An impact assessment methodology for small scale renewable energy projects in developing countries funded under Dutch policies defined to contribute to the Millennium Development Goals

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KEYWORDS: ***baseline study, impact assessment, rural energy projects, strategic niche management***

ABSTRACT:

Vulnerable groups, such as poor people in developing countries, are often hit hard by the effects of climate change since they lack the resources needed to cope or adapt to the changing environment. To conduct poverty reduction without compromising on the environment, the Dutch government defined a variety of policy measures. One is the so-called Daey Ouwens Fund, established to implement small scale renewable energy projects in the poorest countries of the world. This Fund aims to contribute to Millennium Developing Goal 1, eradication of extreme poverty, and MDG 7, ensuring environmental sustainability.

This paper describes the methodology developed to get a better understanding of the socio-economic and environmental impact of projects to be implemented under the Daey Ouwens Fund. This methodology uses the multi level "Strategic Niche Management (SNM)" framework to systematically assess drivers and barriers crucial in process of innovation. For three selected projects, indicators are defined within this SNM framework, based on the MGD 1 and MGD 7 and the local socio-economic situation as well as the existing energy system and the innovative renewable energy technology of the project. These indicators are translated into sets of questions to be quantified through a limited number of semi-structured interviews with key persons and questionnaire inquiries of a large number of potential end-users.

The data of the conducted baseline study will be presented in this paper to provide an overall picture of the current socio-economic situation and the energy consumption in the areas were the three selected project are going to be implemented. Based on these data and the SNM framework, an overview will be provided of drivers and barriers for the projects and the expected contribution to MDG 1 and 7. The methodology will be assessed and adapted for the impact monitoring assessment that will be held in 2013.

INTRODUCTION:

This paper is based on the joint research project by AgentschapNL and the School of Innovation Sciences of the Eindhoven University of Technology (TU/e), that aims to assess the socio-economic and environmental impact of small scale energy projects subsidized by the Daey Ouwens Fund (see also: www.daeyouwensfonds.nl). The Daey Ouwens Fund grants subsidies to project that provide more people in Least Developed Countries (LDCs) with access to energy through small-scale renewable energy project aiming at income generation.

This paper discusses the impact assessment methodology developed and the outcomes of the baseline study that is conducted in 2009 -2010. Three energy projects are selected for the assessment, these are a solar entrepreneur project in Madagaskar and two Jatropha projects, one in Madagaskar and one in Tanzania. These project were granted a subsidy by the Daey Ouwens Fund and were starting up at the time of the baseline study. In a follow-up research, planned for 2013, researchers will go back to the field to conduct the final assessment of the socio-economic and environmental situation in the regions of the selected projects and will draw conclusions on the role of the energy projects in local development.

STRATEGIC NICHE MANAGEMENT METHODOLOGY:

The selected projects are introducing a renewable energy technology and induce a transition from traditional fuels towards renewable in this case, pv-solar and Jatropha biofuel. To systematically assess the drivers and barriers crucial for the innovation process, the multi level "Strategic Niche Management (SNM)" framework is being applied. SNM is an analytical method that studies the introduction, development and diffusion of totally new sustainable technologies through societal experiments (Caniëls and Romijn, 2006). These experiments, have to take place in a protected environment that enhances the chances of the new technology to prosper before it has to face the challenges of competition with other technologies.

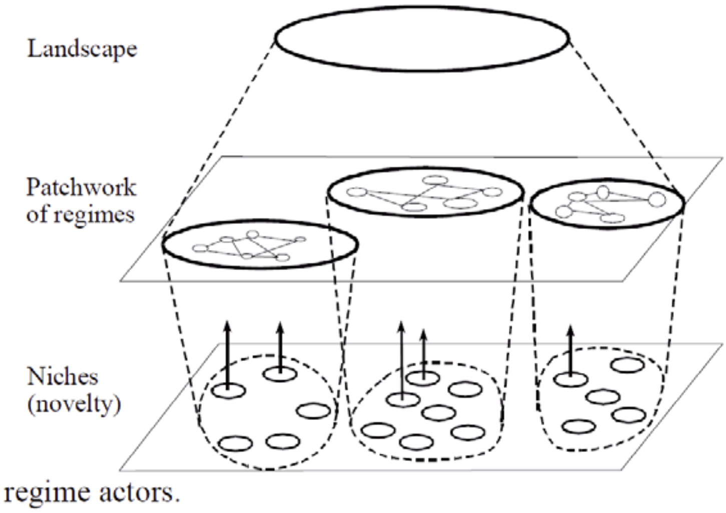

Figure 1: Multi-Level Perspective (Geels, 2000)

