From biomess to biomass

A framework towards influential factors of biogas projects in rural areas of Burkina Faso

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Abstract: *Burkina Faso, land of the upright people, is among the poorest countries in the world. The energy situation is one of the most critical issues to be addressed in the country. Biogas is thought to be one of the most sustainable solutions for developing energy self sufficiency in rural areas of Burkina Faso. Biological fermentation is not a new concept in the land of the upright people, as the first biogas plants were already in operation in the 70's. Although this technology has a long history in this African state, no significant breakthroughs in using this technology have occurred still. This paper presents a study aimed at analyzing the partial success and failures of the attempts to establish biological fermentation plants. The investigation resulted in a table of influential factors of biogas projects in the rural area of Burkina Faso. These factors were grouped into eight main categories and will serve as a mayor framework for planning future plants.*

Keywords: *Biogas, Burkina Faso, influential factors*

Introduction

Around the world approximately two billion people do not have access to electricity (The Economist, 1995). A large number of these people live in Africa where the electrical power grid infrastructure is very low developed with great differences between urban and rural areas (Bugaje, 2006). People living in Africa, mainly in Sub-Saharan countries, are forced to rely on solid biomass sources - firewood, charcoal, agricultural residues, animal wastes, etc. - in order to meet basic needs for cooking, heating and lighting (Brown, 2006). Charcoal and wood account for about 74 % of the total energy consumption in comparison to Asia with 37% and 25% in Latin America respectively (Davidson, 1992). Bottled fossil gas, kerosene, batteries, paraffin, petroleum, diesel and other fossil fuels are also used. These resources are not renewable (Green and Sibisi, 2002).

Figure 1. Burkina Faso (Munzinger, 2008).

Among Sub-Saharan countries Burkina Faso is one of the poorest. Burkina Faso, literally "the country of the upright people" (Slezak, 2008), is situated in West Africa, south of the Sahara desert (Metzler and Poeschel, 1992). It comprises an area of 274,190 km² with a population of 13,4 million (Mang et al., 2007). The country is facing a number of severe problems. Extensive deforestation is causing a galloping desertification of the country whereby the ongoing soil degradation contributes to this development. Burkina Faso has insufficient electrical energy and is forced to import it from neighboring countries. Burning wood is the primary source for cooking. Due to deforestation this resource is becoming dramatically scarce – for instance at a radius of 70 km around the capital city Ouagadougou, fire wood is no longer available (Mang et al., 2007). Energy is a major concern in Burkina Faso as conventional means of energy are either not available or not affordable by locals. Biogas has in this context a great potential to contribute towards the energy sustainability of Burkina Faso. Installations running on renewable energies, viz. biogas plants can be installed within a short time and they can be operational on a small scale, under comparably "low cost" and "low tech" conditions (Misi and Forster, 2001:19). Biogas offers a good choice for adapting economic growth to sustainable development and will meet human needs while preserving and guaranteeing ecological well-being (Zhang et al., 2009). It provides remote places with energy and empowers people by providing decentralized energy (Karekezi, 2002). In the light of these arguments, anaerobic digestion is seen as a promising technology for Burkina Faso. A major product of anaerobic digestion is biogas. It can be used for cooking, lighting (Raphael and Matengaifa, 2009), electrical power generation or even for gas refrigerators (Kossmann et al.,1998).

Biogas

Biogas is a combustible mixture of gases produced by micro-organisms when organic substance, respectively biomass, are allowed to undergo enzymatic degradation or fermentation in the absence of air[1] in closed containers (Gallert and Winter, 1998). The organic substrate could be human- or animal faeces as well as residues from agro industry, plant residues, sewage sludge, or even municipal waste. The range of applications is vast and is continuously expanding (cf. e.g. Amigun and von Blottnitz, 2007; Day et al., 1990; Adeoti et al., 2000). This is demonstrated by successful trials in Burkina Faso using water hyacinths from the "Banger-Weoogo"[2] park (Almoustapha, et al., 2009) or even using a latex plant called Calotropis procera as substrate (Traore, 1992). Another successful biogas project comes from the neighboring Nigeria, where biogas is produced from slaughterhouse residues (Streets, 2008). Biogas is a relative simple, adaptable and a straight forward process and can either run on large as well as on small scale (Karekezi, 2002).

