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A (new) cultural turn toward solar cooking—Evidence from six case studies across India and Burkina Faso

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ABSTRACT

Solar cooking can generally be described as a way to use the sun's energy for cooking. Despite its multiple benefits as a clean, modular, simple source of energy, the implementation of solar cookers is not as widespread as one would hope. In the literature it is argued that solar cookers are not adopted because they are often considered to be culturally disruptive. This paper shines a new light on the cultural dynamics of cooking by showcasing the social acceptance of solar cookers. Six cases are presented from two different countries, Burkina Faso and India where a particular type of solar cooker (Scheffler reflectors) was installed among bakeries, shea nut butter producers, and steam kitchens. These cases demonstrate how cultural factors can be adoption-enhancing or limiting in different contexts. In essence, the paper finds that solar cookers are successfully implemented where they conform to underlying cultural factors. The study concludes that by implementing solar cookers as part of an existing socio-cultural framework, solar cookers move away from an image of a mere foreign technology to an integrated part of the target society.

1. Introduction

> . . . We don't want to pollute the nature and this goes along with solar energy. Clean the mind and clean the earth. The world suffers from polluting thoughts. . .
>
> (Brahma Kumaris devotee at Shantivan complex, 17.12.11).

Solar cooking can generally be described as a way to use the sun's energy for cooking. The principle of solar cooking is simple: sunlight is converted to heat energy that is retained for cooking. This is not a novel concept. The first solar cooker designs can be traced back to the 18th century when Nicholas de Saussure (1740–1799) built a black insulated solar cooker [1].

Solar cooking is regarded as a fruitful alternative for people in developing countries where primary energy needs are often met by using biomass on a three stone fire (see [2]). It is a clean cooking technology because it does not produce smoke, as opposed to the conventional use of firewood for cooking. In the case of solar cooking, the sun provides the "fuel" for cooking. Furthermore, solar cookers have also become a relevant technology in the context of climate change as a Clean Development Mechanism (CDM) [3]. Several NGOs, such as the Kyoto Twist Solar Cooking Society, support existing solar cooking projects with the aim of reducing GHG (Greenhouse Gas) emissions, and the western nations' environmental footprint, while simultaneously addressing poverty with this intervention [4].

There are currently many different organizations working with solar cooking technologies worldwide, resulting in the development of a wide range of solar cookers. One of the largest non-profit organizations is Solar Cookers International (SCI), founded in 1987. Through its information exchange network, SCI contributes to a widespread awareness of solar cooking around the world [5]. Solar cooking gained popularity, especially in the 1990s, and the number of solar cooking projects increased drastically [2]. Solar cookers are being developed and distributed in several countries and engineers in different parts of the world are working on technical design improvements.

An interesting aspect is that solar cooking proponents often address the household level in their campaigns (see [6–8]). However, solar cookers can be also applied at a level beyond households, among institutions. In this paper, solar cookers are examined among three types of institutions: bakeries, shea nut butter producers, and kitchens. At an institutional level solar cookers become even more relevant to lessening vulnerability to supply shortages

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and offsetting rising energy-related expenses. Solar energy is a free energy source. As the cost of electricity, gas, kerosene or charcoal continues to rise, the use of solar cookers can create substantial energy savings [9].

Despite these multiple benefits, the implementation of solar cookers is not as widespread as one would hope [10]. Several technologies have been developed for solar cooking at a household and institutional level such as boarding schools, religious centers and hospitals that can improve the situation. However, we lack information on the continuous use of these technologies particularly at an institutional level. Tucker [3] argues that solar cookers are not adopted because they are often considered to be culturally disruptive, since they introduce a new way to prepare food. In addition, Toonen [11] states that solar cookers need to be coherent to the cultural context.

This paper shines a new light on cultural factors—and partially invalidates the findings from Tucker and Toonen—by focusing on adoption at an institutional level. The study argues that cultural factors can be constraints but also enablers for the social acceptance of solar cookers and encourages NGOs (Non-Governmental Organization) to utilize these factors in their implementation strategies.

More specifically, the paper investigates the cultural dynamics of solar cooking in a comparative case study. Six cases are presented from two different countries, Burkina Faso and India where a particular type of solar cooker (Scheffler reflectors) was installed at an institutional level. These cases will show how cultural factors can be adoption-enhancing and limiting. The article captures two cases from Burkina Faso where a solar cooking system was installed in the form of a solar bakery and shea nut butter production and four cases from India where the same solar technology was installed in the form of a steam kitchen at the Brahma Kumaris,[1] a religious group in India. The inclusion of several cases from two different countries is considered to increase the explanatory power of the data.

The paper is structured as follows: First, it starts with a short review of different case studies that address the relationship between culture and technology, which presents the point of departure for this study on solar cooking. From this general literature review on technology and culture, the second part of the paper presents a short review on how different cultural factors are assumed to play a role for the limited success of solar cookers. Third, the paper introduces the six cases and offers a short overview of the technical functioning of the solar cooking technology installed at these institutions. Fourth, based on the case descriptions, it analyzes how underlying cultural practices in the different contexts influence the adoption or rejection of solar cookers. Finally, the paper concludes that cultural factors should find more attention in solar cooking programs, not only as barriers but also as enablers for successful adoption.

