Manuals and Tools for Promoting SPIS

Workshop “Promotion of Solar-Powered Irrigation Systems (SPIS)”

Multicountry

Minutes of the Workshop
Eschborn, 31.03.2015

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Workshop	Promotion of Solar-Powered Irrigation Systems (SPIS)
Date	31.03.2015
Time	9:00 - 16.45
Location	ED11086, GIZ in Eschborn, Germany
Facilitator	Ziemann Britta
Participants	Manuela Günther (GIZ- 4530), Patricia Mejias (FAO), Mischa Bechberger (GIZ- 3300), Bastian Lange (GIZ- 4420), Marian Breitenbücher (GIZ- 4520), Dishna Schwarz (GIZ- 4420), Waltina Scheumann (DIE), Richard Colback (IFC), Annette von Lossau (GIZ-4520), Dorothea Otremba (GIZ- 4420), Jan Sass (GFA), Christine Fröhlich (GFA), Andreas Hahn (ah Advice International), Britta Ziemann (GFA), Caspar Priesemann (GIZ- 4420), Charlie Moosmann (GIZ- 4530), Tina Eisele (GIZ- 4410), Corinna Zimmermann (EnDev Benin via Lync), Samuel Adoboe (EnDev Ghana via Lync), Lucius Mayer-Tasch (GIZ Cape Verde via Lync), Hari Natarajan, Nilanjan Ghose, Christian Liedtke (all GIZ India via Lync)

Agenda

Time	Topic	Speaker
9.00 - 9.15	Welcome address	C. Moosmann (GIZ)
9.15 - 9.30	Introduction of participants, agenda and methodology of the workshop	Moderator
9.30 - 10.00	SPIS-study - conceptual approach, overview of case studies	J. Sass (GFA)
10.00 - 10.30	Technical characteristics and design of SPIS	A. Hahn (ah Advice International)
10.30 - 11.00	Coffee break	
11.00 - 12.00	Poster presentations	J. Sass (GFA), A. Hahn (ah Advice International)
12.00 - 13.30	Management requirements	J. Sass (GFA)
12.30 - 13.30	Lunch break	
13.30 – 14.00	Ecological impacts and sustainability	A. Hahn (ah Advice International)
14.00 – 14.30	Financial viability	J. Sass (GFA)
14.30 – 15.00	Potential and barriers for SPIS distribution	A. Hahn (ah Advice International)
15.00 – 15.30	Coffee break (including first feedback collection)	
15.30 – 16.00	Planning manuals and tools	C. Fröhlich (GFA)
16.00 – 16.30	Discussion and next steps	Moderator
16.30 – 16.45	Closing	C. Moosmann (GIZ)

1 Welcome address

The workshop on Solar Powered Irrigation Systems (SPIS) was opened by Charlie Moosmann, consultant at GIZ Project Powering Agriculture - Sustainable Energy for Food. This GIZ project is part of a global initiative, called Powering Agriculture – an Energy Grand Challenge for Development (PAEGC) that commissioned the SPIS study and manual.

PAEGC is a collective effort of the US Agency for International Development (USAID), the Swedish International Development Cooperation Agency (SIDA), the US energy company Duke Energy, the US government agency Overseas Private Investment Corporation (OPIC) and GIZ on behalf of the German Federal Ministry of Economic Development and Cooperation (BMZ). PAEGC aims at supporting the development and dissemination of marketable initiatives for clean energy technologies in agriculture, such as Solar Powered Irrigation Systems.

Although SPIS have been analysed before in the past (incl. by GIZ), this was mostly done from a technological or energy-supply based angle. With the prices of solar panels becoming increasingly affordable and diesel subsidies on the decline, this gave rise to analyse SPIS anew, with an integral approach.

2 Objectives and methodology of the workshop

The main objective of the workshop was to present and discuss the Stocktaking and Analysis Report as the first output component developed by the consultants with a view to gather detailed feedback from experts and fieldworkers before the finalization of the report. Furthermore it was intended to present and discuss the concept and approach for the SPIS manual that is being developed subsequently in the second stage of the project as outlined in the terms of reference. Finally, ideas and inputs to inform the development of the dissemination concept for both the report and manual were to be discussed.

