ENERGY INNOVATION SYSTEMS IN DEVELOPING COUNTRIES – experiences with the implementation of PV in Kenya

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Abstract
This paper deals with the implementation of western-based renewable energy technologies within a developing country context. It describes theoretical frameworks that can be used to analyze and interpret this process. It also offers insights on good governance and civil society in developing countries and on cultural differences between western societies and societies in developing countries. Then, the paper describes research findings on the implementation of PV in Kenya. It shows that even the very early stages of an innovation system – network formation – is confronted with serious bottlenecks. These bottlenecks can at least partly be explained by the cultural background of Kenya’s society.

1. Introduction
Implementation of technologies developed in Western countries within the context of a developing country is not an easy matter. Successful implementation and long-lasting use requires a good match between the technology and the local context. Not only knowledge and technical or organizational skills are involved, but also attitudes, social interaction and values. In this contribution the authors report on some of their experiences in Africa in this regard with a special focus on Kenya, and they interpret these experiences within the framework of respectively (1) innovation systems, of (2) the debates on good governance and civil society and of (3) the cultural characteristics of the African context. They argue that although the complexities of the African context do not make it impossible to implement a western-based solar energy in Africa, they do require a special effort in order to make implementation successful. The authors will mention some of the conditions and prerequisites to take further steps.
2. Innovation systems

Innovations are not developed and implemented in isolation. They are developed and implemented within a socio-cultural context. In the literature, this innovation context is coined by different terms: sociotechnical system (see e.g. Geels, 2005), technological system (Carlsson and Jacobsson, 1997) or innovation system (see e.g. Edquist, 1997). Here, we choose to use the term ‘innovation system’. Innovation systems are commonly defined as: (Freeman, 1987):

“...systems of innovation are networks of institutions, public or private, whose activities and interactions initiate, import, modify, and diffuse new technologies”.

An innovation system consists of three building blocks (Malerba, 2005):

(i) technology and knowledge
(ii) networks of actors
(iii) institutions (defined as ‘rules of the game’)

Networks of actors develop and implement new knowledge and technology, within their institutional context. These actors can be subdivided into technology developers, technology users/owners, policy makers / government institutes, knowledge providers, NGOs etc. Knowledge consists of ‘hard’ technical knowledge but also ‘soft’ knowledge, e.g. on how to use the technology, or on which governmental agencies or NGOs to ask for subsidies. Institutions involve formal institutions like laws, government regulations and technical standards and norms; and informal institutions like common law, cultural aspects, tradition, norms, codes of conduct, practices, etc. (North, 1990).

For an innovation system to be successful in developing and diffusing technologies, these three building blocks need to be aligned (Malerba, 2005). Furthermore, these three building blocks co-evolve in time. Actors enter or exit networks, new technologies and knowledge are developed or discarded and also institutions can change over time. A successful innovation system requires a fit in this co-evolution (Malerba, 2005).

Different kinds of innovation systems can be distinguished: national innovation systems, which focus on all innovation in a particular country; sectoral innovation systems, which uses sectoral boundaries; and technological innovation systems, which focus on the development and implementation of a specific technology within a geographic setting. This paper will regard technological innovation systems. Within the literature, two different research strands are developing: one that investigates the co-evolution between innovation system building blocks (e.g. Malerba, 2005), and one that analyses so-called ‘Functions of Innovation
Systems’ (e.g. Hekkert et al., 2007; Bergek et al., 2008; Van Alphen et al., 2008). The first research line is a bit more abstract and analyzes (1) technology and knowledge, (2) actor networks, and (3) institutions and their dynamics and how they influence each other. The second research strand is more specific. It analyzes specific prerequisites for an innovation system that have to be fulfilled in order for technologies to be developed and implemented successfully within a certain geographic area. These prerequisites are called functions and were based upon literature research and case study research. What is a bit confusing is that three lists of functions have been proposed in the literature. The list of function used by Hekkert et al. (2007) is depicted in Table 1, the list of Bergek et al. is shown in Table 2 and the list of Van Alphen et al. can be found in Table 3. Below the tables, the differences between the lists will be explained.