SNM utilizes a multi-level framework (see Figure 1). The three included levels are the socio-technological landscape at the macro-level, the technological regimes at the meso-level and the technological niches at the micro-level. Factors in all of these three levels are determinant for the success of a new technology. A new technology, after having become a successful niche, can find itself enhanced or threatened by changes at the landscape- and regime level. This paper focuses at the technological experiments, the renewable energy projects, in the niche. In the SNM framework the renewable energy projects are seen as transition experiments in niches, which play a vital role in the transitions to more sustainable patterns of development. SNM urges the necessity of niche creation in order to stimulate innovative technologies. When the performance of the technology improves, protection can gradually be reduced and niche technologies can enter the mainstream markets. Three internal processes are determinant for the success of a niche are (1) *articulation and stabilization of expectations and visions* (matching of promises of the innovation and the stakeholders needs), (2) *building of a cooperating actor network*, and (3*) experimentation based learning processes* (about the technological and environmental possibilities and constraints of the innovation) (Caniëls, Romijn, 2006, Geels 2004). These three processes are inter-dependent, each of the three processes is essential for successful niche creation. According to Kemp "experimentations are a way to stimulate articulation processes that are necessary for the new technology to become socially embedded." (Kemp et.al, 1998). For a successful niche creation the participating actors should share a common core view about the technology, its applications and the way of managing its introduction. (Caniëls, Romijn, 2006). If one project is successful it gains external attention and increases expectations. Other projects are, then, more likely to be introduced, what makes the social network grow. In that way the technology is being tested in different environments and scales, lessons learned by the trial and error technique enhance the technology, what makes the expectations grow again.

Therefore, we chose the three internal niche processes; expectations, social network formation, and experimental learning are used to structure the data collection. In the baseline study expectations do play an important role. Network formation and learning are in a first phase and therefore the baseline study is merely maps the early developments and opportunities for network formation an learning in the context of the renewable energy projects to be implemented. These niche dynamics are essential for niche creation and as such indicators for the successful implementation of the projects. However, to assess the impact of the project on the local population and environment, we need to quantify the current status and the status after a few years project implementation. Therefore, the baseline study also aims to quantify the social economic status of the local population and the state of the environment in the target areas at the start-up phase of the projects. How this is being assessed is explained in the next paragraph.

ASSESSING THE SOCIO-ECONOMIC AND ENVIRONMENTAL IMPACT OF ENERGY PROJECTS:

The plausible claim of all small scale renewable energy projects is that access to energy created will greatly improve the quality of life of the local population. Lighting alone creates benefits such as increased study time, extended hours for small businesses, and greater security (World Bank 2003, Foster 2000). Also for the projects in our impact assessment expectations on improvement of quality of life are high, for instance; health can be improved by introducing cleaner energy, income generating activities are in the form of jobs and stimulation of entrepreneurship can lead to poverty reduction, savings can be made through the introduction of more efficient energy sources, and the daily productivity can be increased by extending working hours beyond daylight time and by lowering the time spend on collection of traditional fuels such as firewood. Indirectly, spinoffs such as for instance increased knowledge may enhance local development as well.

This research we aim to quantify the impact of the projects to see whether these claims are realized and to what extent the project contributed to poverty reduction and sustaining the environment. But how to quantify the impact of the renewable energy projects?

We chose to take the Millennium Development Goals (MDG) as point of departure, since these are meant to provide a compass and yardstick for development and to place poverty reduction on the international development agenda (Watkins 2008). And therefore widely used in policymaking, although, of course there is an ongoing discussion on the choice of indicators and the targets set (Saith 2007, Sumner and Tiwari 2009.) The MDGs merely represent the agenda of the Human Development (HD) initiative of the UNDP, expanded to embrace also the one-dollar-a-day poverty line, the key income poverty monitoring measure used by the World Bank. There is no MDG).