Institutions dealing with biogas in Burkina Faso

Biogas has a comparatively long history in Burkina Faso. Biogas prototypes were first installed in Burkina Faso in the mid 1970. As early as 1976, the *Comité Interafricain d'Études Hydrauliques* CIEH and *the Institut de Recherche Agronomique Tropicale* IRAT started a research and experimentation program on the valorization of organic waste by producing compost and biogas. The *Association Internationale du Développement Rural* AIDR installed several biogas plants from 1978 onwards (Mang et al., 2007). Since then the *Institut de Recherche en Sciences Appliquées et Technologies* IRSAT installed a number of biogas plants in : Farakobâ, Koudougou, Gaoua, Fada, Pô, Ziniaré, Pabré, Matourkou, Boromo, Tenkodogo, Yako, Kamboinsé, Kombissiri, Bogandé, Diébougou, Banfora, Polgo, Ouagadougou, Saaba, and Zorgho (Oumar, 2008) ; *Le Centre Régional pour l'Eau Potable et l'Assainissement à faible coût CREPA* built in 2009 a composition of three biogas plants, à 50m³ (CREPA, 2009).

IRSAT is a governmental research institution and is taking place in the national biogas program as part of an African wide initiative "Biogas for better life" B4B (Nes van and Nhete, 2007). The construction of several new digesters is ongoing. CREPA is an institution with nongovernmental organization NGO characteristics, dealing with biogas since 2005. It is intended to install another six digesters in the near future. The *Office National de l'Eau et de l'Assainissement ONEA* is in decision to get involved in biogas in Burkina Faso (CREPA, 2009; IRSAT, 2009). The Dutch volunteer service SNV -

[1] Anaerobic fermentation, anaerobic digestion, or biological gasification (Raphael and Matengaifa, 2009)
[2] A protected park within the city limits of Ouagadougou

technical implementation - and HIVOS - financial management - are Dutch NGOs which are executing the “Biogas for a better life” program in Burkina Faso. They intend to install 2 million biogas plants in selected African countries (Nes van and Nhete, 2007).

Despite the intensive activities in the period after 1979, only approximately 42 out of 60 installed biogas plants in Burkina Faso were operating for maximum 12 years. Today only a few plants in Burkina Faso are still running (Oumar, 2008).

Towards an appropriate framework for influential factors

To date, several digesters have been installed in different African countries but only a small number are operational. Most of them have been installed in schools, health clinics and mission hospitals and small-scale farms, mostly by NGOs (cf. e.g. Parawira, 2009; Bhat, Chanakya and Ravindranath, 2001). Problems and obstacles connected to the implementation of biogas in African-, respectively Sub-Saharan countries, can be classified according to Ni and Nyns (1995) into four groups: “technical constraints, institutional constraints, socio-economic constraints and financial constraints” (Ni and Nyns, 1996:1526). Pandjaitan (1990) developed a similar categorization and Akinbami et. al (2001) distinguished technical, economic and socio-cultural factors (Akinbami et al., 2001; Pandjaitan and Hutapea, 1990). Parawira (2009) extended and redefined these to political, social-cultural, financial, informational, institutional, technical and training constraints. It was attempted by the authors to classify factors which influence the implementation of biogas in African countries. These classifications are based on biogas project observations in selected African states. The result was a summary of undifferentiated factors across African.

Table 1. Biogas plants in Africa (Mashandete 2009: 117).