Table 1: Innovation system functions used by Hekkert et al. (2007)

<table>
<thead>
<tr>
<th>Function</th>
<th>Description</th>
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<tr>
<td>1</td>
<td>entrepreneurial activities</td>
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<tr>
<td>2</td>
<td>knowledge development</td>
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<tr>
<td>3</td>
<td>knowledge diffusion</td>
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<td>4</td>
<td>guidance of the search</td>
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<tr>
<td>5</td>
<td>market formation</td>
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<tr>
<td>6</td>
<td>resource mobilization</td>
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<tr>
<td>7</td>
<td>counteracting resistance to change</td>
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The functions will be explained here in a very short way. For a longer explanation, we refer to the given references in the tables. The term ‘entrepreneurial activities’ is evident. According to Hekkert et al. (2007), this function plays a crucial role within an innovation system. Knowledge development has to do with R&D, learning by doing and learning by using. Knowledge diffusion concerns the transfer of knowledge between different (kinds) of actors, such as the transfer of user knowledge to technology developers. Guidance of the search refers to the way R&D is directed into a certain direction, e.g. by policy programs or by technological paradigms. Market formation is considered to be important already at an early stage, if necessary by way of subsidies. Resource mobilization refers to financial resources, but also to human resources and physical resources, such as the availability of silicium for the production of solar cells. Counteracting resistance to change has to do with opening up a space for the new technology within the incumbent technologies, e.g. finding a space for solar cells within the electricity market that is currently dominated by mainly coal and natural gas.
Table 2: innovation system functions used by Bergek et al. (2008)

Function 1 knowledge development and diffusion
Function 2 influence on the direction of search
Function 3 entrepreneurial experimentation
Function 4 market formation
Function 5 resource mobilization
Function 6 legitimacy
Function 7 development of positive externalities

Bergek et al. (2008) describe a slightly different function list. Their function 1 is a combination of Hekkert et al.’s functions 2 and 3. Furthermore, they write that knowledge development is the main function within an innovation system. Their function 6 is close to Hekkert et al.’s function 7 – creating legitimacy for the new technology, especially among the incumbent actors. Their function 7 is new. With ‘development of positive externalities’ they mean that within an innovation system part of the investment should become available for external actors too. This makes it easier for new entrants to enter the market and therefore helps the innovation system to expand further.

Table 3: innovation system functions used by Van Alphen et al. (2008)

Function 1 creating adaptive capacity
Function 2 knowledge diffusion through networks
Function 3 demand articulation
Function 4 creation of legitimacy
Function 5 resource mobilization
Function 6 market formation
Function 7 entrepreneurial activities

Van Alphen et al.’s least is derived from Hekkert et al.’s list – in fact, a number of the authors are the same for both publications. The difference is that Van Alphen et al.’s list is not developed for the development and implementation of new innovations in developed countries, but for the transfer of technologies from developed to developing countries – and applied, so far, only to the analyze the transfer of renewable energy technologies from western countries to the Maldives. Van Alphen’s et al.’s function 1 deals with the creation of human, organizational and institutional capacity within the developing country context to be able to implement the new technology. Function 3 has to do with creation of demand for the new western technology. Entrepreneurial activities in Function 7 refer to entrepreneurs related to repairing, maintaining and ultimately also producing the new technology.
What becomes clear immediately is that the authors use slightly different functions. Another difference between the authors is that they emphasize different functions. Whereas Hekkert et al. emphasize the central role for entrepreneurial activities, Bergek et al. lay more emphasis on knowledge diffusion and diffusion. The lists from Hekkert et al. and from Bergek et al. were primarily developed for the analysis of technological innovation systems in Western countries. Van Alphen’s list, on the other hand, focuses on technological innovation systems in developing countries and then primarily on the diffusion of western-based innovations within a developing country context.

From this overview of innovation system approaches we can conclude that two of these approaches are suitable for the analysis of technology specific innovation systems in developing countries: Van Alphen et al.’s list of functions and Malerba’s more general subdivision of innovation systems in the three building blocks. Before describing an example of application of these approaches, we will first describe some general characteristics of developing countries, related to good governance, civil society and cultural characteristics.

