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The use of three perspectives to make energy implementation studies more culturally informed

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Abstract

Background: In our research on the social and technical feasibility of a small-scale electrical power system in Tanzania, we have perceived a need for an alternative framework or method for social scientific studies of limited scope. The approach we suggest is also a response to the growing criticism of cultural ignorance with which many energy implementation projects are handled.

Methods: Theories from Social Anthropology and Sociology form the core of the approach we present. In addition, concepts from Science and Technology studies are used, as well as lessons learned from History of Technology. We suggest that particular attention should be paid to three aspects: identification of social actors, perceptions of change, and long-term feasibility and sustainability. The approach has been developed and concretised through application in our own research.

Results: To elucidate our suggested approach, we use examples and results from our ongoing research project, in which the 'Three-perspectives-approach' is currently applied.

Conclusions: We have combined theories, approaches and knowledge from different disciplines in order to formulate a framework for studies of social aspects of energy projects that is structured, concise and comparable. The approach is developed to target multi-disciplinary researchers with limited training in social scientific research. It may also be used by project implementers, or as a way for social scientists to present their findings in a way that facilitates for non-social scientists to integrate them into practice. We suggest that the Three-perspectives-approach may be applied independently, or as a complement to other tools.

Keywords: Three-perspectives-approach; Energy implementation; Energy transition; Social actors; Socio-cultural change; Multi-disciplinary research

Background

There is little doubt that social aspects are crucial to energy implementation; the technical artefacts and energy services are introduced and used in societies, by and for individuals. People influence the way a technology is handled and used. Yet, we see many energy implementation projects failing, often due to problems associated with social aspects: the product is 'misused', there is not sufficient knowledge to maintain the technology or there is a lack of financial means or spare parts. Like many social scientists, we address the importance of including the varying practical knowledge of social actors and the significance of specific social contexts and situations, in all energy studies [1-5].

This paper describes one way of supporting projects which deal with the implementation of new energy technologies. The 'Three-perspectives-approach' has evolved from a perceived need for an alternative way for scientists with limited training in social sciences to handle energy studies in a more culturally informed way. The approach was originally suggested by AH (social anthropologist) as a way for CB (engineer) to carry out fieldwork and analyze data for her multi-disciplinary Ph.D. work. It is currently being applied on her research, which concerns rural electrification in Tanzania. Examples from the ongoing research are used in this article to illustrate how the Three-perspectives-approach may be applied.

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Current trends and criticism

Ideally, both the development and implementation of technology start out with an investigation of the needs and priorities of a particular group of people. Such an investigation is preferably carried out by a social scientist, with education and skills to perform such research. Unfortunately, many energy implementation projects tend to begin at the opposite end, with a particular technical solution to an environmental problem or an assumed social problem. The task then becomes a matter of having the technology adopted by suitable users. The surprise when finding reluctance among these to adopt the product (despite obvious benefits) is often what makes the investigator look for barriers or ask social scientists to inform and improve the behaviour of energy end-users [6].

An approach which is commonly used among scientists and other investigators in the area of technology implementation is the identification of 'drivers-and-barriers' [7-11]. The approach has received some substantial criticism though, since the search for barriers implies that we must find and remove whatever it is that prevents the developments from taking place [6,12]. In accordance with this, both Shove [13] and Ryhaug and Sørensen [14] argue that the conventional way of perceiving and treating the implementation and transfer of technology as a one-way process implies that non-technical aspects are merely something which may impede the road to adoption and technological progress. Ryghaug and Sørensen have also pointed out that energy efficiency policies, as well as researchers working with energy efficiency, have tended to view 'non-technical' aspects of energy performance as obstacles to technological progress. In their article on the Norwegian building industry, for instance, they argue that the failure of improving energy efficiency is often an effect of a combination of particular policy-making, market processes and professional and industrial practices [14].

Similar criticism concerns the persistent and common assumptions that energy technologies carry with them certain predefined potentials for change [15,16]. Kooijman [17], for instance, brings forward criticism regarding presumed correlation between access to modern energy and poverty reduction through small-scale enterprises in rural areas. In real life, as Wilhite [6], Laufer and Schäfer [18] and others have made clear, technologies are perceived and used differently depending on the individuals who use them and the situations and contexts in which they are used. Westskog et al. have argued [19] that a consequence of this realisation is that effective energy interventions often need to be tailor-made. Winther's extensive study [20] on the process of introducing electricity and the impact that this has had on a rural society on Zanzibar is one example that highlights the importance of the social context for the outcome of an electrification project. It also puts focus on how different social actors contribute to, form, experience and are influenced by changes in their society.

The approach we are presenting can be seen as a response to a growing criticism among social scientists of the socio-cultural ignorance with which many projects of energy transfer, energy efficiency or energy transitions are handled. In order to increase the focus on social and cultural aspects of energy implementation, we believe that we do not only need to increase the number of in-depth social scientific studies in the topic. Such research should be complemented with more multi-disciplinary and trans-disciplinary research, as well as better trans-disciplinary understanding. We believe that researchers with multi-disciplinary profiles can contribute to decreasing the gap between social scientific research and technical research, and thereby make energy implementation projects more culturally informed.

We have perceived a need for a framework that can facilitate certain social scientific aspects of multi-disciplinary research (see also Millinger et al. [21]). Furthermore, as also Schäfer et al. [22] have pointed out, a commonly used framework for evaluation of decentralized energy systems would be helpful for the comparison of different case studies. For these reasons, we are presenting the approach that we are using in our own multi-disciplinary research project. The approach is tailored to help researchers with non-social scientific background to approach multi-disciplinary tasks in a way that comes closer to some of the methods and theories that are used within social sciences. Since the approach offers a structured way of carrying out and presenting research, we believe it can facilitate comparison between case studies and be used by social and multi-disciplinary scientists as a way to present their research to individuals outside their own discipline. Thereby, we hope that social scientific results can be better integrated into practice.

We also believe that the approach we present can be valuable and useful for engineers, technicians and other individuals involved in energy implementation projects. As stated earlier, extensive social scientific studies are not always carried out in advance of energy technology implementation. Unfortunately, it is not realistic to believe that such studies will be carried out for every implementation project in the future either. Also as already mentioned, it is often difficult for project implementers to comprehend and make use of social scientific research and evaluations made in other projects, in order to improve the success of their own projects. For targeting project implementers, there are several project management tools used by international organizations which facilitate the consideration of social aspects in projects, including technology implementation. One example is the logical framework approach (LFA), which was used

by USAID as early as in the 1970s, and is applied by Swedish SIDA, UN, EU, German GIZ and Australian AusAID among others [23,24]. With its separate steps with different foci, it does not only promote the involvement of social actors of different kinds in all stages of a project but it also advocates identification of the cause and effect relationships. This is valuable for the identification of which problem needs to be solved and by what means, in order to achieve the desired goals. The method also compares the situation before the implementation of a project and the situation after, in order to trace the changes that the project has led to.