Before proceeding with the main content of this paper, it needs to be acknowledged that the objective of this article is not to develop a full or consistent theory on the adoption of solar cookers. Rather, it seeks to provide examples that might better clarify the impact of cultural practices on solar cooking. Furthermore, the paper does not presume that cultural practices are the only factor that influences the adoption of solar cookers. The situation is much more complex and a comprehensive list of those factors is available elsewhere [see 12]. However, this paper focuses primarily on the cultural turn.

[1] When it is referred to Brahma Kumaris in this paper, I refer to the Brahma Kumaris as a religious group.

2. Culture and technology—a literature review

Several scholars have addressed the question whether the characteristics of cultures have an impact on technology adoption. Before reviewing different case studies that address the relationship between culture and technology, we need to define the term culture. Steers et al. [13] collect different concepts of culture and conclude with one overall definition, which is also applied in this paper. They define culture as follows:

> Culture is characterized by shared values and norms and mutually reinforcing patterns of behavior. Culture is learned and evolves over time, albeit slowly. Culture is also often invisible. Indeed, so inextricably it is interwoven into the fabric of society that both its characteristics and the manifestations of these characteristics are often recognized least by the very people affected most. [13:256]

The emphasis here lies on the invisible aspect of culture [14]. In the context of solar cooking it is argued that promoters often disregard the underlying cultural aspects of their target societies, which leads to an abandonment of solar cookers. Wentzel and Pouris [15] argue that the process of implementing solar cookers has focused on a "technologically driven approach", which means that a certain technology is favored by NGOs without addressing the actual consumer needs of their target group. In order to make solar cookers more acceptable, it is argued that their implementation should begin with an assessment of the underlying cultural aspects including the user needs of the target group:

> The dissemination of solar cookers must begin with an analysis of the local situation, i.e. of traditional cooking habits and local needs – not with the selection of a certain type of solar cooker. [15,16]

If we move beyond the solar cooking literature, we can see that several scholars have discussed the role of culture for technology adoption in different case studies. Nardon and Aten [17] analyze the adoption of an ethanol-fueled transportation system in Brazil. They conclude that by developing the *flex fuel* car that can run with ethanol and petrol, or a mix of the two, the Brazilian government chose a so-called logic of flexible adaptation that is culturally derived and led to a successful innovation. Flexible adaptation is considered to be a characteristic of the Brazilian culture anchored in the concept of *jeitinho*. Nardon and Aten [17:270] describe jeitinho as the logic of action of flexible adaptation, which is commonly applied by Brazilians to deal with various problems.

Another study by Lee and Ungson [18] investigates the role of cultural factors in explaining Korea's rapid adoption of the internet economy. They mainly identify five cultural values of Korean society influencing the rapid take up: (1) Collectivism, (2) Rule orientation, (3) Harmony and affection, (4) Power orientation, and (5) Monochromic time. Palis [19] analyses the influence of culture for the adoption of agricultural technologies. She shows in her study how culture plays a role in the context of integrated pest management (IPM) as an agricultural activity in central Luzon, Philippines. IPM is considered to be better adopted when it is implemented in the form of farmer field schools (FFS). FFS are considered to include the user's agency and people's own culture. Furthermore, this kind of training requires collective working, which means that the participants are "socialized in a cultural system" [19:492]. Palis [19] describes the different fears of uncertainty farmers had to face during the FFS and argues that the Filipino culture and particularly the group-oriented norms *pakikisama* (which means getting along with the others for the good of the group) and *hiya* (which stands for shame and embarrassment) helped to overcome those fears.

Fig. 1. Three stone fire.
Source: Pia Otte.

Fig. 2. Solar cooker.
Source: Pia Otte.

However, these studies focus on national culture. This paper steps back to a smaller level by presenting six case studies that will enable a deeper analysis of the cultural factors that influence the use of solar cookers. However, before moving on to the case description, the paper presents an overview of the various relevant cultural factors assumed to influence the adoption of solar cookers. Some of those variables become relevant in the case analysis but take on another meaning than previously assumed in the literature.

2.1. Cultural factors in the context of solar cooking

There are several cultural factors identified at the household level that are considered to be a barrier to the social acceptance of solar cookers.[2] In the following, the paper presents a short overview of those mentioned in the literature. First of all, the fact that solar cookers do not make use of a visible fire (as the use of a conventional three stone fire) is considered to limit the use of solar cookers. Fig. 1 shows a typical three stone fire place, while Fig. 2 shows the use of a solar cooker.

Since a solar cooker prepares food without a visible fire, people tend to be skeptical toward the proper functioning of these cookers. Furthermore, in some cultures an open fire can imply an *additional meaning to cooking*. For example within the Tswana culture in Botswana the fireplace (called Leiso) plays a significant social role. Leiso is considered to be the place where family members gather together during evening hours. Furthermore, it presents a reception for visitors where they are welcomed with a cup of tea [20]. By replacing a normal fire with a solar cooker, promoters might interfere with these cultural practices.