In terms of expectations from the participants, the main interest was around learning about the various SPIS projects and field examples that were visited, with particular regard to technical developments, socio-economic and entrepreneurial challenges vs. environmental aspects and the lessons learned that can be extracted. Participants were also keen to share on experiences from various countries. Reference was also made to the energy, water, food security nexus as well as the role of farmers as entrepreneur vs. environmental and conservationist concerns.

The workshop was guided by a number of input presentations by the team of consultants which were then subsequently discussed and commented by the participants. Eight case studies from the four countries visited were visualized on posters and discussed in small groups.

3 SPIS study – conceptual approach & overview case studies

The importance of SPIS is increasing worldwide. Yet, despite being increasingly affordable, the take-up of SPIS has remained low due to lack of awareness, limited access to SPIS service providers, and limited financing opportunities. Therefore the manual and tools promoting SPIS addresses the needs of development practitioners, extension staff/advisors and key staff of financing institutions and helps overcoming some of those barriers by providing information, comparison of different systems, identification of planning and management requirements, case studies, good practices and lessons learned.

This will be done by means of a dual approach:

- Firstly: The provision of an initial stocktaking and analysis report for development professionals;
- Secondly: The development of a manual on promoting, financing and advising on SPIS.

Discussion

In the subsequent discussion, the target group for the manual was further clarified as ‘extension staff in direct contact with farmers as well as loan and finance institutions’. The manual is to help them convey the full potential of SPIS, its investment opportunities as well as its risks. Furthermore, it was stated that apart from providing technical know-how, the manual is to increase the know-how on entrepreneurial decision-making related to SPIS. However, the manual on SPIS is still in process and the final scope is not yet defined. Lastly, some challenges in Morocco were exemplified: As the country heavily subsidizes SPIS, they are now widely available for commercial farmers. Yet, financing options for smallholder farmers remain scarce and people are hesitant to install collectively managed Solar Irrigation Systems. Overall, this example emphasized that there is also an important discussion to be held around the role that development cooperation currently plays and in future could/should play in the sector (advantages and disadvantages of subsidizing SPIS).

4 Technical characteristics and design

Some basics concerning the fluctuating nature of solar radiation and the consequential technical characteristics and design of SPIS were presented. To this end, it was pointed out that in order to increase solar energy yield and reduce maintenance requirements, panels should be tilted with an angle of at least 15°. Tracking solar panels have higher absorption rates than fixed solar panels, but are at risk of technical faults. Whether a water storage tank or direct injection should be employed is among others a question of cost. The size of the photovoltaic (PV) generator is mainly determined by the water and pressure requirements of the irrigation scheme, while drip irrigation is very well suited for PV pumps thanks to economic use of water and relatively low operating pressure. Furthermore, the importance of a monitoring system was explained. As SPIS configurations are always dependent on site-specific conditions, there is a need for complex sizing and planning based on local characteristics. For a proper design, on which the success of SPIS rests, a complex set of data and information is therefore required. A three-step design approach was recommended.

Discussion

During the following discussion questions with regard to technical details were raised:

- The size of the pumping head is technically unlimited with current setups ranging from a depth of 0 to 400 meters. Most systems are normally installed at water depths between 30 - 60 meters. However, the size is ultimately dependent on economic viability as a bigger pumping head requires more PV panels (making the system less economic in comparison to Diesel generators).
- Is it possible to install a monitoring system for the produced electricity? However the most decisive factor is that sufficient pressure is provided for the water supply system.
- With regard to irregular radiation, PV Pumps adapt to lower energy supply. In case of stark variations, a water reservoir can ease the management of SPIS.
- While it is likely that water consumption will increase due to lower incurred pumping costs, one should not disregard the fact that PV pumps do not allow for night-time pumping, al-

lowing the groundwater table to recover. Nevertheless, some farmers may use traditional pumps during nighttime, and thereby drastically increase overall water extraction rates, which will in turn affect the groundwater supply.

- Since farmers are also businessmen and have to act with profit-orientation in mind, they are likely to extract the maximum amount from the same well, which leads to the risk of groundwater depletion. This reveals the importance of a strengthened socio-economic framework (i.e. enforcement of water legislation) in order to enable a sustainable development of SPIS.
- This is linked to the issue of subsidies, as they alter the economic equilibrium and can lead to an oversizing of pumps and consequently water depletion. The question around the role of development cooperation in this session and was further discussed in subsequent sessions as well.