There are also several analytical models in technology development involving different social actors in early stages of product development and technology introduction. We have seen, for instance, the emergence of 'User-Centered Design', in which the needs, wishes and limitations of potential future users are given significant attention as early as in the design phase of a new technology [25]. From the 'Technology Assessment' approach, a range of concepts have evolved, with the aim of shaping public policies and involving users and the public in the development of technology [26,27]. Furthermore, energy systems are increasingly being regarded as service providers rather than pure technical artefacts. The 'Product Service System' approach, for instance, is part of this aim to shift focus from consumption of products to consumption of services, and from products to service oriented businesses [28-30].

The approach we are suggesting can thus also be used as a complement to existing project management and product development tools, such as the ones just mentioned. It may be used alone or in combination with other tools in order to get closer to some theories and methods used within social scientific research.

The outline of the article

In the following chapter, 'Methods', we describe a series of useful concepts and tools and we introduce and explain the three perspectives that our suggested approach consists of. In the same chapter, we also describe the case study on which the Three-perspectives-approach is currently applied. In 'Results and discussion', we use a selection of experiences, results and findings from our field work to exemplify the three different perspectives that we suggest. The paper ends with some final conclusions.

Methods

We have used a selection of theories and analytical concepts from four different disciplines - Social Anthropology, Sociology, Science and Technology studies, and the History of Technology - to compile an easy-to-use model for approaching some essential social aspects of energy implementation. The Three-perspectives-approach has been concretised through application on our own research, which is further described later in this chapter. The approach supports a search for answers to three essential questions: Which social actors are relevant for our study? What will change with the introduction of this energy technology? How can we estimate the options for long-term feasibility and sustainability? To support the application of the methodological and analytical approach outlined below, we start this chapter by presenting some certain concepts that appear to us to be particularly useful.

Some useful concepts

The approach we suggest contains the following concepts: 'social actor', 'socio-technical energy system', 'energy service', 'energy carrier', 'inside and outside perspectives' ('emic' and 'etic' respectively), and 'social differentiation' with its 'horizontal' and 'vertical' components. These concepts are particularly useful when considering the socio-cultural contexts of energy technologies, and the changing circumstances in which these technologies may be involved.

The first of these, the social actor, is a common term denominating an individual, an organization, a company or any other group of individuals who are acting together in a certain way. The second concept, the socio-technical system, is a way of widening the idea of a technical system to include social components. Thus, an energy system may be defined in a narrow sense, consisting of technical equipment for extracting, transforming, transporting and using energy [31]. It may also be defined more broadly as a socio-technical energy system, including not merely the technical components but also the social actors who construct, operate and use the plant, as well as the economic and legal prerequisites for the activity [15,31,32].

Within sociological and anthropological energy research, it has been important to call attention to the fact that people do not consume energy. Rather, in real life, people make use of culturally meaningful 'services' that happen to depend on a supply of gas, oil, electricity etc. [33,34]. One advantage of focusing on energy services rather than energy supply is that it opens up for studies of energy-related ways of living and how these may be altered [33]. Another advantage is that it draws attention to the fact that the same service can be provided by different equipments and sources of energy [34]. Three different kinds of cooking stoves, the three-stone open fire, the wood-fuel saving stove and the solar cooker, may exemplify the differences between the concepts energy service, energy carrier and technical equipment. The three stoves all provide the same energy service - the ability to cook. However, the energy carriers are two: biomass and solar energy, while the technical equipment differs in all three cases.

Furthermore, we argue for an increased use of one of the theoretical and methodological fundamentals of Social Anthropology; the relationship between the view from within, emic and the view from the outside, etic. The first of these concepts relates to life as experienced and described by the members of a society themselves, while the latter relates to its counterpart, the analytical descriptions or explanations of the researcher [35]. For instance, Matinga concludes from her studies of the Xhosa culture that activities such as collecting firewood and cooking are meaningful beyond their utilitarian functions [36]. An etic observer, she says, might interpret an activity such as collecting firewood simply as a workload one should try and reduce, while from an emic perspective, the same activity could be interpreted as part of being a 'good woman' and as an opportunity to socialise.

A final important concept is 'differentiation', which is borrowed from the sociological and anthropological bodies of theories [35]. It is a universal feature of human societies for members to see themselves and others as belonging to different groups with differing characteristics. Differentiation may be explained by class, gender, age, caste, ethnicity, profession, economic status, geographical location etc. However, it is essential to understand that such features do not speak for themselves. Human beings interpret differences in a large variety of ways. There are no societies where all adults have exactly the same influence over each decision and where everyone has exactly the same rights and duties [35]. It is important for the feasibility and long-term sustainability of a project to consider this varying ability of social actors to have an impact and influence over a particular situation. Still, we also need to separate issues of power and subordination from division of responsibilities that are not expressions of inequality. This can be referred to as horizontal and vertical differentiation, where the horizontal dimension stands for egalitarian differences and the vertical dimension for differences in power or rank [35].

Relevant social actors

We suggest here the use of three main perspectives, or foci of attention. The first of these entails the process by which individuals, groups or organizations are included in, or excluded from, a research or project investigation. An immediate focus on relevant social actors, we think, is a way of laying a good socio-cultural foundation for any energy implementation project and a way of counteracting the tendency to overemphasize undifferentiated users or the technology itself. 'Stakeholder analysis' is a common procedure in project management [37,38] and fairly similar to what we propose here. Still, a majority of energy efficiency and implementation projects throughout the world seem to be carried out with little consideration of their social context [39]. Those who do include social actors have a tendency to focus on energy end-users alone, although it is just as important to take into consideration the actors involved in the delivery of energy and the manufacturing of equipment [32,39,40]. Consequently, we consider it important to point out the necessity of identifying relevant social actors.

We suggest an identification procedure starting with two key concepts, one being the 'socio-technical energy system'; the other, the energy service. One way to use this conceptual model is to begin with the technical equipment (of a specific case) and think of it as the core of the socio-technical energy system. Each of these technical components has to be produced, supplied, repaired and handled on a day-to-day basis. The question is which individuals, companies and organizations do this.

The characteristics and relevant actors of socio-technical energy systems vary particularly strongly depending on whether or not they are connected with a grid or pipeline [32]. Naturally, there are also substantial differences between small electric grids, as in our case, and large grid-connected systems, such as the Scandinavian and North European grids. Basically, however, three main types of actors can be thought to be linked to an energy system. These are the deliverers of energy, the users of energy and the producers of equipment [31]. Another way of describing an energy system is to say that its 'task' is to tie the energy raw material to a certain energy need. Kaijser et al. [32] have described this as a chain reaching from the extraction of raw material via refinement and transportation to usage.

As a further complement, it may be valuable to contemplate the different stages of an energy project. In an early stage, social actors who initiate and promote the technology are of particular interest [31,41]. Later, the people involved in the actual work of installing and implementing the new technology or energy carrier are important. Finally, once the implementation of the technology is completed, the focus is on those who are involved in the daily operation and maintenance of the technology. In all these phases, decision-makers, implementers and other actors with an interest in the energy system should be considered.