Furthermore, solar cookers are considered to be culturally disruptive if they do not correspond with *traditional cooking habits*. This can include various issues. First of all, it has to be possible to cook the staple food with a solar cooker. For example, if it is common to fry food in a certain place and if this is not possible with a solar cooker (e.g. insufficiently high temperatures for frying), people will become discouraged. Second, in places where food is traditionally prepared and eaten after sunset it may be difficult to use a solar cooker if the system does not provide heat storage. Furthermore, if the solar cooker has to be placed outside for cooking, but people are used to cooking inside the house, the solar cooker will be less successful.

Domestic solar cookers,[3] such as the box cooker or parabolic type (as presented in Fig. 2), need to be placed outside and thus cooking has to be undertaken outside the house. This presents a difference to the conventional way of cooking. In addition, solar cookers can have limited acceptability if they are not able to prepare the appropriate amount of food for a family [21].

Additionally, solar cookers have to be consistent with the *schedule of daily routine* [22]. This means that the time taken for food preparation must go along with the conventional cooking [23]. Furthermore, *food characteristics* (such as taste, texture and color of the cooked food) can influence the social acceptance of solar cookers. Solar cookers are considered to be less successful if the users experience differences in the food characteristics in comparison to the conventional fuel use [24].

3. Materials and methods

The results of this study are based on qualitative semi-structured interviews that were conducted with six different institutions in Burkina Faso and India. In Burkina Faso interviews were conducted with bakers employed at a local solar bakery and women who produced shea nut butter using a solar kitchen. In India, interviews were conducted with Brahma Kumaris devotees at four different retreat centers that had installed solar steam kitchens. The primary case study presents the four solar steam cases installed at the Brahma Kumaris retreat centers while the two additional cases from Burkina Faso serve as supplemental cases to reveal the multiple impacts of cultural factors. The fieldwork was conducted in several intervals between November 2011 and November 2012. Before proceeding with the case descriptions, the paper will first provide a short technical background on the functioning of the type of solar cooker implemented at the different institutions, which will bring the technology closer to the reader.

3.1. Scheffler reflectors

The type of solar cooker implemented at the different institutions is called a Scheffler reflector. Scheffler reflectors are designed

[2] The relevancy of these factors will be tested in an institutional context.

[3] There are also institutional solar cooking systems that make it possible to cook inside the house. However, the most common household systems require that the cook prepares the food outside.

Fig. 3. Set up Scheffler reflectors for community kitchens.
Source: Pia Otte.

Fig. 4. Solar bakery Zabre.
Source: Pia Otte.

as both direct and steam kitchens. Scheffler reflectors are parabolic reflectors, which focus the sun's rays onto a central focal point that is ideally located under the cooking vessel. There is a secondary reflector installed under the cooking vessel that reflects the sunrays up to the cooking vessel, which then heats up the cooking vessel.

Compared to domestic parabolic concentrating solar cookers, Scheffler reflectors are very innovative because they do not require manual tracking. Wolfgang Scheffler, who developed this technology, aimed to design a solar cooking system, which is as comfortable for the user as possible. Thus, he realized that it would be useful to design a solar cooker where the cooking place does not have to be moved and where the cooking can be done from inside the house. Earlier solar cookers (e.g., box cooker type, concentrating type) require a manual tracking of the whole solar cooker, every 15–20 min, to ensure that the sun rays reach the focal point of the solar cooker. In addition, people have to place the cooker outside, and stand outside while cooking – this can be inconvenient in a dry hot climate.

Thus, Scheffler constructed the shape of the reflector such that the focal point is outside of the reflector (other solar cookers, e.g., parabolic solar cookers (SK 14), have their focal point located inside the cooker). Locating the focal point outside of the reflector makes it possible to locate the cooking place inside a building, while the reflector is placed outside. Fig. 3 shows a typical set up of a Scheffler reflector in form of a direct kitchen.

In order to ensure a convenient way of cooking, where food can be prepared inside the house and to avoid the need for manual tracking, Wolfgang Scheffler developed an eccentric, flexible parabolic reflector which rotates around an axis parallel to the earth-axis [25].

In addition to these types of solar cookers that convert sun rays into heat energy for cooking, Scheffler also designed solar steam kitchens for larger institutions, such as the retreat centers run by the Brahma Kumaris included in this study. Solar steam kitchens make use of at least four reflectors (in series) and can provide energy for the preparation of food for a minimum of 1000 people. The difference here is that the sunrays are not reflected to an opening in a kitchen wall but to a receiver that is connected to a pipe for generating steam.

Scheffler reflectors have been installed in several countries, while the largest number can be found in India with approximately a total of 700 installed systems of 8–12 m^2 surface area (see [26]), mainly installed at boarding schools and retreat centers. However, it is not known how many of these systems are still in use.

The following section will describe the different cases included in this study, starting with the two cases from Burkina Faso and following with the four cases in India where Scheffler reflectors were installed at different retreat centers run by the Brahma Kumaris.