Country	Number of small/ medium (100 m^3)	Number of large digesters (>100 m^3)
Botswana	Several	1
Burkina Faso	>30	–
Burundi	>279	–
Egypt	Several	Few
Ethiopia	Several	>1
Ghana	Several	–
Cote D'Ivoire	Several	1
Kenya	>500	–
Lesotho	40	–
Malawi	–	1
Morocco	Several	–
Nigeria	Few	–
Rwanda	Several	Few/Several
Senegal	Several	–
Sudan	Several	–
South Africa	Several	Several
Swaziland	Several	–
Tanzania	>1000	–
Tunisia	>40	–
Uganda	Few	–
Zambia	Few	–
Zimbabwe	>100	–

In the past influential factors of biogas plants were generalized for Africa. It was assumed that each African country faces the same context conditions. In reality the differences between African countries are as great as are the differences in the influential factors towards biogas implementation. In order to understand the manifold reasons why biogas projects work and do not work one has to look mainly on a national level. This work intends to deliver a category scheme for influential factors on biogas projects in the rural area of Burkina Faso. It is the first attempt to summarize the knowledge and experiences on biogas in this African country as complete as possible. Addtionally, it should serve as a decision base for further biogas projects.. It is part of a collaborative project between the University of Innsbruck, and the Université Polytechnique de Bobo Dioulassou.. This cooperation aims to create common synergies for the academic support of the dissemination of biogas in Burkina Faso. A concrete goal is to establish a model biogas plant in a rural village about 50 km outside Bobo Dioulassou.

Material and Methods

A basic category scheme was developed based on an extensive literature review on factors influencing biogas projects in the rural area of Burkina Faso. This framework was extended by empirical data. The empirical data was retrieved during the field studies in Burkina Faso. Four sites of existing biogas plants were visited. Seven interviews with experts and three focus groups with potential users were conducted.

Expert interviews included the chief researchers of IRSAT, and CREPA, two kitchen chefs, the headmaster of a Lyceè, the representative of an NGO implementing biogas in Burkina Faso and a governmental representative of the Ministry of Livestock Resources - responsible for biogas - in Burkina Faso. The focus group interviews were conducted in the village where the biogas plant of the university cooperation is supposed to be built. One focus group was composed of villagers, the second focus group was composed of nomadic herders supposed to provide the substrate for a biogas plant and the third focus group consisted of pupils in a primary school who will be the benefitionaries of the biogas plant.

The systemic approach, including technical as well as socioeconomic aspects, yielded a wealth of factors which can potentially influence the success of biogas projects in rural areas of Burkina Faso. Furthermore the empirical data was enhanced by data from the open participatory observation. The focus group and the expert interviews were conducted on the basis of guidelines following the design of Helfferich (2004).

For the analysis the open character of the grounded theory as well as the qualitative content analysis according to Mayring (2002) was used. Through the use of Computer Assisted Qualitative Data Analysis CAQ-DAS it was possible to unite the advantages of both rationales. The dictate of material was based on the grounded theory (Corbin and Holt, 2006) while data was structured into categories according to the method of Mayring. It is notable to remark, although computer and software were used to process the data, these were only used as an assistant tool for this work (Kuckartz, 2004).

Cultural factors of the investigation and status characteristics

In order to provide full transparency and objectiveness it is a necessity to document the characteristics of the researcher in this project. During the whole period of the field studies I was aware of the influential factor of my cultural background.

During all stages of the research process I reflected and investigated to what extend my Eurocentric view influenced my work. Concluding, it is impossible to avoid looking on the ground situation through a European perspective. Furthermore it is impossible to feel, perceive and see things the same way as people in Burkina Faso. The fact that I am a *Toubabu*[3] grants me superior respect among

[3] The word in Jula for white man viz. foreigner

locals, which was facilitated by the fact that I am male. This of course influenced the content of information I got. On the one hand there was the impression I was told more than the respondents would tell to affiliates in the village. On the other hand it became sometimes clear that I was not allowed to get a certain kind of information. In some situations, my age was a problem – for African standards I was too young.