In the construction of a technical system as well as during maintenance and repair, product and service suppliers are crucial. If the supplier of the initial components is a not a locally based actor, which is sometimes the case when small-scale energy systems are installed by donor-driven organizations, the social actor that is supposed to take on the supply of spare parts after the initial implementation of the technology must be identified. The same applies to the knowledge-based resources needed in construction and repair work as well as the everyday operation of the system.

Another important group of actors are those using the energy services provided by the energy system in focus.

This includes people that actually use and handle the energy, such as people cooking or using electrical tools, and people that benefit from the energy service, for example those eating the cooked food or buying furniture produced by using those tools.

We suggest that social actors are not only identified as individuals who organize activities, deliver particular technical equipment or use certain energy services. We also need to find other patterns, such as whether a certain energy service is primarily used by women, young people, by the wealthier, or by certain villagers or employees. Among the long list of people affected by the studied project, an appropriate judgment must be made of who are and who are not relevant social actors. To do so, the aim of the study must be considered. The key message is that the involvement or exclusion of a certain group of actors should preferably be a sensible decision rather than an unconscious action due to poor investigation.

Socio-cultural change

The second phase of the Three-perspectives-approach involves attempts to learn more about the everyday life of each of the relevant social actors and to try to understand how their daily lives might change due to the introduction of a certain technology. This perspective is inspired by social anthropological works elucidating the importance of the cultural changes related to the technology implementation [6,20,40,41]. The task here is to understand what a change of technology or energy carrier means for men and women, the young and the old, the wealthy and the poor, the well-educated and the less well-educated etc. [6,33,34,40]. How does each of these individuals and groups perceive the proposed measures? Who gains and who loses and according to whom? Further, how important are those changes in comparison to other things in the peoples' lives?

Thus, what we want to understand eventually is the emic perceptions of the energy implementation or transition in focus; the view from inside the society and of the relevant social actors. This includes actors involved in activities related to the technology or energy carrier used before, as well as those involved in activities related to the new ones. For the investigator, who is often an 'outsider', it may help to start by obtaining a picture of changes that are easily observable.

Depending on the context, the introduction of a new technology or energy carrier may lead to the introduction of new energy services that were not present before. Such a service may, for example, be the possibility of charging mobile phones when electricity is introduced. Situations where some established energy services are carried out in new ways may also occur. For example, if solar cookers are introduced, social actors who are responsible for cooking may switch from the habit of cooking on wood-fuelled stoves to the habit of cooking on solar cookers. This is a change easily observable for an outsider. The introduction of the new technology may also lead to related changes in everyday life. People may start cooking at other times of the day due to the dependence on sunshine, or somebody may spend less time and effort on collection of firewood. These changes, in turn, may influence how other less cooking-related activities are carried out. Such alternations may be more difficult to observe for an outsider, but are still changes from an etic, an outsider's perspective.

However, it is of great importance to realize that it is not primarily these 'objectively' observable changes that influence the outcome of an energy transition or implementation project, but the ways in which the changes affect people's lives and the ways in which people perceive these alterations. The importance of this distinction for energy implementation projects can be illustrated by an example from South Africa, where the promoters of a solar electrification project were surprised to find the low-income households reluctant to replace paraffin with electricity [42]. From the promoters' outsider perspective, electricity was a natural step towards improved welfare and modernity. It also seemed like a perfect way to counteract hazardous fire incidents and the frequent toxic accidents caused by the use of paraffin. However, from an inside perspective, paraffin has a social quality that electricity lacks. Like food and other household items, paraffin can be bought and shared in small quantities. It can be borrowed from a neighbour, relative or friend when someone runs out of it or does not have the cash to buy it. Since these households tend to rely on social relationships for survival, paraffin is well embedded in the social fabric, while electricity, which cannot be split and redistributed, is socially disadvantaged [43].

From this example, we learn that it is of vital importance for anyone who embarks on an energy implementation project to become as fully aware as possible of the difference between one's own impressions and expectations as an outside observer and the varying perspectives and experiences of the social actors one is set to observe. Contrary to what is commonly believed, the point is not to find out whether one is more correct than the other [35]. The point is to get as close as possible to the subjective experiences, hopes and aims of different social actors. Contrary to traditional positivist claims [44], one can never take things for granted or use one's own frame of reference as the only guideline. Understanding of the subjective experiences of others is necessary to be able to understand the altering of social practices and to stand a good chance of introducing a socially feasible energy system.

Long-term feasibility

This last perspective of our suggested approach involves an investigation of risks and potentials for the completion

and long-term sustainability of a specific energy implementation. It is based on the conclusion that a technical solution is never enough to achieve successful energy implementation and is inspired by the 'socio-technical systems' approach launched in the 1980s by authors in the Science and Technology genre, such as Bijker et al. [15]. To further assemble certain circumstances that tend to be important for the success or failure of attempts at energy or technology implementation, we learn from success stories as well as failures of technology implementation from the History of Technology [45]. From Social Anthropology, we are aware of the importance of taking an interest in the culture-specific ways of perceiving differences in rank, status and prestige [35]. We use the knowledge we have gained by applying the two previous perspectives in order to understand the varying abilities that social actors have to influence energy-related issues. Here, we will start by suggesting an investigation of how social actors, in consideration of the cultural change they are subjected to, unite to shape the opportunities and challenges for the success of a project.

Based on understanding of social actors, their internal roles and the changes occurring, we try to become aware of conformities and possible gaps between social actors that perceive that they benefit from a certain change and social actors that are in power in the specific context. If the benefiting or interested social actor is not the same as the one with power and authority to make decisions regarding the particular question in focus, there are potential challenges to consider before continuing with the project or implementation. We have thus come back to the importance of understanding how people differentiate between themselves and others and what differentiations are vertical and which are horizontal [35]. An example from North Western Tanzania may serve as illustration. The task for one of our master students was to investigate whether photovoltaic (PV) systems could be used for improving working conditions in the kitchen houses of this area [46]. One of the main conclusions of his thesis was that the system should include at least two lamps in order to be effective. He had noted that culture-specific ways of perceiving gender differences included different roles and work tasks as well as differences in power. While women were responsible for cooking, men had the power to decide on the purchase of new technical items. Thus, provision of electric light for the main building (which was also more highly valued and of higher priority to men) was suggested as a prerequisite for successful implementation of light in the cooking house.

Studying success stories as well as failures of technology implementation is a great way of gaining understanding about what has worked out well in previous projects as well as what has been challenged or reasons for failure. It should be remembered that each project is unique and no project has exactly the same preconditions as another one. We claim that one can thus never be sure that all criteria required for successful technology implementation are fulfilled. Having said this though, we mean that the increased understanding of social aspects, in combination with lessons learned from earlier projects similar to the one that is about to be implemented or studied, will increase the likelihood of identifying weak and strong points of a project and thereby possibly influence its outcome.