3.2. Solar bakery (Zabre)[4]

In Zabre two Scheffler reflectors were installed at a local bakery (see Fig. 4). In total four bakers are employed who learnt how to use the Scheffler reflectors. The bakery opened in 2008 and in the same year the solar bakery was installed. The solar bakery is currently not in use. The bakers report that the solar bakery did not meet their expectations and that it was not possible to bake bread at the appropriate time. The demand for bread is high since this is the only bakery in the nearby area. The bakers report that people come to the bakery already in the early morning to buy bread for breakfast. In order to have the bread readily prepared in the morning, the bakers work mainly during the night (11 p.m. to 8 a.m.). This makes it difficult for the bakers to apply the solar bakery, since it is not possible to bake bread during the night because of the lack of sun.

In addition, the capacity of the solar bakery does not conform to their demand. The bakers report that they have to produce an average of 1000 bread loaves per day depending on the day. During market days (every third day) and local celebrations, the demand is higher so they have to produce more bread loaves during the day. However, the bakers report that with the solar bakery alone it was only possible to prepare around 50 bread loaves per day. This means that the solar bakery as standalone technology cannot cover the current demand. Furthermore, the preparation time is not constant due to the strong weather dependency of the solar kitchen. During cloudy days the preparation time takes longer. The bakers report that many customers come from villages further away and want to buy their bread immediately and do not have time to wait until the bread is readily prepared.

In addition, the quality of the bread loaves varies due to the weather dependency of the solar bakery. The bakers report that the customers want to buy bread that is golden brown. With the solar bakery it is difficult to ensure a standard quality of the bread

[4] Interview date 29.11.2012.

Fig. 5. Shea nut butter solar kitchen Tiakane.
Source: Pia Otte.

loaves since the temperatures decrease when clouds appear and this has an impact on the consistency and color of the bread, which makes it less attractive for the customers.

Due to these problems with the solar bakery the bakers switched to electric stoves. However, they mention that the current costs for electricity present a burden and they would prefer the solar bakery, since it is more economical, if they could overcome the current constraints.

3.3. Shea nut butter production (Tiakane)[5]

In Tiakane two Scheffler reflectors were installed for producing shea nut butter[6] at a women's organization. One of the reflectors with a kitchen unit is presented in Fig. 5. The solar kitchen was installed in 2007 but is not in use anymore. In total around 100 women were enrolled in producing the shea nut butter at the kitchen. Before the installation of the solar kitchen, the women prepared shea nut butter on their own, individually by using firewood. In an interview with one of the women who was part of the initiative, it was reported that the solar kitchen produced higher amounts of shea nut butter, which they were not able to sell at the local market. The next local market is located in Pô (ca. 7 km from Tiakane) and the women did not own any mode of transportation that could bring the shea nut butter to the market. My informant reports that they were disappointed and stopped using the solar kitchen.

However, another interesting aspect mentioned in a report by WISIONS [27] is that "organizing the production was a major challenge as families traditionally produce the butter on their own, whereas the solar installation is a community resource centrally located in the village." We can see here that the introduction of a solar kitchen for shea nut butter production requires new forms of social organization, which can be very different to conventional practices of shea nut butter production.

3.4. Brahma Kumaris

The Brahma Kumaris are the pioneers of solar steam cooking in India. They were the first ones to install solar steam kitchens in India and today they have five solar steam kitchens installed at their retreat centers around the country.[7]

Fig. 6. Solar steam kitchen Om Shanti Retreat Center.
Source: Pia Otte.

3.4.1. Om Shanti Retreat Center (Gurgaon)[8]

The Om Shanti Retreat Center is an educational and training center in the state of Haryana. According to Brahma Kumaris [28] "the center aims at developing a holistic personality of individuals by empowering them to inculcate higher order values of life and providing the training in Rajyoga Meditation." The center has installed 28 Scheffler reflectors with a surface area of 9.2 m^2 in the form of a solar steam kitchen (see Fig. 6). The solar steam system can cook for up to 2000 people during meditation gatherings. The center cooks for its 200 residents on a daily basis. They make use of the solar steam kitchen on sunny days and have a diesel back up for cloudy/rainy days and for food preparation in the evening hours. Warm food is prepared twice a day. Lunch preparation starts at 11:30 a.m. and is served at 1:00 p.m.

Dinner preparation starts at 5:30 p.m. and is served around 7:30 p.m. The typical food served at the center includes rice, dhal and potatoes with chapattis. They prepare all boiled items consisting of rice, dhal and potatoes with the solar steam kitchen. These dishes are cooked in 150 L cooking vessels. The chapattis are baked on gas.

3.4.2. Shantivan Complex (Abu Road)[9]

The solar steam kitchen at Shantivan was installed in 1999 and has 84 dishes with a surface area of 9.6 m^2 (see Fig. 7). During the time of the data collection the steam kitchen was closed due to a relocation of the kitchen. In an interview with one of the Brahma Kumaris' devotees it was told that the existing solar steam kitchen was no longer sufficient to meet the current demand. The Brahma Kumaris organize spiritual gatherings every 15 days at the Shantivan complex where around 20,000 devotees from all over India (and other countries) come to Abu Road. The center cooks for all those visitors as well. The number of pilgrims, visiting the center to attend meditation course and retreats, has increased over the years and thus the kitchen is currently being extended to meet this need. On a daily basis, without the spiritual gathering, the center accommodates around 1500 people daily, for whom food also needs to be prepared.