None of the MDG's directly addresses the impact of access to energy to development. As such, the main focus in our research is on MDG 1 Eradication of Extreme Poverty and MDG 7 Environmental Sustainability and on additional indicators on the access to energy. Note that we chose not to assess the MDG's literally, but to capture the meaning of poverty more broadly defined in terms of the inability to meet basic needs and that we mainly look at the environmental impacts related to energy use. Indicators for access to energy cover availability of sources, different uses, affordability and reliability. Tables 1, 2 and 3 list the indicators we selected and used to set-up the questionnaires used in the surveys and semi-structured interviews for the base line study (Tables copied form Heijnen (2010)).

Table 1 Access to energy indicators

Indicator	Description	Data collection
1. Coverability	Energy sources available to beneficiaries	Interviews, observations
2. Usage	Energy sources used by beneficiaries for different purposes (light, cooking, agriculture, business)	Household survey, observations
3. Problems usage	Perceived problems of different energy sources	Household survey, interviews
4. Fuel cost	Money spend on energy sources	Household survey
5. Capital cost	Prices of equipment (e.g. stove, lamp)	Interviews
5. Reliability	Availability energy sources	Household survey, Interviews

Table 2: Indicator related to poverty defined as the inability to satisfy basic needs (MDG 1)

Indicator	Description	Data collection
1. Income	Level of income	Household survey
2. Consumption	Food consumption, period of hunger, composition daily meals	Household survey
3. Wealth index	Proxy for household welfare based on several socio-economic variables	Household survey
4. Entrepreneurship / HBE	Portion of people that are entrepreneur / have a Home Based Enterprise	Household survey
5. Employment ratio	Portion of people employed	Household survey

Table 3: Indicators related to sustaining the natural environment (MDG 7)

Indicator	Description	Data collection
1. Source of water	Source of water for drinking, other purposes and livestock	Household survey
2. Sanitation	The type of sanitation used	Household survey
3. Size of agricultural land	The size of cultivated land by the household	Household survey
4. Battery use	The use of rechargeable and non-rechargeable batteries	Household survey
4. Deforestation	Problems and policies related to deforestation	Interviews
5. Erosion	Problems and policies related to erosion	Interviews
6. Biodiversity	Presence of threatened species	Interviews

RESULTS OF THE BASELINE STUDY FOR PROJECTS IN MADEGASKAR AND TANZANIA:

Data collection for the baseline study is done in 3 separate field trips of 6 weeks each and consisted of surveys for database creation supplemented by information collected in semi-structured interviews of key-persons and focus groups, observation and studying of project documentation (for details see text box on the 3 projects at the end of this paper, see also Dijk 2010, and Heijnen 2010).

In the different field studies similar questionnaires were used, adapted to the project and local conditions. The household surveys included around 95 questions categorized as follows: Household Characteristics (8), Agriculture and Livestock (18), Housing (13), Food (9), Income (11), Healthcare and Education (7), Energy (19), and Project specifics (10).

Data collection and analysis provided a broad overview of the general living conditions of the population in the target area's, information on energy related environmental impacts, as well as insight in the expectations on the projects and the early stage of network formation and experimental learning.

Looking at MDG 1, the possibility to contribute to poverty reduction is twofold, through the creation of new jobs and additional income and through offering a cheaper sources of energy.

For the solar entrepreneurship project, based on the interview with village entrepreneurs, it is concluded that the project did so far not directly created a new job for these people. All of the village entrepreneurs, so far, already had other sources of income. Also should be taken into account that the village entrepreneurs were highly educated and had a financially stable situation. It seems that the possibility of starting a new business is mainly achievable for a wealthier part of the population. This is supported by one of the main obstacle of the project, the starting amount which is needed to start up a business. It is highly likely to expect that it will be very difficult for unemployed or poor people to start up a business. This financial threshold creates a situation in which only wealthier people are able to start up a business. In this way the village entrepreneur project does not contribute to reduce extreme poverty, since it does not seem to create new jobs for the poorest. Nevertheless it needs to be said that the village entrepreneurs used for this analysis may not turn out to be the typical type of village entrepreneur. This is hard to tell since the analysis is done in the initial phase of the project. Furthermore the possibility of getting a loan would help lower the threshold, and makes it possible for more people to start a business. Another point which needs to be made is that the village entrepreneur business could indirectly provide for new jobs. For instance, two new jobs were created for the boys that bring around the lamps. Interesting would be to see if this will happen more often in the future.