Two examples from the History of Technology will provide an illustration to some of the most basic prerequisites for a successful long-term technology implementation. The first is a success story; the other, a story of failed implementation. The first example is about the introduction of the electric light bulb [45]. Edison and his colleagues did not invent the light bulb, as is often assumed. Neither was the light bulb per se the key to their success; the key was their organizational ability. Edison had support from financiers and political decision-makers, and through media and spectacular light shows arranged during dark winter nights, an intellectual reading population was convinced that candescent electric lighting was superior to both gas lamps and arc-lamps. Still, according to Hård [45], the most important achievement of Edison and his colleagues was to start about a dozen companies for production, distribution and maintenance. They managed to create a complete chain of coordinated companies and products.

The second example concerns the first steam engine that was brought to Sweden from England in 1782 [45]. It was to be used for mining ore. The social actors who tried to carry the technology into the Swedish society had the power and economy to do so. They had access to the technique, and they were well informed about its possibilities and limits. Still, the project eventually failed. One reason was the many technical problems related to the transfer from the industrialized England to the colder, wood-based country Sweden. However, Hård [45] argues that the primary reason why this energy implementation project failed was lack of a long-term functioning organization. The project was dependant on the knowledge of two well-educated men from Uppsala and Stockholm. When they eventually lost interest in having to work outside the urban area, powerful financiers also withdrew their support.

These two historic examples illustrate that a technical solution is never enough. Certain features are recurrent characteristics of a successful technology implementation. Some of these may be put together and serve as a checklist when estimating the strengths and weaknesses of a particular project. The following questions are examples of issues which most probably are important to consider [41,45,47]:

- Is the technology, as well as the social actors who promote it, considered credible by the users-to-be?

- Do the producers, suppliers and end-users have enough knowledge and interest?
- Is the energy carrier, technical equipment or energy service easily accessible?
- Are social actors with long-term management and commitment present?
- Are there social actors with enough economic and political strength to carry through the project?
- Finally, is there a complete chain of coordinated companies and products?

We do not claim this list to be comprehensive. Still, it may guide a discussion concerning strong and weak characteristics of a certain energy implementation, as well as how such characteristics could be handled.

The case study

The research project, on which we are applying this suggested approach, started in 2011 and is financed by the Swedish International Development Cooperation Agency (SIDA). The aim of the research is to suggest ways of improving both social and technical feasibility of mini-grids supplied by renewable energy in general, and a certain hybrid PV-diesel system in Tanzania in particular. The project is multi-disciplinary, involving a Ph.D. student in engineering physics and her two supervisors in technical and social scientific issues respectively. The main research questions of the social part of the study relate to how the technical system in focus affects the community in which it is operating and how the functionality of the technology depends on the way people organize themselves in order to implement, introduce, use and maintain the technology.

The owner, operator and user of the power system in our main focus is a community-based Tanzanian organization that runs a vocational training centre with courses in sewing, carpentry, masonry and welding. At their centre, there is also a carpentry workshop, a kindergarten, a business centre, a meeting hall, a guest house, two offices and a kitchen. Other activities and projects are also organized and administrated by the organization, such as women's groups, credit-saving groups and peer education programs dedicated to people infected by HIV/Aids.

Qualitative interviewing and participant observation are the main methods used in the social parts of the study [44]. The interviews have been of semi-structured nature; open-ended questions were asked, and the interviews often included digressions from the planned questions which could result in new, unexpected information depending on the interviewees' answers. This article is based on 6 months fieldwork carried out in 2011, 2012 and 2013.

Interviews as well as conversations during participant observation have mainly been carried out in Swahili and to a lesser extent, in English. The interviewer (CB) is fluent in English and speaks and writes 'every-day-Swahili'. We have chosen not to use any interpreters. This choice has the disadvantage that not everything was understood by the interviewer. Subtleties of the language were to a large extent poorly comprehended, and sometimes the conversations were interrupted by the interviewer asking for explanation for expressions or words. However, we believe that the advantages of using Swahili as the language of communication, without involving any third party, outweigh the disadvantages. Firstly, many of the interviews could occur spontaneously. Secondly, we believe that the presence of a third person would have limited the advantages we had from establishing personal relationships with the informants.

Results and discussion

In this chapter, we present a selection of experiences, results and findings from our case study in Tanzania. The main intention here is to provide examples illustrating how the Three-perspectives-approach can be used and applied on a specific project, in this case a study of an already implemented energy technology. Since our research is ongoing, the examples presented consist of a mix of parts of the study which have already been carried out, ongoing analysis and things that we would like to investigate in the future.

Although the three perspectives are presented in the order that we recommend them to be used, we think it is necessary to alternate them when carrying out studies and field work. In our study, we have alternated between the perspectives in order to make use of the findings from one perspective to further develop the findings of another.

Relevant social actors

We started our study focusing on the identification of social actors, as we also suggest in the previous description of the Three-perspectives-approach. We think this helps to widen the perspectives and include a large variety of actors. As one way of reasoning, we choose to begin the identification of social actors by outlining some of the basic characteristics of the socio-technical system in focus. We do so by first looking at the technical components of our socio-technical system. Thereafter, we try to relate social actors to the different stages of implementation of the technology as well as the operation and maintenance phases.

The technical system in our case study is a mini-grid combining the use of PV panels and a diesel generator to provide the community centre with electrical power [48]. Components formerly used in small PV systems at the centre were, as far as possible, used to form the central mini-grid. The required additional equipment was purchased in a nearby city or ordered from Dar es Salaam,

Tanzania. Our research project started after this central mini-grid was already constructed. In order to identify the social actors related to the early phases of the construction of the system, we are conducting interviews with people who were involved during this phase. This work is still ongoing, and we wish to investigate in greater depth the process by which the system was first considered, promoted, initialized and implemented as the research goes on. However, we can already present some key actors at this stage. The expansion of the electrical power system was promoted by the leaders of the Tanzanian organization, in collaboration with a Swedish NGO. Both these organizations contain a few individuals that are strongly involved in managing the activities at the centre in Tanzania. The design and installation of the PV-diesel hybrid system was made by a local electrician after general design suggestions from a Swedish energy researcher. The research team involved in the technical parts of the now ongoing multi-disciplinary research project (including CB and the researcher giving initial advice) has also been involved in later modifications of the power system together with the local electrician. In the detailed planning and construction phase of the central power system, the local electrician received support regarding specific equipment from various other electricians and retailers in Tanzania.

Since the installation of the PV-diesel hybrid system, the day-to-day operation and use is handled by some of the organization's staff; the diesel generator is operated, the inverter is turned on and off as needed, and electricity consuming appliances are used. Minor maintenance and repair work is done by one particular employee, who is knowledgeable about the technical details of the power system. The electrician who installed the system is contracted for more extensive work. He runs a small one-man business in a nearby town. For decisions concerning the continuous operation of the electricity system, the manager of the organization plays a key role. The Swedish NGO is also an important actor, both as discussion partner concerning the development of the organization and for its economic support. Now and then, advice is also sought from Swedish researchers linked to the technical part of our research project.