[5] Interview date 27.11.2012.
[6] She nut butter has a variety of applications. It particularly presents a popular product for the cosmetic industry.
[7] The Brahma Kumaris are the pioneers in solar steam cooking because one of the devotees working for the solar department at Abu Road came to learn about some Scheffler dishes in Ahemadabad and then found out that Wolfgang Scheffler worked with a solar company in Gujarat.
[8] Interview date: 23.11.2011.
[9] Interview date: 17.12.11.

Table 1
Meal times and type of meals prepared at Shantivan.

Type of meal	Preparation start	Preparation end	Meal time	Type of food
Breakfast	05:00	07:00	08:00	Roti, idli, aloo, tea, coffee
Lunch	09:00	11:30	12:00	Rice, vegetables, chapatti/roti
Dinner	16:00	18:00	20:00	Rice, vegetables chapatti/roti

Table 2
Meal times and type of meals prepared at Gyan Sarovar.

Type of meal	Preparation start	Preparation end	Meal time	Type of food
Breakfast	05:30	06:30	07:30	Roti, idli, aloo, tea, coffee
Lunch	09:30	11:30	12:00	Rice, vegetables, chapatti/roti
Dinner	16:15	17:30	20:00	Rice, vegetables chapatti/roti

Fig. 7. Solar steam kitchen Shantivan (Abu Road).
Source: Pia Otte.

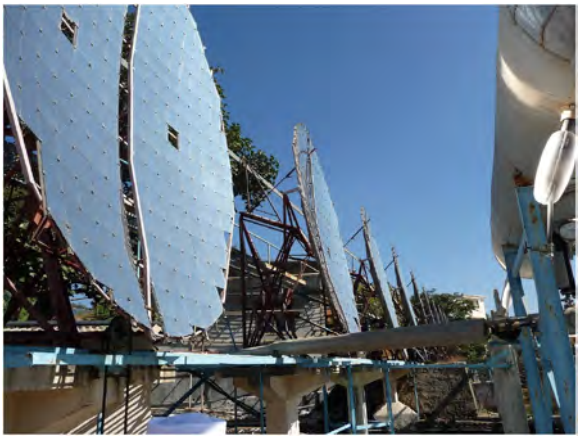

Fig. 8. Solar steam kitchen Gyan Sarovar.
Source: Pia Otte.

The steam kitchen is mainly used for the preparation of rice and vegetables. During the spiritual gatherings, when many pilgrims are staying at the center, the kitchen starts cooking already at 2 a.m. At this time there is no sun, which means that a backup is necessary. The backup consists of three diesel boilers for steam production and is mainly used for early morning times and night times. In addition, the center relies on the backup in the monsoon season that takes place between July and September. In this time the solar steam kitchen is completely shut down.

There are around 50–70 people working in the kitchen. The kitchen staff works daily in three shifts. Table 1 provides an overview of the meal types, preparation times, meal times and food types prepared at Shantivan.

We can see here that the kitchen is not only in use during hours of sunshine. For earlier breakfast preparation the diesel boilers are used for steam generation. During summer time the correct steam pressure is achieved about 9 a.m, so they can switch to the solar steam for lunch preparation. In the winter it is not ready before 10:30 a.m. However, the kitchen staff has to start cooking at 9 a.m., no matter if the solar steam is ready or not. Thus, it can happen that the staff starts cooking with the steam produced by the diesel boilers and switches to solar when the pressure is right.

3.4.3. *Gyan Sarovar (Mount Abu)*[10]

The Brahma Kumaris started their work with solar steam cooking at Gyan Sarovar, which they also call the Academy for a Better World. According to Brahma Kumaris [29], Gyan Sarovar presents "an international campus—a place where men, women and children can reach their unique human potential and cultivate the values of our common humanity." Different courses are taught at the academy such as for example, meditation, self-empowerment, self-management and positive thinking.

The solar steam system at Gyan Sarovar was the first solar steam system installed in India. It was built in 1997, renovated in 2005 and includes 24 reflectors with a surface area of 7.25 m^2 (see Fig. 8).

The system has a thermal output of 40 kW which is equal to 600 kg of steam and it can cook up to 2000 meals daily. When the system was renovated in 2005 the major changes that were done was to exchange the mirrors. Some mirrors were broken at that time. The mirrors on the reflectors today (December 2011) are still the same from 2005.

There are also two diesel boilers installed as a backup, particularly for the morning times and when visitors come and stay at the center, which increases the demand for cooking. The diesel boilers are also used during cloudy days and the monsoon season that takes place between July and September. The cooking times and types of food prepared are presented in Table 2.

3.4.4. *Pandav Bhawan (Mount Abu)*[11]

Pandav Bhawan is the International Headquarters of the Brahma Kumaris. The solar cooking steam system at Pandav Bhawan was installed in 2001. It cooks approximately 1000 meals daily. There are six reflectors with a surface area of 12 m^2 located on the roof of the building (see Fig. 9).

[10] Interview date: 16.12.11.

[11] Interview date: 16.12.11.

Table 3
Meal times and type of meals prepared at Pandav Bhawan.