The language barrier was a clear hindering issue. The local language is hard to translate directly. The context needs to be known very well in order to get the full meaning. Due to the help of a highly skilled interpreter losses of translation were minimized.

With reference to Eriksen (1995) I sometimes trespassed over a hidden border or broke a cultural law but I have not done the same error in the same way twice. I have learned from experience and adapted.

Results

The following section outlines the influential factors of biogas implementation in Burkina Faso. The results were structured into eight main categories.

Socio cultural

Choice of substrate (whether it be animal faeces or human faeces) seems to be a very crucial factor in biogas projects. In some cultures a socio-cultural stigmatization exists towards dealing with human faeces which led to a complete refusal of the technology by the population (Taelea, Gopinathana and Mokhuts'oane, 2007). This goes along with the observed doubts of a kitchen chef who said "it would be strange to use gas produced from human feaces - the food could smell like toilet". The results from the focus group discussion with the children revealed similar results. They do not have any concerns when animal feaces are used for biogas production. Human faeces were generally denied by the pupils and regarded as filthy. Some cultures even refuse pig manure due to religious reasons (Sendegeya and Silva, 2000). Experiences of IRSAT in Burkina Faso only revealed problems with the solid fraction of human faeces, while there is hardly any resistance using human urine.

Akinbami et al. (2001) recognized the importance of wood fire for the taste of the traditional food. One kitchen chef remarked that *To*[4] tastes better when cooked with wood while for other kind of food, it does not matter. Also the cooking time plays an important role: it was said that "the time is important, because the food needs to be cooked very long in order to taste good".

It was observed that the cooking convenience is also an influential factor. This comprises the time needed for cooking the food as well as the number of stoves which are used. I found out that a minimum of two stoves (ideally three) are needed for cooking in a convenient way. It takes longer to cook with biogas than with conventional fuels (Mang et al., 2007).

Public awareness of biogas processes is a important social driver which influence the adoption of biogas technology. Participants who were not confronted with biogas before improved their knowledge about biogas through the focus group interviews. The increased understanding of biogas with its advantages and disadvantages resulted in an increased acceptance of biogas technology among the focus group participants.

Key facilitators play an important role whether a new technology will be accepted or not in a village. The interviewed representative of IRSAT said: "If you find one person who likes the technology it solves a basic problem and the others will accept it". It was observed that in the villages the *Notables du village* - board of elders - play the main role as key facilitators. The term key facilitator also includes partners which hold a key role influencing the dissemination of biogas in Burkina Faso.

[4] Local food, main component millet

Ownership of biogas plant installations is a crucial factor. Due to the high investment cost the construction needs to be financed by foreign institutions. Completely subsidized technological installations without contribution by the target group tend to be left alone after finishing the construction (CREPA, 2009). Biogas users who are inadequately informed fail to distinguish between the raw animal manure and the highly valuable digestate (Srinivasan, 2008). It is highly vital that the target group, especially women who are in charge of firewood issues in Sahalian communities, feel the short, medium and long term economic, ecological and social benefits of the biogas plant. Furthermore it is also important that people perceive the effects on their increased living standards (Almoustapha,et al., 2009). Therefore the level of ownership is a strong influential factor for the adoption of biogas technology in Burkina Faso.

Projects intending to introduce new energy technologies in Africa have shown in many cases shortcomings of proper understanding of the needs, problems, capabilities and priorities of the target users (Parawira, 2009). Many of the introduced biogas plants in Africa, on the base of technology and knowledge transfer from India and China, are not functional since national interests and individual family/community interests are colliding. Hence biogas technology depends on individual interests and may not totally respond to those on a national level (Ni and Nyns, 1996). Following the field habitus theory of Bordieu (Engler, 2003) the alignment of habitus and field depends on the transfer of knowledge and technology from one culture to the other. Bordieu expresses the habitus as the internalized world view which is composed of thinking-, perception- and action schemata determining social practices while the field is interpreted as the fighting-, respectively the play ground becoming objectified in things and institutions (Engler, 2003). This is one explanation for the poor success of biogas programs in Sub-Saharan countries, although the same programs are successfully running in India, China and Vietnam (Oumar, 2008; Parawira, 2009).