In contrast to many other energy systems, the 'energy producer', the 'energy provider' and the 'energy user' are in some aspects the same actor in our case study, since it is the same organization which produces and consumes its own energy, distributed only within the compound. The individuals associated with the production, distribution and use of the energy are to some extent different though. Not all people who use electrical appliances are also involved in the operation of the system and thus the production and distribution of electricity.

With the most important initiators, promoters and operators defined, and before we moved on to the identification of different end-users, we considered the people in the geographical proximity of the technical system. Since the focus of our particular study is a community centre, it seemed natural to include the employees in our overview of relevant social actors. Thus, apart from the manager, the following social actors are employed at the centre: vocational training teachers, kindergarten teachers, night watchmen, a driver, and employees working in the kitchen, guesthouse, business centre, café and shop. At the centre however, we also find other actors who are using the facilities for longer periods or who are merely visiting some of the facilities on an occasional basis. We find children in the kindergarten, students of sewing and carpentry, villagers and students who take computer classes and people enrolled in programs that are managed or supported by the organization. Furthermore, we find villagers stopping by to have a cup of tea or a chapati at the café, or to buy something or have their mobile phones charged at the shop. Sometimes the facilities at the centre are rented out for special occasions, such as meetings, during which visitors from nearby or far away come to the centre. One of the offices is used by the educational coordinator of the ward. By focusing on the geographical surroundings, we have thus been able to identify other social actors that may be relevant for our study, although they may not necessarily be either users or implementers or promoters of the electrical power system.

In order to become more clearly aware of which actors make use of the particular energy system, the concepts of energy service, energy carrier and 'technology' are useful tools. In our case study, the system supplies power for lighting, computers, a copy machine, a TV, a refrigerator, charging mobile phones and tools of various kinds. Some of those who participate in the activities at the centre do not actively use any of these services though. For instance, neither the café personnel nor the kindergarten teachers nor some of the women's groups meeting at the centre make use of any electrical equipment in their activities related to the organization. One example of social actors who *are* using an energy service supplied by electricity from the mini-grid is the teachers and students in computer classes who are using computers. Other examples are the carpenters, who use electric machines in the workshop, and teachers and students in sewing classes using electric sewing machines. We also find members of staff, who handle the mobile phone charge service for villagers, who use electric irons or use the refrigerator.

Apart from people actively using energy services at the centre, such as the actors just mentioned, we also find more indirect users of the energy services which are made possible by electricity. Examples of such beneficiaries that we will include at a later stage of our research are the villagers who get their mobile phones charged, external carpenters who utilize the opportunity of having their wood sawn up by machines in the carpentry workshop, and

people who have documents written, printed or copied by the staff in the business centre. Identification of people who benefit from a certain energy system can make a nearly indefinite list. The demarcation of any particular study is, however, a matter of judgement, and may vary with the circumstances and particular aim of a certain project. In our research we have, for example, decided to omit from our interviews people who receive calls from mobile phones charged at the centre, those who buy furniture produced by a carpenter who has his wood sawn in the workshop or subcontractors to the electrical stores in the nearest city. In our case, the study would be unmanageable from a practical point of view, and we also believe that these actors have limited effect on issues related to our research questions.

Socio-cultural change

Applying this second perspective of the Three-perspectives-approach, we shift our focus from the identification of social actors to change. We now try and learn more about the everyday life of the relevant social actors that we have identified and see how the introduction of the energy system in focus for our studies has contributed to the changes in the society and in people's lives. We suggest that it is not primarily the objectively observable changes that influence the outcome of an energy transition project, but the way they affect people's lives and the way the people perceive these changes. Still, we start our investigation by focusing on the 'view from the outside' to get a picture of the changes taking place.

We conclude that the presence of the PV-diesel hybrid system has altered energy-related activities at the centre and possibilities in the village in two major ways. Firstly, it has led to the introduction of services that were not available before the introduction of electricity. Such services cover activities that can only be carried out by electricity, such as the charging of mobile phones and the use of computers. It has thereby allowed for new activities at the centre, such as computer classes and the possibility for villagers to get documents typed, printed and copied. Secondly, the PV-diesel hybrid system has enabled a transition from one energy carrier to another in order to provide energy to services that already existed. Services which previously were available at the organization, but achieved through other energy carriers than electricity, include the use of electric sewing machines instead of treadle machines. Another example is the use of electric woodworking machines for work that was previously done exclusively using hand tools, such as drilling and sawing wood.

We also try to look at the changes in a wider perspective and can conclude that the possibility of charging mobile phones at the centre has led to people living close to the centre not needing to walk long distances to charge their mobile phones, which many of them did before. The same service may thereby increase the times that people's mobile phones are charged and, hence, influence the way people communicate with others using their phones. Another aspect that we would like to further investigate is whether better access to charging opportunities influences how much money people spend on that service and how much money they spend on calls. Although coming closer to reason around changes in people's everyday lives, this is also an example of changes that are 'observable' or measurable from an outside perspective.

An example which illustrates the 'inside perspective' relates to the way employees and management consider the power system and its services. For many of them, the power system does not only influence the everyday working conditions, for example by facilitating the use of computers and tools, but also contributes to the ability to fulfil the organization's aims and goals; to function as a resource centre for sustainable development within the community. The power system for example helps the teachers to offer high-level educational training programs, contributing to the students' abilities to find meaningful occupation after graduation. The electricity also supports seminars, courses and workshops by enabling the use of television and computers for educational purposes and offers services that are regarded as advantageous for the villagers such as the possibility of buying cold drinks, charging mobile phones and printing and copying documents. We perceive the employees and the management as being proud of the technical system and the way they can use it in order to support the development of their community.

The particular employee knowledgeable about the technical details of the system was formerly the night watchman at the centre. He has been trained by the electrician contracted by the organization, by participating when work has been done to the centre's PV-diesel hybrid system and other power systems. As he is now able to carry out dimensioning and installation of small PV systems by himself, he is no longer working as the night watchman. Instead, he assists the organization, private households, schools and health clinics around the nearby villages to install and maintain PV systems. He shows genuine interest in his work and expresses interest in getting further education in PV technologies. Some employers at the organization have expressed a future vision of being able to offer vocational training at the centre in PV technologies, too. Those interests, we conclude, express effects that the particular power system has had on the employees' perception of the power system and its services. The importance thereof naturally varies between different employees, from being an essential part of his or her life to something rather minor.