Type of meal	Preparation start	Preparation end	Meal time	Type of food
Breakfast	05:00	07:00	08:00	Roti, idli, aloo, tea, coffee
Lunch	09:00	10:30	12:00	Rice, vegetables, chapatti/roti
Dinner	16:00	17:30	20:00	Rice, vegetables chapatti/roti

Fig. 9. Solar steam kitchen Pandav Bhawan.
Source: Pia Otte.

This solar system also has a diesel backup. The local engineer in charge of the solar steam kitchen reports that during a very sunny day the diesel boiler is used for only one hour per day, consuming only 18 L of diesel. The solar steam system is mainly used for preparing breakfast and lunch. Dinner is often prepared with the diesel boiler. The steam for the breakfast is prepared with the rest of the steam generated with the solar steam from the day before which is stored. The meal times and the type of food prepared are presented in Table 3.

We can see that three meals are prepared each day at all four centers. The cooking times vary slightly from center to center but overall they follow a similar schedule and the same diet. The diet at all four centers mainly consists of vegetarian meals since Brahma Kumaris devotees do not consume meat because it is considered to be impure.

4. Results and discussion

The six presented case studies showed different levels of use of solar cookers. Some of the earlier identified cultural variables relevant for the long-term use of solar cookers are of importance in this context. However, the data presentation showed that these variables can be both adoption enhancing and limiting.

4.1. Cultural factors in the context of the two cases in Burkina Faso

In the two presented cases from Burkina Faso *traditional cooking habits* and *schedule of daily routine* became relevant. In the case of Zabre, the solar bakery clearly did not conform to the existing cooking habits and the schedule of preparation since bread is mainly prepared during the night. In addition, the solar bakery cannot cover the bakery's daily needs since it cannot produce the required amount of bread loaves. Furthermore, customers are used to a certain type of bread with a specific consistency and color. We can see that the strong weather dependency of the solar bakery has an impact on traditional cooking habits. With the appearance of clouds temperatures drop, which leads to increased cooking times and difficulties to ensure the same quality of each single bread loaf.

In the case of Tiakane, besides marketing problems, the new ways of social organization required by the women are considered as being culturally disruptive. The data presentation showed that women were used to preparing shea nut butter individually with firewood at home. The use of the solar kitchen requires a central production of shea nut butter where different tasks within the preparation process have to be divided between the women.

However, the case of the Brahma Kumaris showed that cultural factors can be also adoption-enhancing in a different context. In the following the paper will show how the underlying cultural characteristics of the Brahma Kumaris, embedded in their spiritual way of thinking, play an enhancing role for the use of solar steam kitchens. In order to understand the discussion on the relevant cultural factors for solar cooking within the Brahma Kumaris, the paper will start by presenting a general background on the Brahma Kumaris and their spiritual belief.

4.2. Brahma Kumaris

The Brahma Kumaris is a spiritual, international, and non-governmental organization that aims to make people aware of their thoughts and feelings as a basis for their actions. The Brahma Kumaris was one of the first institutions that launched solar concentrating cooking systems in India, and they were the first to install solar steam kitchens that can feed up to 25,000 pilgrims per day in their main centers in India. According to the Brahma Kumaris their use of solar kitchens is primarily driven by environmental awareness and not financial benefits.[12]

The Brahma Kumaris use their solar steam kitchens mostly at their retreat centers, where a fixed number of devotees permanently lives and works at the center. The retreat centers offer a place of education, where pilgrims from all over the country attend meditation and yoga courses. The first solar steam kitchen was installed in Gyan Sarovar in 1997, which is also included in this study. The Brahma Kumaris not only install their solar steam systems themselves but they also manufacture their own systems at a workshop in Abu Road. Their newest project includes the construction of the first 1 MW solar thermal power plant based on an innovative 60 m^2 Scheffler type reflector at Abu Road. The project is supported by the German and Indian governments [30].

The data presentation reveals that by applying solar steam kitchens it can be controlled for some of the cultural factors. In comparison to the cases from Burkina Faso the cooking situation as such does not change for the cooks at the Brahma Kumaris retreat centers. The cooks prepare the food in exactly the same way as before, only the source of fuel changes (from diesel to solar), while in the case of Tiakane the use of the solar kitchen requires new forms of social organization and in the case of Zabre the bakers would have to adapt to new baking times. However, a closer look at the major spiritual principles of the Brahma Kumaris reveals additional insights that play a role for the earlier presented cultural factors, which is discussed in the following.

[12] Interview Brahma Kumaris member, Shantivan complex, 17.12.11.

4.2.1. A worldview that matches solar cooking

The Brahma Kumaris offer meditation courses at their retreat centers. In these courses, participants learn how to control their thoughts. Furthermore, through meditation, Brahma Kumaris members learn how to connect to the supreme. The Brahma Kumaris believe in one supreme who is the father of all people. They also believe in reincarnation; while our bodies can die, our souls are eternal. The supreme god is the supreme soul. In comparison to other souls, he is not subject to the incarnation process, and remains un-incarnated. He is described as being beyond the limits of time and has absolute knowledge [31]. In addition, the supreme is also regarded as the spiritual sun who gives light to everyone, no matter where they are. Furthermore, he reminds people of their ability to love and live in peace and happiness.