5 Poster presentation of selected SPIS

The session featured a presentation of eight selected case studies from the four countries visited in preparation of the Stocktaking and Analysis Report (Chile, India, Morocco, and Kenya). Information on selected SPIS locations was displayed on posters and workshop participants were given a ‘tour’ of the case studies on display.

Poster Presentation

The session featured a total of eight case studies, including two SPIS from each country visited during the preparation of the report. The selection illustrated the varied spectrum of cases considered during the analysis, with areas under irrigation ranging from as little as 1ha (India) to 37ha (Morocco) and widely differing irrigation systems in use:

- Installed PV capacities ranged from 1.0 kW (Chile) to 42.2 kW (Morocco), with significant variations in quality both in terms of the technology used an on-site installation.
- While irrigation water was commonly sourced from wells utilizing submersible pumps, a river floating surface water pump was used in one case from Kenya.
- Types of irrigation applied comprised of surface irrigation (Kenya), sprinkler irrigation (India) and drip irrigation (most cases, especially Chile and Morocco), or combinations of the latter two (India). One of the cases from Kenya used an SPIS for hydroponics.
- Total costs of SPIS presented ranged from around EUR 6,500 (no water storage and excluding irrigation system), to over EUR 300,000. The degree to which costs were covered through subsidies varied widely, from highly subsidized systems in Chile (subsidy levels at over 90% of total system costs) and India (around 70%), to fully privately funded investments (Morocco, one case in Kenya). At one occasion, 100% of total costs were covered by the implementing development agency.
- In all but one case, SPIS were installed to replace diesel or grid-electricity based irrigation (brownfield sites). The one Greenfield site included is situated in northern Kenya.
- Among the presented sites, a majority of irrigation systems was managed on an individual farm level, whereas irrigation was managed cooperatively among smallholder farmers in two cases from India and Kenya.

Common issues arising with regards to SPIS installed included inadequate sizing (over- or under-sizing). This was largely due a tendency of agricultural extension staff or government programs to apply standardized solutions, insufficiently adapted to site-specific conditions. A lack of system integration, i.e. a mismatch between SPIS components, furthermore represented a common deficiency.

Investment into SPIS was found to be profitable in all cases presented. While subsidization was deemed necessary in many cases, exceedingly high levels of financial support (e.g. in

Chile) were criticized for their distortive influence on market development for SPIS technologies.

Discussion

In subsequent discussions, workshop participants highlighted the versatility of framework conditions and site specific factors as a key challenge towards replicability / scalability of SPIS deployment. A question was raised as to whether there could be 1-2 examples of broadly applicable SPIS rather than some of the rather specific approaches that were shown in the case studies. A clearer differentiation between brownfield and greenfield site application of SPIS and their corresponding challenges, as well as a focus on brownfield sites were proposed to enhance comparability and support the process of defining a range of adequate solutions. Questions were also raised with regards to the absence of effective environmental governance in target countries, as well as consideration of manifold socio-economic implications that can be associated with SPIS deployment (e.g. in terms of land-use or employment) and how they can and should be addressed within development cooperation. It was proposed that the SDGs might provide a useful point of reference and an opportunity to integrate the sustainability challenges effectively in the future.

6 Management requirements of SPIS

The presentation provided an overview on the implications of introducing SPIS farm level management decisions, differentiating between a strategic (5-20 years), tactical (up to one year) and operational (above one day) management level. While the introduction of SPIS has implications on all of these levels, requirements for the dimensioning and design of a PV irrigation system as well as comparably high initial investment requirements make strategic management necessary.

In terms of stakeholders involved, SPIS management differs from the status quo with conventional irrigation systems. Neither solar pumping equipment, nor the necessary specialist knowledge can be provided through the established channels, via agricultural advisors and agricultural distributors. By requiring specialist input from additional stakeholders, fragmentation of tasks and lack of integrated management poses a threat to effective SPIS deployment and usage. Farm managers were found to be unable to facilitate integrated planning, due to a general lack of informed advice and relevant knowledge on strategic and tactical management aspects of SPIS.