As another example of the 'view from the inside', we chose to focus on the significance of the copy machine. For the employee who handles the copy machine in the business centre, the power system is essential for the possibility of having a job at the centre. That person can thus relate many things in life and daily activities to the presence of the PV-diesel hybrid system. For the customer though, the impact which the possibility of copying and printing documents at the centre (which in turn is possible due to the presence of the power system) has on his or her life and how that person perceives the possibility depends a lot on what the alternatives are. The following questions exemplify issues to which we have no answers as yet. For instance, if this service was not available at this place, would the customer get the same service from somewhere else? Did the customer use this service there before? What makes the customer prefer this service provider in front of another provider? If there are no other providers of the certain service, how has the introduction of the service affected the customer? What did the customer do to fulfil similar needs prior to the introduction of the service?

The altered working conditions for carpenters and users of sewing machines provide two other examples of how an inside view may add to our understanding. What impact a change of energy carrier has on the perceptions and feelings of the involved actors about a certain activity depends on many different factors. At the centre, the users of the electric sewing machines mean that their work is less physically demanding with the use of electric machines. However, they also consider their actual work to be very similar to that carried out with treadle machines. The carpenters, for their part, experience a much higher efficiency in their work thanks to the use of electric machines, resulting in higher productivity as well as more time to relax. The carpenters as well as the tailors (including students in both subjects) consider that the introduction of electricity has facilitated their work, although to different extents. Important issues that we still wish to investigate include the consequences that this facilitation has for the performance of the specific activity, as well as the people's lives. Does the higher efficiency result in fewer people required to perform a certain activity? Who benefits from this and who does not? Are the employees working longer days because they get less tired? Do they have better opportunities to involve themselves in other activities? What are these activities? Who benefits from these activities?

As we have pointed at earlier, members of human societies tend to associate themselves and others with different groups with different characteristics. It was fairly easy for us, as outsiders, to see that at the centre, all kindergarten teachers are women, while teachers in sewing, carpentry, masonry and welding are all men. Almost all of these differences due to gender correspond to our own cultural experiences; kindergarten teachers are also most commonly women in Sweden, and teachers of carpentry, masonry and welding are mostly men. The fact that the sewing teachers at the centre are men did, however, diverge from the preconception we had about sewing teachers; in Sweden these are mainly female. Based on these scanty statistics, we cannot draw any conclusions regarding whether these respective occupations are regarded as masculine or feminine in Tanzania, or if this centre is an exception. The possible disparity in differences due to gender, however, made us further challenge our preconceptions related to different occupations and work tasks, including preconceptions regarding vertical and horizontal differentiation of, for example, gender.

In order to understand the ways in which the various categories affect or are affected by a particular energy system, it is valuable to combine the researchers' outside perspective on the varying roles and opportunities with inside perspectives. In our study, it seemed reasonable to differentiate between, for instance, groups of employees and non-employees. However, there is a distinction between the categorization that we as researchers make and the ways in which the employees themselves discuss users of power systems. We found, for instance, that men and women with financial difficulties tend to emphasize the economic and health-related benefits from using PV lanterns rather than kerosene. Many of them claimed that if they had had enough capital to invest in a PV lantern, this would be given a high priority. In contrast to such utterances, men and women who actually had the financial ability to buy a PV lantern or PV system did so to a much lesser extent than the poor people claimed they would do if they could. This observation that some of the identified social actors made this division related to economy between themselves and 'the others' made us aware of the relevance of including the actions and opinions of these wealthier 'others' in the study.

As an outsider, it is easy to take it for granted that electrification is always desirable and for the good. The carpenters as well as the tailors at the organization of our focus point at the importance of being able to use the electric tools as well as hand tools though. Especially for their students, it is crucial for their possibilities to work at other places and for future employment that they know how to use electrical machines as well as hand tools and treadle sewing machines. For successful implementation, the possible negative impacts of the introduction of a new energy system must also be considered [42]. It is also necessary to understand how desirable people find the new energy technology compared with other necessities of life. In our research, we are

interested in understanding what impact the particular electrical power system has on people's perceptions of PV. Coming back to the wealthier others mentioned earlier; they own PV systems to a lesser extent than we first thought they would, but we have noticed that many of them own motorbikes. To them, for some reason as yet unknown to us, they consider it more desirable to own a motorbike than a PV system (which are comparable investments in terms of initial cost).

Long-term feasibility

The third perspective involves an estimation of whether or not a project has what is necessary to allow full implementation and to achieve long-term success. To begin with, we use an example from our case study to illustrate how the internal relation between social actors and the changes which occur may influence the success of an energy implementation or energy transition project.

As we have mentioned earlier, the carpenters and the tailors at the centre all consider that the electric machines they use reduce the physical burden related to their work tasks. They are generally positive to the use of electric machines. In addition to the employees' positive experiences, the electric tools in the carpentry workshop have resulted in higher productivity. In consequence, this is of interest to the management of the organization, whose aim is to provide services to the community and to make the organization economically viable. From the tailors' perspective though, the electric machines mainly make them less tired, but they consider their work speed to be only marginally affected. If the tailors consequently do not increase their working capacity significantly thanks to the use of electrical power, there is a possibility that the management perceives it as being of limited interest to provide the tailors with electricity and electrical machines. Thus, what we see here is one example of a situation where one group of users and the management have a common interest and one where there is a possible discrepancy between the two. Generally speaking, if the social actors with the power to make decisions regarding a certain technology are not the ones who benefit, there is a risk that the technology will be given limited priority.

Our next example relates to the perceived credibility of the technology and the promoters. The organization in our main focus is well established and actively working on many different levels to support and improve the living conditions in the target villages. After many years of community-based work, they are regarded as a credible organization amongst villagers and collaboration partners. PV technology is not only used at the centre but is spread amongst other institutions and private households in the villages. The technology has been received by many villagers as a source of energy superior to many other alternatives. However, it has also been met by scepticism by others, who have previously experienced or heard of PV systems that failed after short time. The credibility of the technology is thus split. The organization we focus on does not only use a PV-diesel hybrid system at the centre but is also involved in activities promoting PV technologies in neighbouring villages. Such activities' success is strongly dependent on whether the social actors who are willing to adapt the technology are also the ones with power, financial means, access to the technology and sufficient knowledge to adapt the technologies for themselves as private people or for common institutions such as schools and village centres.

An incident from our case study is used to point at the importance of availability of products and knowledge. The power system at the centre does not have the highest energy efficiency available with today's technologies [48]. This is partly because the components in the system are not especially developed for hybrid systems, and for various reasons they have not been selected to fit each other in an optimum way. On one occasion, there was a fire in an energy meter installed for research purposes by the research team and not by the local electrician. It was found later that the fire was caused by a defect in a component in the actual power system. The fire did not only destroy the monitoring equipment used for research purposes, but also damaged the centre's power system. To solve the problems that the fire had caused, the electrician was called in. He could repair the system as part of his routine work, without being too disrupted by the researchers' monitoring equipment. Since all components were selected by him and purchased locally, it was easy for him to know where to look for spare parts and how to repair the system. Furthermore, since the electrician is not continuously present at the centre, it was also essential that the people in daily contact with the system were knowledgeable about when and where to turn for advice. We consider that this shows how locally based knowledge can help make a system sustainable, although the quality of the components are causing problems.