3. Good governance and civil society
Since the publication of the report of the World Bank in 1989 about the economic crisis of sub-Saharan Africa the concept of "good governance" entered the development debate. Logically, problems with good governance and a well functioning civil society have a tremendous effect on the implementation of new technologies within a developing country, since the presence of a supporting institutional context is indispensable for this.

African states often lack proper checks and balances on the democratic process. On the surface they sometimes may look democratic. But often, even if there are elections, there is no transparency on the public budget and there is no stable legal framework to rely upon (Collier, 2007). State officials in many countries serve their own interests and are not called into account. Individuals rely on personal networks and systems of patronage, which are essential for the maintenance of power and for the access to reliable state services. "The leadership assumes broad discretionary authority and loses its legitimacy, information is controlled, and voluntary associations are co-opted or disbanded. This environment cannot readily support a dynamic economy" (World Bank, 1989, cited in OSSREA, 2009, p.103). During the 1990s, the project of implementing good governance was meant as complementary to the Structural Adjustment Programs of the World Bank and was primarily targeted at increasing the effectiveness of the state. In the United Nations Development Program we find good governance defined as "the set of values, policies and institutions by which a society manages its economic, political and social affairs through interactions among
the government, civil society and private sector. It is the way a society makes and implement decisions - achieving mutual understanding, agreement and action. It comprises the mechanisms and processes for citizens and groups to articulate their interests, mediate their differences and exercise their legal rights and obligations. Its rules, institutions and practices set limits and provide incentives for individuals, organizations and firms" (UNDP/German Ministry of Economic Cooperation and Development, 2000, p.27). The World Bank report of 1989 more or less unleashed the debate on the proper functioning of a civil society, as a countervailing force against the state. International agencies tried to identify elements associated with effective government and Western polities and tried to transplant them so as to "strengthen the capacity of governments of developing nations..." (Shiva Kumar, 1998, p.7, cited in OSSREA, 2009, p.94). Core aspects of good governance are considered "legitimacy of the exercise of power, construction of solidarity, reciprocities, development of trust in state society relationships, and institutionalization of accountability" (Hyden, 1992, cited in OSSDREA, 2009, p.95). This list shows how the concept of good governance is linked up with a well functioning open civil society.

Development agencies have taken up this analysis in their approach by often making donations dependent on the contribution of NGOs and other self organizations to civil society. In the process this concept often became narrowly interpreted in the sense that organizations should challenge and oppose the state (Kasfir, 1998). Wiarda (2003) goes as far as to warn that the civil society approach after starting as a creative new approach may already have passed its peak, because it has been interpreted and applied narrowly and superficially. This calls for a deeper understanding of civil society.

It is Stackhouse (1984) and Rosenstock-Huessy (1993) who have come up with a deeper understanding of civil society. Stackhouse contributes by his definition of civil society as a free space of association independent from tribal loyalties and state authority. In European history, in a period of thousand years from the Middle Ages until present a set of different characteristics and values has been developed and articulated, which enable civil cooperation within this free space, i.e. free from the exclusive bonds of tribal collectivism and imperial power (Rosenstock-Huessy, 1993). In sociocultural analyses on cultural differences (e.g. (Hofstede, 1997) and (Trompenaars and Hampden-Turner, 1993)) between East and West, North and South such human qualities suddenly pop up as distinctive features of different cultures to be taken into account in intercultural communication.

4. Sociocultural values and bottlenecks
Both in (Hofstede, 1997) and in (Trompenaars and Hampden-Turner, 1993) a list of specific cultural characteristics is represented which create cooperation between individuals and groups apart from tribal loyalty and state authority and which are at the basis of a well-functioning civil society. Below, we describe the four main characteristics in their lists.

- **Universalism**: Trompenaars points out that universalism as distinct from particularism sticks to the rules instead of favoring some persons in particular. Everybody is treated equally. Universalism is connected to the principle of “rule of law” and to checks and balances in the political system, which prevents concentration of all powers in one person.

- **Neutral relationships** (in distinction to affective relationships): it means not only to stick by the rules, but also by the roles. Like and dislike and friend or foe should not play a role in civilized social intercourse.