Planning and construction

Technology can only be as good as the nature and quality of the supporting mechanisms, viz. context conditions in place (Mulugetta, 2008). Following this, site planning is an important factor. This comprises design issues concerning the construction, the gas distribution system, the feedstock storage, and as well as the utilization of by-products and the appropriate location (Akinbami et al., 2001). This impression was supported by the evaluation of a currently operational biogas plant where the composter and the water supply were inconveniently situated and the latrines were not connected to the digester.

The size of the biogas plant has to be suitable for the context. If the plant is over dimensioned, the economical efficiency of the biogas plant decreases and the microbiological activity is low (Amigun and von Blottnitz, 2007).

Examination of failed projects shows that poor, imprecise construction techniques, poor choice of materials due to inexperienced contractors and consultants (Day et al., 1990) and unsatisfactory technology in combination with inadequate repairs and maintenance were reasons for the malfunction of biogas plants (Bhat, Chanakya and Ravindranath, 2001). Interviews and observations have revealed that special care was given to the quality of construction and the used materials in the last few years by IRSAT and CREPA. This has resulted in reduced breakdowns. IRSAT employed highly skilled personal for the construction work, while the representative of IRSAT commented that “Burkina Faso is lacking expertise in producing highly sophisticated materials” (IRSAT, 2009).

Currently the Chinese fixed dome type or the Indian floating dome type have been the prime reactor designs installed in Burkina Faso. These reactor types are named after their origin and it is basically attempted to implement them in Africa. The fix dome type is mainly made out of bricks. As seen in figure 2 it has typically a cylindrical shape with a manhole on top and an inlet and an outlet (Amigun and von Blottnitz, 2007). This type is cheaper compared to the floating dome since it uses basically locally available materials and needs less maintenance, but it is more vulnerable to gas tightness problems (Akinbami et al., 2001). The Indian floating dome type has a cylindrical or cubic form for the top part. This so called gasholder could be made out of metal, fiber glass or any similar material. The gasholder is floating on top of the digester tank and rises and falls with gas production and usage. This has the positive effect of a nearly constant gas pressure (Day et al., 1990). Furthermore it allows a visual monitoring of the gas production and consumption (Sendegeya and Silva, 2000). This type is in general more expensive compared to the fixed dome since it uses more industrial advanced materials, which are mostly locally not available. Due to the comparable high tech materials, the digester needs more maintenance (Akinbami et al., 2001).

Fixed dome | Floating dome

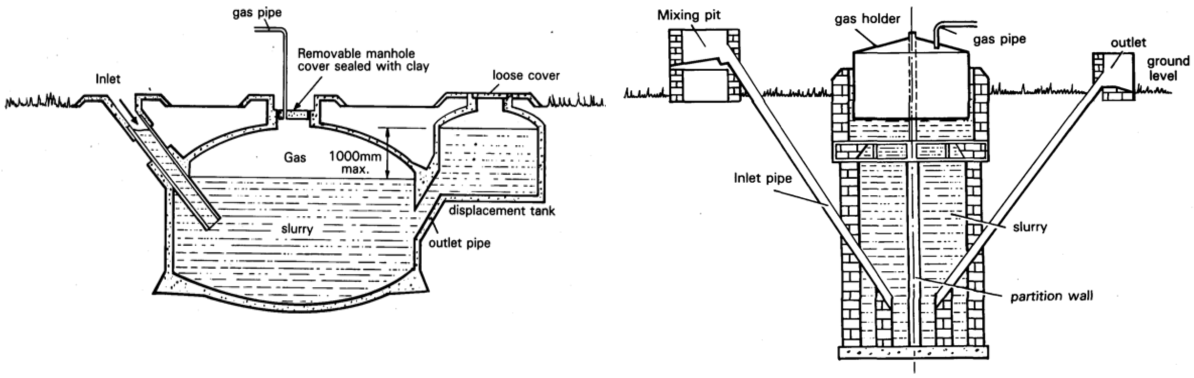

Figure 2. Digester types (Fraenkel, 1986).