The fact that there is only one electrician, a very important individual, could be seen as a sign of vulnerability. Still, the centre's proximity to a large city makes technical equipment, advisors and electricians quite accessible. That lets us conclude that the possibility of obtaining spare parts and technical advice is good in this particular case, even though the main knowledge about the technical specifications of the system is currently connected to one particular individual.

To achieve long-term sustainability of an introduced technology, History of Technology has shown us that there is also a need for long-term management and interest, with power and economical strength to nurture

the interest for the technology continuously. Albeit that the organization is well established in its target area and has several committed employees, it is to a large extent driven forward by some few strong individuals. Without saying that this must be a problem for the long-term sustainability for the energy transition project in focus, it is something to reflect upon and to be aware of; what will happen if those strong individuals for some reason lose their ambitions or ability to carry the organization forward? The organization's ambition is to become self-sufficient, and the employees are working hard to implement and extend income-generating activities. At present, financial support for investments and running costs is received mainly from one of their partner organizations, the Swedish NGO. This may not necessarily be contradictory to economic sustainability if it is continued over a very long time. Still, if such support is reduced without alternatives being found, it may even be difficult to cover the organization's running costs. These are risks that apply to the whole organization, which thus affect the particular power system in focus as well.

Conclusions

This article discusses the use of three perspectives to make energy projects more culturally informed. In our research on social as well as technical aspects of a PV-diesel hybrid system in Tanzania, we have perceived the need for an alternative framework or method for social scientific studies of limited scope. The Three-perspectives-approach is composed of a combination of established practices, methods, theories and concepts from Social Anthropology, Sociology, History of Technology and Science and Technology Studies.

The first of the three suggested perspectives concerns the identification of a wide selection of social actors. This does not only involve the users of the technical artefact or its services, but all other actors affecting or being affected by the energy system in focus. This includes, for example, related companies offering components and relevant services, policy and decision-makers, non-users in the vicinity of the technical system, other actors working within the same fields and areas and local authorities.

In the second perspective, we focus on change. Technical artefacts do not cause certain predefined changes but are perceived and used differently depending on the contexts. This perspective involves learning more about the everyday life and perceptions of each of the relevant social actors before and after the introduction of a certain technology. We combine the researcher's outside perspective on the varying roles and opportunities with inside perspectives in order to understand what a change of technology or energy carrier means for men and women, the young and the old, the wealthy and the poor, the well educated and the less well educated etc.

Finally, we combine the outcome of the first two perspectives with lessons learned from historic success stories as well as failures of technology implementation to estimate whether a project has what is necessary to achieve long-term success. One of the aspects we consider here is the internal differentiation between the varying social actors and in what way their varying roles, interests, knowledge or power have an impact on the feasibility or long-term sustainability of the project in question. Other aspects are the availability of technical components and long-term commitment and coordination of companies and organizations.

The approach has been concretised and developed through application on our research concerning the social and technical feasibility of a PV-diesel hybrid system in Tanzania. Initially, the approach was outlined as three distinct steps of investigation, which we suggested should be carried out, one at a time, in a specific order. When the approach was tested in the field, we found it useful to start the study, as was suggested initially, by identifying social actors and thereafter proceed to the analysis of socio-cultural change and later to long-term feasibility. What we realized, though, was that the results from one perspective often result in new aspects which should also have been considered in the 'previous' steps. For example, during interviews that concerned our investigation of change, we discovered new social actors that we had not thought of before. We also found that it was of little use to try and think of relevant social actors, without considering what changes have taken place or are about to occur and how long-term sustainability would be achieved. Consequently, since each of the perspectives can be used as an input for the other two, we now suggest that the investigator try and alternate between the three different foci of attention.

The Three-perspectives-approach should be regarded as a conceptual model, aiming to facilitate increased understanding of ways in which social aspects are part and parcel of the transfer and implementation of new energy technologies. It is designed as a concise way for master students, Ph.D. students or other researchers in multi-disciplinary energy projects to use a selection of theories and methods from the social sciences. However, we believe that the approach could also be useful for technology implementers who wish to increase their cultural awareness or for social or multi-disciplinary researchers when communicating their results to people outside their own fields.

Competing interests
The authors declare that they have no competing interests.

Authors' contributions
AH and CB have co-authored this paper. Both authors read and approved the final manuscript.

Authors' information

AH is an associate professor in Social Anthropology with long experience of working with technical researchers in energy implementation projects and with supervising and teaching technical students. CB is a Ph.D. student with an engineering background and is now working on a multi-disciplinary research project. The basic ingredients of the Three-perspectives-approach were originally suggested by AH as a way for CB to carry out fieldwork and analyze her data. Since then, the approach has been continuously developed through repeated discussions and field tests.

