public institutions show that in nine out of 24 institutions the solar cooking system was still in use during my visit. In the other 15 cases the system was either completely abandoned or only partially taken in use.

In this study I applied a two-step QCA that allows differentiating between proximate and distant conditions. At this point I do not intend to go into more detail on the methodological framework of this study since this is presented elsewhere but I will concentrate more on the findings and their relevancy for the implementation of future solar cooking projects[3]. The QCA analysis leaves us with four conditions that are considered as necessary and sufficient for the successful adoption of solar cookers in nine cases. These are 1.) High levels of economic motivation, 2.) High levels of environmental motivation, 3.) High Compatibility with Local Food Characteristics and 4.) High Compatibility with schedule of daily routine.

Interestingly, all nine positive adoption cases are located in India and eight out of nine cases present solar steam kitchens. One explanation for this is that when taking a look at the cultural factors related to the cooking process, informants did not report of any changes when using the solar steam kitchens. There are mainly three cultural variables that are relevant in this context. These capture 'food characteristics', 'schedule of daily routine' and 'cooking habits'. In the case of the solar steam kitchens informants reported that the use of solar steam kitchens conforms to the cultural factors. For the cooks themselves the cooking situation as such does not change. They cook still in the same way as before just the type of fuel is changed (Otte, 2014b).

At this point the in-depth knowledge of the cases becomes relevant for contextualizing the role of the four relevant factors. In the following, I will describe each of the four factors and their relevancy in the context of the public institutions that continued using solar cookers.

Economic motivation

Economic motivation captures whether an institutions shows interest in a solar cooking system due to its potential of saving costs for energy fuels. All institutions that successfully adopted solar cookers showed high levels of economic motivation. Even though the institutions cannot entirely make use of solar cookers due to its weather dependency, the institutions acknowledge the savings they make during sunny days by reducing the costs for alternative fuels such as diesel, LPG and firewood. Depending on the region, institutions report that they can use the solar cooker between 270 and 300 days per year. The only institution that makes use of a direct solar kitchen, which is included among the nine positive adoption cases reports that they save approximately 200 kg of LPG per month by using the solar kitchen.

[3] The methodological approach is discussed in another paper entitled "Solar cookers for developing countries – A framework to compare success rates of institutional solar cookers in developing countries, which has been submitted to the Journal of Energy in Southern Africa (June 2014).

Environmental motivation

High levels of environmental captures the drive to protect the environment. The interesting aspect here is that all nine positive adoption cases capture religious institutions that show a strong interest in protecting nature as part of their spiritual belief. Solar cookers are considered as clean energy that does not pollute or harm the environment. One religious group included with several positive cases in the solution path uses solar kitchens at their retreat centers and shows that environmental motivation is an integrated part of their spiritual belief. The use of solar energy for cooking is very consistent with this spiritual belief and thus enhances the use of solar cookers (Otte, 2014c).

Local Food Characteristics

Local food characteristics captures whether the food prepared with a solar cooker has the same taste and consistency when prepared with conventional fuels. In all nine positive adoption cases the institutions did not mention any changes in the food taste. As earlier mentioned eight out of nine cases include solar steam kitchens where the food preparation is not changed as such but just the type of fuel is different. Thus, we can control for variation in this variable.

In addition to the objective taste, the study found out that in the context of religious institutions in India, purity as important concept within Hinduism, played an important role for the food taste. Food prepared with a solar cooker is considered to be "pure" because it is prepared with a clean and renewable energy source (ibid).

Schedule of daily routine

Schedule of daily routine captures whether the solar cooking system fits into the schedule of daily routine. This becomes particularly relevant at an institutional level where food has to be readily prepared at certain times. Solar cookers are often criticized as being too slow and unable to prepare food on time. The nine institutions that successfully adopted solar cookers did not report about any problems related to the duration of the food preparation. However, they also reported that the solar cooking system is most appropriate for lunch preparations since levels of sunshine are high then. Furthermore, all of them had installed a backup system that was used during evening hours and the monsoon season. Many of these institutions are large institutions that have to prepare food for a high number of devotees coming to the spiritual centers and where food preparation presents a continuous process during the day.

Reasons for the not successful adoption

The major aim of the study was to identify the relevant factors that influence a continuous use of institutional solar cookers. However, in addition to the nine positive outcome cases I also investigated the cases where solar cookers were not in use anymore. All cases with the negative outcome shared the absence of economic motivation. Many of these institutions were characterized by changes in their management, which led to a change in the levels of economic motivation. For this study only those institutions that showed a high economic interest in solar cookers at the time of my visit were calibrated as [1] outcome. However, in many cases where solar cookers were not in use anymore institutions reported of shifts in the management that led to changes in interest. For some of the institutions it was common practice to change the management frequently. Thus, there were directors who got interested in solar cooking and initiated the installation of solar kitchens but when this director was transferred and a new director overtook the management, he/she often did not follow the same vision and the system was abandoned.

Some of the cases that did not continued using solar cookers show also the absence [0] of the variable supplier characteristics. 'Supplier characteristics' captures the support of maintenance service by the provider who installs the system or the training of local people who are able to maintain the system. At many institutions where the solar kitchens were not in use anymore, the supplier did not maintain the kitchens due to the remote location of these kitchens. High transport costs and poor infrastructure made it difficult for suppliers to follow up with the systems. However, the interviews with the public institutions showed that in some places the suppliers trained local people to maintain parts of the kitchen. Unfortunately, these people often did not stay at

the institutions but saw their newly acquired technical knowledge as opportunity to move to town and start their own business. In addition, these people did not train others before leaving the institution to avoid competition.

5. Conclusion - Implications for solar cooking projects

The adoption of solar cookers is very complex and four factors could be identified in this study as necessary and sufficient contexts for the continuous use of solar cookers. However, this does not mean that they are the only ones and all other factors become irrelevant.

The findings of this study show that the choice of the type of solar cooker should be a people's and not technological one (see also Wentzel and Pouris, 2007). This captures two cultural variables identified in the framework (food characteristics and schedule of daily routine). The first step for solar cooking organizations is to study the local cooking situations and energy needs, which determines the choice of the technology. In addition to these cultural variables, we need to study the underlying institutional structures that determine the long-term use of solar cookers. The study showed that in cases where solar cookers were not in use, changes in the management took place that led to differing levels of economic motivation. Thus, it is very important to analyze the organizational structures at institutions before implementing a solar cooking system. Solar cookers are more likely adopted if the local management can see the economic benefits of this technology.

Furthermore, by referring to the example from India where solar cookers correspond to the predominant spiritual worldview, we can see here that by integrating solar cookers as part of the underlying cultural framework we make the technology part of the target society. Thus, a very important task of solar cooking organizations is to study their target groups, identify the local cultural preferences and find ways to integrate them into the design of solar cooking projects.

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