For the Jatropha projects In the Jatropha projects job creation on plantations as well as additional income for households through outgrower schemes is a project target as well.

Than secondly, all 3 projects offer access to a cheaper source of energy. In the case of the Solar Entrepreneur project on Madagaskar, a cheaper source of lighting is offered to the poor. Our baseline analysis shows that the lamps are rented out against the same price of a candle. Therefore, this does unfortunately not decrease the costs for lighting for a household, and thus it cannot contribute to reduction of extreme poverty in that manner.

For the Jatropha projects it is too early to quantify the opportunities for cost reduction. However, both projects do target to provide Pure Plant Oil (PPO) as an affordable substitute for diesel, which may offer an opportunity for households to save money on fuel, especially, when PPO can be used for cooking and lighting. However, if used as transport fuel impact on reduction of extreme poverty is expected to be considerably lower.

Whether the projects contribute to MDG 7 "Environmental sustainability" is a complex question.

A more simple question in place is, whether the solar entrepreneur project enables to replace applications which use non-renewable sources of energy (such as kerosene) with pv-solar. The data shows that 65% of all the households renting a pv-charged LED-lamp claim that this lamp can replace the use of a candle and 52 % of all the households say it can replace the use of a kerosene lamp. Nevertheless there is no significant difference between customers and non-customers in the use of candles or the use of kerosene. Therefore currently the data does not show that the solar-energy powered lamps are indeed replacing candles or kerosene lamps. But it must be said that there is a trend noticeable which shows that customers are using less candles (50% vs. 52%) and less kerosene (52% vs. 62%). Since the project has just started it would be interesting to see how this will progress. As for the replacement of other applications, the numbers are low. Only 8% uses the cell phone charger, 2% uses the rechargeable batteries. Clearly with a low level of usage, it is evident that other solar powered applications offered through the village entrepreneur project are not yet able to replace other energy sourced applications. This also shows that there is enough room for growth for the business of the village entrepreneur, enough new solar-powered applications to offer and to promote.

For the Jatropha projects the simple questions is what amount of fossil energy do the projects aim to replace? Please note that assessing the total environmental impacts of Jatropha biofuel production is still under discussion as data and knowledge are still lacking. Based on the available literature, crucial impacts seem to be: the initial carbon debt created through land use change, the use of artificial fertilizers and polluting transport kilometers by heavy duty trucks locally or long distance transport over sea (Balkema 2010).

Overall conclusions that can be generalized for all 3 projects is that there is enough room for improvement of quality of life through access to energy in the project target areas as local populations do live in extreme poverty and income generation (Brew-Hammond 2010) and access to more affordable energy sources are local priorities.

CONCLUSION AND DISCUSSION:

The methodology based on insights of the Strategic Niche Management (SNM) Framework combined with the selection of indicators based on the Millennium Development Goals (MDG) 1 "Eradition of extreme poverty" and MDG7 "Sustaining the natural environment" and additional indicators on access to energy is successfully tested in the baseline study. A general overview of the present socio-economic status of the population is given and in addition project related threats to and improvements for the local environment are identified. Furthermore insight into the project expectations, social networking and experimental learning processes is provided. However, choices for example projects and in sampling will only be proven right if the projects are successful implemented as planned and may be disturbed by unpredicted changes in the regime and landscape such as the introduction of new economic activities in the region that are competing for the same resources, an enduring economic crisis, radical political changes, changing perceptions on biofuels, periods of extreme drought, etc.

In previous assessments with SNM in developing countries (Verbong et al 2010) it was concluded that, although a certain regime instability is required to open opportunities for successful niches to become part of the regime in the longer term, the highly unstable regimes as often found in developing countries increase uncertainty for investors to such extend that it becomes a limiting factor in niche development. Whether this occurs in the selected target regions for projects has to be studied more thoroughly. But what we found in addition in the baseline study is that a population living in extreme poverty does not express expectations, the focus is on providing basic needs on the short term rather than realize long term expectations. This may prove to be a limiting factor in niche development as well. Underlining the importance of niche protection as partly offered by the Daey Ouwens Fund subsidy as well as the focus of the projects on income generating activities.