Discussion

Discussions focused on the question of where to institutionalize trainings in partner countries, to effectively overcome the established knowledge and capacity gaps. Insights gained by the authors during site visits suggest that channeling training provision for farmers through system integrators is unlikely to provide for an adequate solution due to their limited presence on site. Hence, it was suggested that an increased emphasis on the involvement of research and academic institutions in disseminating knowledge to farmers might be beneficial for SPIS promotion approaches.

7 Ecological impacts and sustainability of SPIS

With regard to environmental impacts, it was shown that SPIS can be an efficient tool in fighting climate change by replacing conventional fossil fuel based irrigation systems.

- PV systems have a lower carbon footprint: an off-grid solar system, replacing a typical diesel generator unit, will save about 1 kg of CO2 per kWh of output.
- SPIS have low emissions during operation but produce some emission during the production. While the energy payback time of PV systems was unviable in the past, it now varies between 0.7 and 2.0 years only.
- PV pumps may lessen the risk of groundwater depletion given that they are adjusted to the well's capacity, allowing the water level to recover during the night.
- Recycling of up 95 % of PV panels is possible.

Furthermore, there are many problems related to using a conventional diesel generator:

- Groundwater contamination: a diesel engine produces approx. 10 g of waste oil per kWh of delivered energy. This results in 300 kg of waste oil over its life-span.
- Conventional generators produce noise and exhaust fume, which are harmful to the health. According to the WHO the latter is carcinogenic to humans.

Additionally, SPIS is known to be technically reliable and enjoys a wide level of acceptance. Most components can be purchased locally, which is a prerequisite for successful dissemination. Yet, while local production is increasing in many developing and emerging markets, there is still room for improvements and a need for technical training. Reoccurring failures concerning SPIS use in developing countries include:

1. Technical faults e.g. the partial burning of a component (hot spot effect), delamination, and defective trackers,
2. Faulty design and planning e.g. a retrofitted filter system, incorrect tilting (horizontally installed PV Panels), and unwanted shading and,
3. Installation failures e.g. unsealed junction boxes, non-water proof circuit breakers, misplacing of cables and pumps, etcetera.

Discussion

During the subsequent discussion it was noted that environmental concerns are usually not shared by farmers as their main motivation usually relies upon short-term economic interest. Also concerns were voiced with regard to the positive claims made to reduced water depletion. In areas where irrigation was too costly before, more farmers might use irrigation systems (SPIS) which in turn will lead to declining groundwater levels. This is especially the case when a sprinkler system is used that can be powered by conventional methods at night. This is largely happening in India where the widely available singular PV pump model was not adjusted to farmer's needs. However, it should be kept in mind that the issue of water depletion is also of political nature and exists disregarding of the type of irrigation system in place.

8 Financial viability of SPIS

Financial viability, which allows for profit generation or at least for breaking-even, is an important factor when opting for the right SPIS technology, as cost and financial implications of different irrigation solutions vary according to system design and local prices. The presentation provided measures for the assessment of financial viability, using methods of costsbenefit-analysis such as net present value and internal rate of return. However, in a comparative assessment of project alternatives, using life-cycle costs or a comparative analysis of annual operation/financing costs was suggested. Additionally, an overview of cost factors and components was provided, also with regard to the impact of different irrigation methods on investment and operational costs. It was pointed out that replacement costs are often neglected. Examples from solar powered irrigation systems in India and Chile were provided in order to exemplify the computing of financial viability parameters and the consecutive decision-making. The basis is the calculation of gross margins for all crops.

While the exercise showed the financial viability of SPIS, it remains a question whether farmers are able to shoulder the initial capital requirements without subsidies. No case study involved external financial services, as PV systems in developing countries are often considered high risk, and the lack of collaterals; the usurious interest rates as well as the rigid repayment conditions make the financing of PV through the commercial banking system difficult. The role that subsidies play in terms of market distortion was also mentioned as a risk for financial sustainability and market as well as product development.

Discussion

While it is true that the initial capital requirement for buying a diesel pump is lower in comparison to a PV pump, diesel generators need quicker replacement, higher maintenance and fuel costs, which make PV pumps more financially viable in the long run. The provision of diesel subsidies or the reduction of PV subsidies can change this, although the remoteness of the farm and hence the consequent transportation costs play a significant role as a case study from Egypt shows. Lastly, the inclusion of a sensitivity analysis was suggested as part of the model for calculation.