According to Brahma Kumaris, a real change in the world can only happen if people become aware of their thoughts and the influence they have on their actions. This includes creating a consciousness of current unsustainable lifestyles and the connection between physical and non-physical energy of mind and matter [32]. The Brahma Kumaris view of the world is a life cycle that repeats every 5000 years. The world is in transformation and goes through five different epochs of time [33]. The first part of this time is called the Golden Age. During the Golden Age, people live in harmony with each other and their nature. People enjoy complete purity and peace in prosperity. The second part of time is described as the Silver Age. In this age many people still live in peace and purity, but their level of divine is less than in the Golden Age. The third age is called the Copper Age. In the Copper Age, people turn to a path of unrighteousness and divide into several religions, ultimately leading to conflict and sorrow.

The fourth age, the Iron Age, is characterized by war, impurity and sufferings. People no longer look after each other and have turned away from the Supreme Father. The fifth and last age is the Confluence Age. According to the Brahma Kumaris, we are currently in the Confluence Age, the end of the 5000-year cycle. "This is the time to receive divine Knowledge from God, and practice spiritual discipline and easy Raja Yoga and re-acquire deity status" [34]. During this time, God is descending to Earth with the goal of the moral reconstruction of mankind. It is the time in which people on Earth must practice spiritual discipline to "re-acquire deity status". After this stage, the world will be free of violence and sorrow. Peace and happiness will be part of the world again and with this comes the return of the Golden Age.

The worldview of the Brahma Kumaris shows a very strong affinity for protecting nature as part of their spiritual belief. One important part of the Brahma Kumaris' spiritual program is to live a sustainable life. The use of solar energy is consistent with their spiritual belief and brings a very strong and positive meaning to the Brahma Kumaris. When Brahma Kumaris members in India were asked why they decided to install solar steam kitchens, they focused on this environmental aspect anchored in their spiritual belief, in addition to the obvious economic effect through reduced diesel consumption during the dry and sunny months.[13] One of the principles of the Brahma Kumaris is to live in harmony with the environment, as it was at the time of the Golden Age. Using solar energy is consistent with this spiritual belief. Solar energy can be freely and directly collected from the sun, and thus corresponds with the spiritual principle of living in harmony with the environment.

Living in harmony with nature also means that humans should avoid polluting their environment. The use of solar energy presents one way for the Brahma Kumaris to fulfill human energy needs without polluting the environment. Besides harmony, the principle of respect for life and for nature is a key part of their spiritual belief. The use of solar energy follows this concept; it is available in plenty, it is renewable, and thus sustainable.

We see here that the adoption of the solar steam kitchens among the Brahma Kumaris is strongly influenced by their spiritual worldview. Many of the aspects that are part of their worldview find their origin in Hinduism. A very important underlying driver for the use of solar cooking seems to be the holistic philosophical understanding of nature that is a part of Hinduism, as articulated in their drive for protecting nature. According to Gardner and Stern [35:46] "Hinduism is the most proenvironmental religion in the world".

Within Hinduism, humans and nature are considered to be in a partnership and the view of humans as rulers of nature is rejected [36:108]. Thus, solar cookers, as a clean and renewable energy source, offer a way of cooking that helps to achieve that goal.

4.2.2. The meaning of purity for the use of solar cookers

In addition to the worldview of the Brahma Kumaris that facilitates the use of solar cookers, interviews with Brahma Kumaris' devotees showed that the meaning of purity as one relevant spiritual principle within Hinduism plays an important part for the adoption of solar cookers. Even though it can be controlled for by the cultural factors, the interviews showed that there is another interesting finding related to the cultural variable *food characteristics*. Here too, the underlying spiritual principles of the Brahma Kumaris seem to have a positive impact on the food characteristics. The case of the Brahma Kumaris shows that the Hindu concept of purity plays a role in cooking and has an impact on food characteristics.

In a strictly Hindu context, purity applies to every aspect of daily life, including cooking. According to Kittler et al. [37:97], "intertwined in Hindu food customs is the concept of purity and pollution. Complex rules regarding food and drink are meant to lead to purity of mind and spirit." Purity is related to various aspects within the cooking process. It includes the ingredients, the food preparation method, the food preparer and the manner in which the food is served. However, the aspect of food purity has not been considered to be relevant in any previous studies on the adoption of solar cookers.

The Brahma Kumaris lend a particular meaning to the cooking process itself. In order to understand how these spiritual principles are related to food characteristics, the meaning of cooking for the Brahma Kumaris is explained in the following.