FOLLOW-UP RESEARCH:

The final step in the impact assessment is planned for 2013, after a few years of project implementation researches will go back to the field to hold similar surveys and semi-structured interviews in the project target areas. Comparison with the results of the baseline, taking in account changes in the regime and landscape, should provide insight into the impact of the small scale renewable energy project on the socio-economic status of the local population and the project related environmental impacts.

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Project 1: Energizing Entrepreneurs on Madagaskar (Dijk van S 2010)

Project Aim: 1052 village entrepreneurs earning a steady income based on renting out solar charged batteries or LED-lights or offering services such as solar-charging of mobile phones.

On the photo solar panels that are charging LED-lights that can be rented for one evening to replace candles (Photo by Simone van Dijk 2009).

Data collection for baseline study consisted of interviewing 3 active solar entrepreneurs in 3 different communities, a survey among all of their costumers (150 in total) and a control group of the same size (150 people in same area non-costumers), observation and interview with village entrepreneurs, key persons in the project and energy sector locally.

Some Key Results of the Baseline:

Sufficient income for basic needs?	All households	Customers	Non-customers
Not enough	31,9%	31,5%	32,3%
Just sufficient	29,6%	27,6%	31,5%
Sufficient	38,5%	40,9%	36,2%

Table 10: Sufficiency of income for basic needs

How many meals per day?	All households	Customers	Non-customers
1 meal	1,6%	0,0%	3,1%
2 meals	24,0%	20,3%	27,7%
3 meals	74,4%	79,7%	69,2%

Table13: Number of meals per day

Use of source of energy	All households	Customers	Non-customers
Wood(collected)	6,2%	6,2%	6,2%
Wood (bought)	**47,1%**	**55,8%**	**38,5%**
Charcoal	**81,9%**	**80,6%**	**83,1%**
Dung	8,9%	8,5%	9,2%
Candles	**51,4%**	**50,4%**	**52,3%**
Batteries	**59,5%**	**63,6%**	**55,4%**
Kerosene	**57,1%**	**51,9%**	**62,3%**
Gas	3,9%	6,2%	1,5%
Electricity	18,9%	19,4%	18,5%

Table 20: Use of sources of energy

Project 2: Jatropha Biofuel cultivation on Madagaskar (Fieldwork by Heijnen 2010)

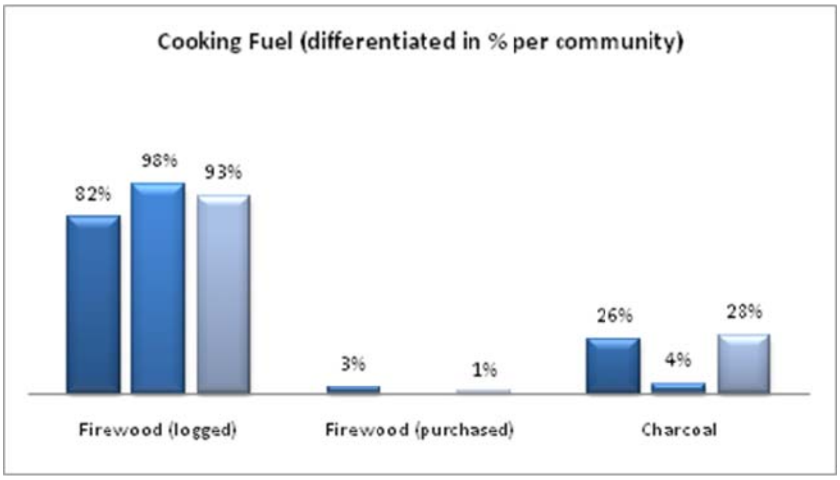
Project Aim: the cultivation of biofuel Jatropha biofuel on large scale plantations and through an outgrower scheme with local smallholders that cultivate Jatropha on their own land.