- **Individualism**: Trompenaars and Hofstede distinguish individualism from collectivism but also put it over against hierarchical top-down relationships, or in Hofstede’s terms, power distance. Power distance does not allow for the equality which individualism requires, whereas collectivism does not allow for the independence. Western individualism became more and more marked by reciprocity, which means that my stand and the criticism of other people are in a constant process of mutual adjustment (Gauchet, 1985). If I express my opinion I already anticipate criticism and accept that without feelings of loss of face. In many African societies, for instance, status and loss of face play a much bigger role.

- **Sequential** dealing with time: Trompenaars puts this cultural characteristic against simultaneous or synchronic dealing with time. Important is the planning attitude. This cultural characteristic is linked to another cultural characteristics which Trompenaars mentions, i.e. voluntarism, and also to what Hofstede calls uncertainty avoidance. The central question is, whether I am the center of initiative and make the process of time *subject* to my actions or rather that I take things as they are and as they come. As such it is linked to individualism, but also with uncertainty avoidance, if we consider that the future is not something just to accept (such acceptance implies uncertainty), but it is something in which we have to intervene. To intervene means to plan. To intervene means, if necessary, to go against the group, and to intervene is what the individual does as an autonomous center of action. Instead of “sequential dealing with time”, we might as well introduce the cultural quality of “the power of intervention”. If people do not want to change out of traditionalism or because of security (or insecurity!) within the in group they are part of, they will not plan, not take decisions, not intervene and not say “from now
on...”. This is also important as a characteristic of civil society is that the uncertainty of time and again regrouping can only be accepted as a fact if there is trust in some future gain although that always remains uncertain. If such trust is not present, people will stick to their traditionalism, leave things as they are, not intervene, not plan.

Although this list is far from complete it shows, that such cultural differences as distinguished by Hofstede and Trompenaars do affect civil society and related to it any form of technology transfer and implementation.

5. Experiences in Kenya

In our section Technology Dynamics & Sustainable Development in the Technology, Policy and Management faculty of TU Delft, we have set up a programme of intercultural internships and Master thesis projects to developing countries. We have relationships with knowledge institutes and companies in a large number of countries such as Surinam, Kenya, Nigeria, Ethiopia, Indonesia, China and Bangladesh. Students go there and mostly work in projects that partly have to do with technical aspects and partly with implementation aspects and cultural aspects. Since two years, a number of students have applied the innovation system approach to the implementation of a specific renewable energy technology in a specific developing country context. Let us give an example from Kenya where the most extensive research has been done and where we have the largest network on solar energy.

One of our Master students conducted a study in Kenya on setting up a PV innovation system and cultural characteristics (Tack, 2010). He did an internship at Sunrays Solar, a medium-sized solar energy company in Kenya and conducted many deep interviews about the present situation of solar energy in Kenya for solar energy, the future prospects and especially the possibilities of creating a PV innovation system in Kenya. The student’s aim was to analyse the extent to which a PV innovation system was present in Kenya and develop ideas on how such an innovation system could be developed further. The frameworks he took with him were Van Alphen et al.’s list of seven functions and Malerba’s more general innovation system building blocks (actor networks, technology and knowledge, and a supporting institutional context). During his stay in Kenya, it quickly became clear that not even a the first stage of a PV innovation system was present. Actors acted individually and had not formed networks; PV technology was present, imported from the west, but not much related knowledge had been developed and no supporting institutional context found to be present. Therefore, he decided to concentrate only on the development ideas on how to stimulate the creation of networks, because already this first phase appeared to be difficult in Kenya. The reasons found were of a general lack of cooperation and because of a climate of
selective trust. Specific cultural characteristics, which have a long tradition, may explain the situation.

In the first place in Kenya there is a strong collectivist attitude, which means, that generally people are part of closed we groups. This can be the tribe or clan, or a patronage or clientele system, but also a company or a governmental organization or an NGO. There is competition, but no cooperation. The consequence of this attitude is that competing companies do not cooperate in efforts to enlarge the market, for instance by organizing an advertisement campaign together. In addition there is no cooperation within the sector to put in place regulations and agreements in order to maintain the quality of the products. Instead, the sectoral organization has set high fees for membership, thereby making it difficult for new companies to enter the market. The lack of regulation, on the other hand, makes it easy for "crook companies" to spoil the market, sell bad products, which lie idle after a while. This is again detrimental to the reputation of solar energy in general.