The construction time depends on the condition of the underground material. Where it is rocky it takes a long time to dig the hole. “Once the hole was dug the plant was finished very fast” (IRSAT, 2009). Under favorable conditions the construction can last between one to two months up to more than a year. It showed that the time of construction plays an important role as well. The expert interviews and the focus group interviews showed that long construction times have a negative effect on public opinion and increase costs.

Amigun and Blottnitz (2007) suggest that the success of a biogas project also depends on the location for the intended site. It is important to stay away from water sources in order not to pollute them. I also observed that regular bush fires could endanger the safe operation of plants. Climatic conditions are important as well since the production of the biogas varies with temperature and water content (Kaltschmitt, 2001).

Plant operation

The lack of maintenance is a common factor influencing the success of an installed biogas plant in Burkina Faso (Bugaje, 2006, IRSAT, 2009). The lack of spare parts is also a very common problem. Often spare parts cannot be purchased due to weak financial capacities or even due to unavailability of spare parts in the country. The concerned operators sometimes underestimate the work and time effort operating and maintaining a digester, resulting in slackness of feeding the digester (Parawira, 2009; IRSAT, 2009) as well observing and breaking the scum on top of the digester (Mwakaje, 2008). The literacy skills needed in order to control and monitor the digester are sometimes not met by the rural population (Bhat, Chanakya and Ravindranath 2001). The experience of IRSAT showed that “people who are operating the biogas plant are not aware of the work load” (IRSAT, 2009) which was also remarked by Parawira et al. (2009).

Discontinuous use of gas (e.g. for a school kitchen during holidays) may lead to breakdowns. Once the fermentation process is stopped it needs a considerable amount of time (minimum 35 days) to restart. Therefore during operation, special attention has to be given to the needed milieu conditions *oxygen content, water content, substrate structure, nutrients, temperature, pH–value, loading rate, retention time, mixing, scum control,* and *inhibiting substances* which influence the plant efficiency to a great extend (Kaltschmitt, 2001).

Economic

Lack of money for operation and maintenance is a common problem in any biogas program in Africa. Many plants have closed operation in Burkina Faso due to this reason. Without a proper financial long term orientation a continuous biogas production seems not possible. The benefits for the local community are not monetary in most cases as there are only very limited income generating opportunities from the sale of biogas and fertilizer (Adeoti et al., 2000).

The overall cost benefit ratio depends strongly on the topography of the area, agricultural productivity, labor cost at the site location, community participation, learning curve, technology, cost of substrate, use of the biogas product, potential for selling the (by-)products, markets for inputs and outputs, and system of organization - just to name the most important (Amigun and von Blottnitz, 2007; Parawira, 2009).

Institutional

Proper social, cultural, political and economical institutions form a base for supporting adoption, dissemination and appropriate contextual innovation of the biogas technology (Murphy, 2001). Currently the government of Burkina Faso is taking part in the national biogas program *Biogas for Better Life* B4B, initiated by a Dutch NGO - SNV. It strives to improve the dissemination of biogas in Burkina Faso. The strategy for the B4B program in Burkina Faso is to involve the government (respectively Ministry for Environment and Livelihood, Ministry of Mines and Energy, Ministry of Agriculture and Water Resources, and Ministry of Livestock Resources) (Mang et al., 2007; B4B Gov, 2009). It is expected this will also have effects on the legislation and erode the legal und bureaucratic barriers while empowering new policy makers (B4B NGO, 2009).

In Burkina Faso three levels of institutions which influence the implementation of biogas can be distinguished. These are the national level, the interregional or regional level (districts or departments) and the local level (villages or groups within the village). The intensity of coordination among these three layers determines the efficiency of biogas implementations in Burkina Faso (B4B Gov, 2009).