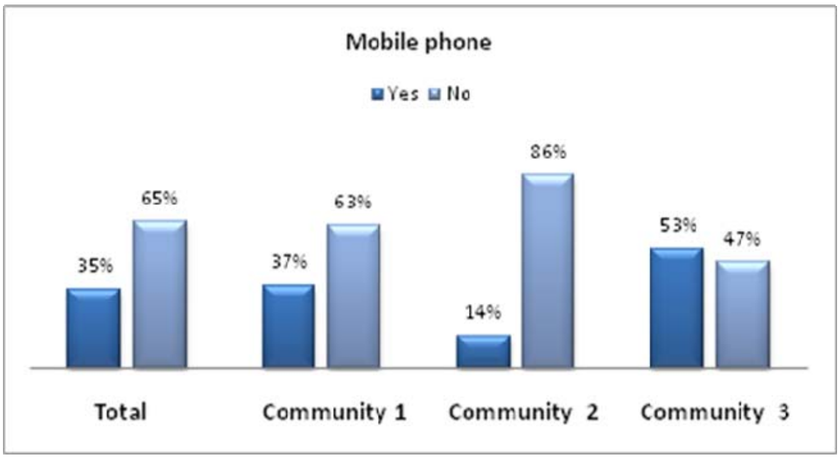
Data collection for baseline study consisted of full sampling of the intervention areas including 472 household surveys in three communities and 17 interviews with key persons and with 1 focus group.

Some Key Results of the Baseline:

Periods of hunger per year per region

	Few Months	Few weeks	Few days	No hunger
Community 1	60 %	18 %	13 %	9 %
Community 2	79 %	1 %	4 %	16 %
Community 3	56 %	14 %	13 %	17 %





Project 3: Jatropha Biofuel cultivation in Tanzania(Fieldwork by Heijnen 2010)
Project Aim: production of Pure Plant Oil (PPO) and biogas from Jatropha cultivated on 2 large scale plantations and on small scale by local outgrowers.
Data collection for baseline study consisted of In the intervention areas a total of 510 surveys is collected. Subdivided in the three target areas, 166 surveys are filed out in 3 communities, in addition 31 interviews with key persons.
Some Key Results of the Baseline:

Regional prices in Tanzanian Shillings for selected products:

	During drought	Today	Normal
Goat	18.000	25.000	30.000
Cattle	100.000	180.000 - 200.000	170.000 – 180.000
Big bull	150.000	300.000	400.000
Maize (20 kg)	11.000	7.000 – 10.000	5.000
Banana	100	100	50
Avocado	250	250	100

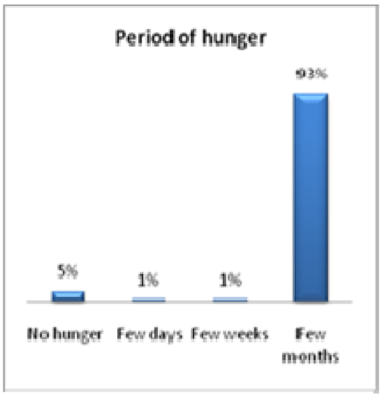


Figure 51: Period of hunger

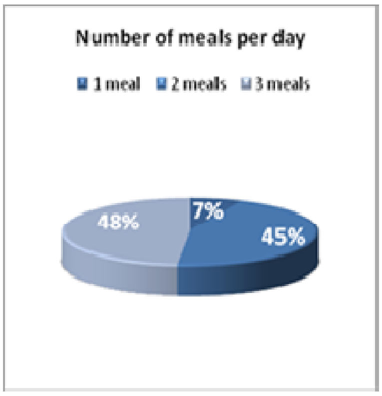


Figure 52: Number of meals per day

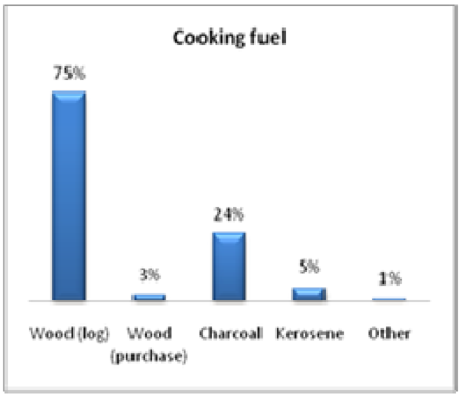


Figure 61: Cooking fuel

Figure 71: Expenses firewood