Cooking plays a very important part of the spiritual belief of the Brahma Kumaris. The importance of cooking and food is also reflected in the fact that the Brahma Kumaris publish a cookbook called "Food and Soul: Easy & Tasty Vegetarian Cookery", which includes many different recipes of vegetarian dishes. The interviews with Brahma Kumaris' devotees showed that the mind can play an important role in food preparation. Brahma Kumaris' devotees eat only food that they themselves prepare or that is prepared by members of their community. They avoid accepting food that is prepared outside of their community. They believe that the cook's state of consciousness is very important while cooking. Brahma Kumaris' devotees try to send positive thoughts while cooking, since these are considered to become part of the final meal and are taken up by the person who eats the meal. When food is prepared from outside the community, the cook's state of mind, while preparing the food, is unknown. It might be that the cook was having negative thoughts, and these could have negative emotional effects on those consuming the food. Furthermore, preparing the food with positive thoughts also expresses gratitude to the supreme and in this way "serves to enhance the spiritual quality

[13] The Brahma Kumaris mention a mix of reasons for using Scheffler reflectors and clearly value the cultural and religious reasons over the return of investment.

of the food and deepen the individual's personal relationship with the Divine. . ." [38:xiii].

But how is this related to solar cooking? We saw earlier that Brahma Kumaris' devotees aspire to live in harmony with nature and that solar energy is considered to be a clean energy source consistent with this goal. Now, we can extend the argument and state that the use of clean energy contributes to a pure state of mind while cooking. Solar cookers are a clean cooking technology that enhances people's ability to create pure (clean) thoughts. It does not produce an imagery of deforestation and pollution. It is clean because it prepares food without fire and smoke, and does not pollute the environment. People can cook with a good conscience with solar cookers because they know that they do not harm the environment while preparing their food. This, in return, has a positive impact on the food characteristics. At the Om Shanti Retreat Center, one of the informants reported that when people want a pure mind, they also want pure surroundings. This can be achieved by using solar energy, since it does not produce smoke or pollute the environment.

> . . .Solar is just one aspect but it is not only about having the technique under control but also your soul, spirit, matter and body. One part is also to have a clean technique and the sun is the only energy source. There is no other source. . .
>
> (Brahma Kumaris' devotee, 17.11.2011)

In the literature, food characteristics are usually defined as the "objective" taste of the food. We understood that solar cookers might not be adopted due to differences in the food's taste, texture or color, compared to the conventionally-prepared food (e.g., the bread not getting brown in the solar oven) [26]. However, in these religious institutions, food characteristics take on another spiritual meaning (besides the actual objective taste). In these institutions, the taste of solar-cooked food is not objectively different – because they make use of steam cooking. The way the food is prepared does not change by using the solar system, only the source of the fuel changes. However, since the Brahma Kumaris pay so much attention to cooking, the fact that solar cookers contribute to a pure mind while cooking can be regarded as a cultural-enabling factor for using solar cookers.

5. Conclusion and recommendations

If there is one central conclusion that can be made from this study, it is that cultural aspects can, at times, enhance the adoption of solar cookers. The Brahma Kumaris' worldview aspires to a life in harmony with nature, which enhances the use of solar cookers because they are considered to be a peaceful technology and suit this image of peace and harmony. Furthermore, solar cookers are considered to be a clean (pure) technology because they do not pollute. In the literature, the non-polluting aspect of solar cookers has been viewed with regards to health. However, the cases examined here demonstrate that this non-polluting aspect can be also relevant for religious groups, such as the Brahma Kumaris, that have anchored their spiritual worldview in Hinduism where purity is important. For the Brahma Kumaris, the use of clean energy contributes to a pure state of mind while cooking. Furthermore, solar cookers are a clean cooking technology that enhances people's ability to create pure thoughts because it does not produce imagery of deforestation and pollution.

However, the question remains: how we can apply this knowledge from these case studies to other contexts? Does it mean that solar cookers work only in places where solar cookers align with the spiritual worldview of the end-users? The answer is most likely "no." The overall conclusion of this paper is not that the intended end-users need to follow Hinduism in order to use solar cookers but that solar cooking promoters have to pay attention to these cultural factors and address them to make solar cookers more successful. The Brahma Kumaris represent a further example of how solar cookers can be successful if the intended target group can integrate the technology in their underlying cultural context. In order to guarantee the successful adoption of solar cookers, NGOs and solar cooker promoters should study the predominant cultural values in their target societies before implementing solar cookers and make use of them whenever possible.

A secondary conclusion is that further research is needed to validate the findings presented here. Indeed, the six cases compared in this study show differences in the size of the institutional cooking operation, and the nature of the customers. In India, the numbers are much larger, and they are mostly pilgrims getting free food. In Burkina Faso, the institutions were paying customers in a local village. Thus, it remains to investigate how different energy markets (charitable versus market oriented) might have different demands regarding the quality of solar prepared food and thereby influence levels of adoption.

Furthermore, this study is limited to six case studies and the question remains how far these findings can be generalized to other contexts. For future research, the presented case studies could be extended to a larger comparative study, capturing also the comparison of solar steam kitchens implemented at religious and non-religious institutions across the globe to increase the explanatory power of the data.

Nonetheless, this study was able to demonstrate that cultural factors should not only be seen as a barrier to implementation, but also as **enablers**. A first step for the successful implementation of solar cookers is to become aware of the cultural differences of the target society. Depending on the target group, different cultural aspects might play a role for the social acceptance, which need to be identified before implementation because they can guide the implementation process. By implementing solar cookers as part of the existing socio-cultural framework, solar cookers can move away from being perceived by some as technology tool of foreign intervention to become an integrated and even cherished part of daily cooking routines and practices.

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