Secondly, in Kenya there is strong particularism, which means that generally not rules but relationships are important and in addition affective relationships, like and dislike, preclude neutral and role dependent behavior. People of high status, or of the same group, or simply people who know each other and trust each other, receive a preferential treatment. This also affects the regulatory body of the government, which has been called into being recently. It is important to have access to high status government officials to keep the company going, because it is easy for the bureaucracy to create obstacles for companies for instance by postponing their license etc. This means that some big players, who are well related to politicians, actually control the market. Customers too find their way to companies via personal relationships. They do not trust a company, but they trust a person. If this person shifts to another company, his customers may easily follow. There is no anonymous trust like one can expect in a situation where everybody plays by the rules and treats everybody on an equal footing.

Thirdly, status usually is derived from the position within a company or group, not by achievement or by labor. Usually, this also means that employees work on their status within the group and their relation with the boss more than concentrating on performance and on work. Not much attention is given to maintain good relations with the users.

In the fourth place, sequential dealing with time, i.e. planning and looking forward, is not strongly developed. From their side users too do not bother about a maintenance contract. Of course it costs money and future days will take care of future problems. Apart from lack of cooperation and of networking between users and companies, there is also lack of cooperation with knowledge institutes. There is strong traditionalism which means that
things remain as they are and as a consequence, even if there are problems, nobody takes
the initiative and everybody is inclined to remain waiting. People recognize that there would
be much benefit in having knowledge institutes like universities involved in the development
of solar energy, if asked. But they are inclined to wait for the other (any other) party to start.
Traditionalism and fatalism are closely connected. And collectivism prevents people to go
against the group and start something new. Creativity means loneliness. Initiative too. In this
regard also another cultural characteristic is involved, i.e. uncertainty avoidance. Generally,
people are inclined to avoid situations in which they do not know for certain how to deal with
it. One might do something wrong. Generally the cultural characteristics summarized here
and described by our Master students in his interviews belong to closed ingroup societies like
tribal and agrarian societies, not to open markets and to open civil society oriented ones.

This leads to a situation in which it is difficult to set up an innovation system around a
new technology, because the first step, network formation is slow. This in turn prevents other
functions such as knowledge development, mobilization of resources and a supporting
institutional context to be created. It has to be mentioned, however, that also in Kenya a
continuous struggle is going on to create a more open society, open cooperation and
anonymous trust. This struggle is going on both on the state level and on the level of society.

6. Conclusion: the way ahead
Kenya, like many other African societies, is in a difficult predicament. The complaints about
(lack of) good governance and (pervasive) corruption only offer a superficial explanation and
do not help much to move things forward. Actually, on a deeper level, two value systems
compete with each other and are at loggerheads. The old tribal value system does not work
anymore, but the modern civil society value system is not yet in place. This means in many
respects, that African nations get the worse of both systems. There is strong inner group
cohesion and collectivism on the one hand and anarchic autocratic individualism on the
other. Within the old tribal systems there were checks and balances on an all too autocratic
rulership of the chiefs. The groups were not too big, there was a council of elders which often
was very powerful and rebels could flee, tribes could split up and central control was weak in
view of a large territory. Actually the political and technological means of modernity provide
African rulers with the mentality of chiefs with the means for a more autocratic type of rules
and they ever had. This once again shows, that the old system in modern times does not
work well anymore. But on the other hand a new set of values is not yet in place and has not
yet become part of the general mindset.
This difficult situation leads to difficulties for successful implementation of renewable energy technologies too – successful in the sense of longer term management, maintenance etcetera. Our example of PV in Kenya shows that in that case network formation appeared to be difficult, as was the creation of stable supporting institutions and of learning processes between the different actors involved. A further transition towards a more open society, open cooperation and anonymous trust is a necessary prerequisite for that.

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