Infrastructure

In the past there was a complete absence of academic, bureaucratic, legislative and commercial infrastructure in the country. Therefore not enough support was given and some projects were dismissed due to these shortcomings (Parawira, 2009).

The bureaucratic and legislative infrastructure supporting biogas projects in Burkina Faso has improved in the last couple of years. Such effects are mainly due to the B4B project (B4B Gov, 2009).

In the past there was hardly any commercial infrastructure allowing biogas installations but now materials become more available and construction companies have started to get specialized in biogas constructions (IRSAT, 2009; CREPA, 2009).

Water and substrate

On site two main factors are influencing the effective operation of a biogas plant: Primarily the availability of the process water and secondly the availability of substrate on site. Water scarcity leads in certain areas in Burkina Faso to the breakdown of the digestion process. This can be either rendered by a priority shift of water usage from e.g. irrigation, drinking water or by the strenuous, work intensive character of fetching the water and transporting it to the biogas plant (Abbey, 2005; Akinbami et al., 2001). Water scarcity is a crucial problem in Burkina Faso, influencing the effective operability of biogas plants (Krings, 2006). Additionally, it can be difficult to make substrate available on site (Bhat, et al., 2001). One main reason is frequently the lack of sufficient domestic animals

(Karekezi, 2002). This can be caused by nomadic or semi-nomadic herding systems or by the fact that it is against the cultural habit for settled farmers to practice extensive cattle herding. Even cattle thefts have been reasons for stock reduction followed by a shortage of substrate (Taelea, Gopinathana and Mokhuts'oane, 2007). Nomadic and semi-noma dic behavior makes dung collection difficult. Additionally it was observed by Berglund and Borjesson (2006),that the energy output turns negative when transport distances of substrates for biogas plants are large. Water and substrate are needed in equal ratios. Apart from this the water and substrate could also contain some process inhibiting substances, e.g. antibiotics pollutants or micro-pollutants e.g. hormones which create operation difficulties (Kaltschmitt, 2001).

Competitive energies

A crucial issue for adopting biogas technology is the work effort and the financial effort for switching to biogas compared to conventional fuels. Several biogas projects in Africa experienced that the rural population finds it much easier to burn biomass directly instead of operating a work intensive biogas plant (Taelea, Gopinathana and Mokhuts'oane, 2007). In contrast, the increasing costs of traditional fuels are facilitating the adoption of biogas (Walekhwa, Mugisha and Drake, 2009). The interviews with the kitchen chefs showed that price followed by the handling convenience determines which energy source is used. Energy from biogas always needs to be compared with conventional energy sources in the rural areas of Burkina Faso. This presupposes the evaluation of current energy needs and energy consumption patterns in the intended project area. Furthermore the input in terms of work needs to be measured against the benefit. During the field research it was critically observed that a huge effort is needed to make a biogas plant work. Is it really worthwhile mobilizing a bunch of people who need to put a lot of work, time and other resources in this project for getting just enough gas for cooking? According to Taelea et.al. (2007) in some cases it is far less effort to stick to conventional fuels. Also the balance of environmental impacts requires consideration. These issues have found little attention in the literature, but observations during this project underpin the importance of these considerations.

Conclusion

The study identified altogether 38 factors which were grouped into eight categories - socio-cultural, planning/construction, operation, economic, institutional, infrastructure, substrate, and competitive energies. Owing to the fact that this factor analysis was done on a national level it offers more detailed factors which specifically apply to rural areas of Burkina Faso. This list of factors should to provide a sound base for better management of future biogas projects in rural areas of Burkina Faso. Furthermore it will provide a framework for what needs to be considered when implementing a biogas plant in Burkina Faso. The analysis underlines that most factors are not technical aspects. This gives strong directions to concentrate more on socio-cultural, environmental and economical factors in the future. However this will require interdisciplinary co-operation of experts in the different disciplines, since up to now the problem has been mainly focused on technical aspects.

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