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References

1. Röpke I (2009) Theories of Practice: new inspiration for ecological economic studies on consumption. Ecol Econ 68(10):2490–2497, doi:10.1016/j.ecolecon.2009.05.015
2. Shove E, Pantzar M, Watson M (2012) The dynamics of social practice: everyday life and how it changes. SAGE, London
3. Warde A (2005) Consumption and theories of practice. J Consum Cult 5(2):131–153, doi:10.1177/1469540505053090
4. Wilhite H (2008) Consumption and the transformation of everyday life: a view from South India. Palgrave Macmillan, Basingstoke
5. Wilhite H, Nörgaard J (2004) Equating efficiency with reduction: a self-deception in energy policy. Energy Environ 15(3):991–1011, doi:10.1260/0958305043026618
6. Wilhite H (2008) New thinking on the agentive relationship between end-use technologies and energy-using practices. Energy Efficiency 1:121–130, doi:10.1007/s12053-008-9006-x
7. Ahlborg H (2012) Electricity for better lives in rural Tanzania and Mozambique - understanding and addressing the challenges. Chalmers University of Technology, Göteborg, Thesis
8. Ahlborg H, Hammar L (2012) Drivers and barriers to rural electrification in Tanzania and Mozambique - grid extension, off-grid and renewable energy technologies. Renew Energy 61:117–124, doi:10.1016/j.renene.2012.09.057
9. Verbruggen A, Fischedick M, Moomaw W, Weir T, Nadaï A, Nilsson LJ, Nyboer J, Sathaye J (2010) Renewable energy costs, potentials, barriers: conceptual issues. Energy Policy 38(2):850–861, doi:10.1016/j.enpol.2009.10.036
10. Painuly JP (2001) Barriers to renewable energy penetration; a framework for analysis. Renew Energy 24(1):73–89, doi:10.1016/S0960-1481(00)00186-5
11. Reddy S, Painuly JP (2004) Diffusion of renewable energy technologies - barriers and stakeholders' perspectives. Renew Energy 29(9):1431–1447, doi:10.1016/j.renene.2003.12.003
12. Guy S, Shove E (2000) The sociology of energy, buildings and the environment: constructing knowledge, designing practice. Routledge, London
13. Shove E (1998) Gaps, barriers and conceptual chasms: theories of technology transfer and energy in buildings. Energy Policy 26(15):1105–1112, doi:10.1016/S0301-4215(98)00065-2
14. Ryghaug M, Sørensen KH (2009) How energy efficiency fails in the building industry. Energy Policy 37(3):984–991
15. Bijker WE, Hughes TP, Pinch T (1990) The social construction of technological systems: new directions in the sociology and history of technology. The MIT Press, Cambridge
16. Jasanoff S, Markle GE, Petersen JC, Pinch T (1995) Handbook of science and technology studies. SAGE Publications, Thousand Oaks, California
17. Kooijman-van Dijk AL (2008) The power to produce: the role of energy in poverty reduction through small scale enterprises in the Indian Himalayas. University of Twente, Enschede, Dissertation
18. Laufer D, Schäfer M (2011) The implementation of solar home systems as a poverty reduction strategy - a case study in Sri Lanka. Energy Sustain Dev 15(3):330–336, doi:10.1016/j.esd.2011.07.002
19. Westskog H, Winther T, Strumse E (2011) Addressing fields of rationality: a policy for reducing household energy consumption? In: Galarraga I, Gonzalez-Eguino M, Markandya A (eds) Handbook of sustainable energy. Edward Elgar Publishing Ltd, Cheltenham, pp 452–469
20. Winther T (2011) The impact of electricity: development, desires and dilemmas. Berghahn Books, New York, Oxford
21. Millinger M, Mårlind T, Ahlgren EO (2012) Evaluation of Indian rural solar electrification: a case study in Chhattisgarh. Energy Sustain Dev 16(4):486–492, doi:10.1016/j.esd.2012.08.005
22. Schäfer M, Kebir N, Neumann K (2011) Research needs for meeting the challenge of decentralized energy supply in developing countries. Energy Sustain Dev 15(3):324–329, doi:10.1016/j.esd.2011.07.001
23. Örtengren K (2003) Logical Framework Approch (LFA): en Sammanfattning av LFA-Teorin. SIDA, Metodenheten, Stockholm
24. Government of the Republic of Serbia (2011) Guide to the logical framework approach: a key tool for project cycle management, 2nd edn. European Integration Office, Belgrade
25. Norman DA, Draper SW (1986) User centered system design; new perspectives on human-computer interaction. Lawrence Erlbaum Associates Inc., Hillsdale
26. Schot J (2001) Towards new forms of participatory technology development. Tech Anal Strat Manag 13(1):39–52, doi:10.1080/09537320120040437
27. Schot J, Rip A (1997) The past and future of constructive technology assessment. Technol Forecast Soc Change 54(2):251–268, doi:10.1016/S0040-1625(96)00180-1
28. da Costa Junior J, Diehl JC (2013) Product-service system design approach for the base of the pyramid markets: practical evidence from the energy sector in the Brazilian context. In: Schäfer M, Kebir N, Philipp D (eds) Micro perspectives for decentralized energy supply: proceedings of the international conference. Technische Universität, Berlin, 28 February to 1 March 2013
29. Mont O (2002) Clarifying the concept of product-service system. J Clean Prod 10(3):237–245, doi:10.1016/S0959-6526(01)00039-7
30. Baines TS, Lightfoot HW, Evans S, Neely A, Greenough R, Peppard J, Roy R, Shehab E, Braganza A, Tiwari A, Alcock JR, Angus JP, Bastl M, Cousens A, Irving P, Johnson M, Kingston J, Lockett H, Martinez V, Michele P, Tranfield D, Walton IM, Wilson H (2007) State-of-the-art in product-service systems, Proceedings of the Institution of Mechanical Engineers. Part B: J Eng Manufacture 221(10):1543–1552, doi:10.1243/09544054JEM858
31. Kaijser A (1990) Ledningen och Makten. In: Beckman S (ed) Teknokrati, Arbete, Makt. Carlssons bokförlag, Helsingborg
32. Kaijser A, Mogren A, Steen P (1988) Att Ändra Riktning: Villkor för ny Energiteknik. Allmänna förlaget, Stockholm
33. Shove E (2003) Comfort, Cleanliness and convenience: the social organization of normality. Berg, Oxford
34. Clancy JS (2002) Blowing the smoke out of the kitchen: gender issues in household energy, Brief No. 1 Gender and Energy. SPARKNET
35. Hylland Eriksen T (1995) Small places, large issues. An introduction to social and cultural anthropology. Pluto, London, East Haven
36. Matinga MN (2010) "We grow up with it": an ethnographic study of the experiences, perceptions and responses to the health impacts of energy acquisition and use in rural South Africa. University of Twente, Enschede, Dissertation
37. Uusitalo J (2013) Project management in practice: evaluating a case project through project management theories. Helsinki Metropolia University of Applied Sciences, Helsinki, Thesis
38. Lester A (2007) Project management, planning and control, 5th edn. Elsevier, Oxford
39. Wilhite H (2012) The energy dilemma. In: Bjørkdahl K, Nielsen KB (eds) Development and environment: practices, theories, policies. Akademika, Oslo
40. Winther T (2012) Negotiating energy and gender: ethnographic illustrations from Zanzibar and Sweden. In: Bjørkdahl K, Nielsen KB (eds) Development and environment: practices, theories, policies. Akademika, Oslo
41. Henning A (2000) Ambiguous artefacts: solar collectors in Swedish contexts: on processes of cultural modification. Stockholm University, Stockholm, Dissertation
42. Mehlwana AM (1997) The anthropology of fuels: situational analysis and energy use in urban low-income townships of South Africa. Energy Sustain Dev III(5):5–15, doi:10.1016/S0973-0826(08)60208-2
43. Boholm Å, Henning A, Krzyworzeka A (2013) Anthropology and decision making: an introduction. Focaal - J Glob Hist Anthropol 65:97–113, doi:10.3167/fcl.2013.650109
44. Bernard HR (2011) Research methods in anthropology: qualitative and quantitative approaches. AltaMira, Walnut Creek

45. Hård M (1990) Teknik - en Social Skapelse. In: Tengström E, Hård M, Berner B, Edqvist C, Kaijser A (eds) Energin, Makten och Framtiden: Samhällsvetenskapliga Perspektiv på Teknisk Förändring, vol 1989: R16. Statens energiverk, Stockholm, pp 31–51
46. Beyanga P (2008) Small PV lamps for rural areas in Tanzania-a focus on female usage. Dalarna University, Borlänge, Thesis
47. Edquist C, Edqvist O (1980) Sociala Bärare av Teknik: Brygga Mellan Teknisk Förändring och Samhällsstruktur. Zenit Häften, Kristianstad
48. Nielsen C, Fiedler F (2012) Evaluation of a micro PV-diesel hybrid system in Tanzania. In: 6th European Conference on PV-Hybrid and Mini-Grid Chambéry. Ostbayerisches Technologie-Transfer-Institut eV (OTTI), Regensburg, pp 86–93

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