9 Potential barriers for SPIS distribution

The presentation involved the listing of the opportunities and risks of SPIS, cumulating in a SWOT-analysis.

Listed **opportunities** include:

1. Despite rapid growth of the PV market, most of its potential remains untapped.
2. Despite a drastic reduction in PV prices, the perception of PV panels being expensive persists. This will allow for higher market penetration levels in the near future.
3. Rural electrification in developing countries continues and PV water pumps present a good off-grid alternative.
4. High potential of the Indian market: If 50 % of the Indian diesel pumps were replaced with PV pumps, diesel consumption could be reduced to about 225 billion liters/year.
5. SPIS opens up opportunities with respect to agricultural productivity.
6. Collective use of SPIS might help overcome the current financing hurdles.
7. PV systems can reduce electricity costs and problems of unreliable power supply.
8. As the PV market develops locally, it will create jobs.
9. There is still room for innovation and improvement.

Listed **risks** include:

1. PV systems are falsely perceived as too expensive.
2. No affordable financing services for PV systems are available yet.
3. Fluctuating oil prices.
4. The use of grants and subsidies could undermine the long-term sustainability of SPIS dissemination.

5. Low awareness of SPIS, especially in the agricultural sector in developing countries.
6. Low quality and false use of SPIS can undermine its technical reliability and credibility.
7. Risks such as theft can negatively influence the decision-making of the farmer.

Discussion

The discussion showed the need for underlining and elaborating on the financial aspects, the collective financing model and the potentials of a feed in tariff as well as the need for technical training. It was also commented that environmental policies play a large role in terms of SPIS sustainability. Development cooperation programs for example could also couple water shed management to the provision subsidies and therefore strengthen links to environmental sustainability. It is possible to have subsidies fade out, granted that the PV pump systems are adjusted to farmer's needs, which will give them a higher incentive to acquire SPIS. The topic of subsidies will also be discussed at the World Water Week in Stockholm.

10 Planning manuals and tools

The presentation depicted the conceptual outline of the SPIS planning manual to be developed, in reference to the objectives and target groups defined in the ToRs. These include agricultural advisors, credit officers, promotion agencies and research / academic institutions.

The modular structure presented for the manual contained four main sections:

- Get informed (background information on solar powered irrigation systems, organized according to SPIS components);
- Promote / initiate (materials for promoting SPIS in target countries and initiating specific SPIS initiatives);
- Finance (information on finance for SPIS, calculation aids for the assessment of economic viability / profitability);
- Give advice on how to (including subsections on designing, setting up and maintaining SPIS).

The promotion, finance and advice sections will each feature an introduction to the topic, a glossary, good / bad practice examples, brochures / leaflets, links to further information, photos and graphical elements, and tools (e.g. checklists, calculation tables). Examples for tools given in the presentation included a leaflet promoting environmental benefits of SPIS and a checklist for maintenance provision.

Discussion

Scope

Regarding scope of the manuals and tools, participants discussed the opportunity to include farmers and providing information and training materials to overcome the existing capacity gaps at farm management levels. It was agreed, that development of such materials to the standard required would be beyond the scope of the project at hand and should be treated as a separate, future step.

In an effort to narrow the already extensive scope, it was explicitly suggested to focus on brownfield developments only, thereby reducing the social and environmental concerns related specifically to greenfield developments (e.g. impacts of land-use change).

There was also the suggestion to make only very few but selected central recommendations on what SPIS systems to use and where to obtain the required data for the recommended systems rather than including a full but unfiltered list. Combinations of options should also be included.

Content and clarification

Workshop participants observed a need to clarify the purpose of the 'get informed' section, suggesting that the title should be changed to more clearly reflect the purpose of providing background information and potentially move the section to the end of the manual. Greater clarity was also called for in distinguishing between solar powered irrigation systems as the focus of the manual and not limit it to solar pumps only.

The absence of an explicit reference to business models (cooperative vs. individual management / ownership) and monitoring in the current outline were noted by participants. Regarding monitoring, it was determined that, as a crosscutting issue, the topic should be integrated into the subsection maintenance.

Reference to external tools

Participants furthermore agreed that where reference is made to existing tools, specific tools should be promoted, rather than providing users with a selection. Corresponding data requirements should be clarified from the onset.

Other comments made:

- It was clarified again that SPIS system providers are not part of the target group for the manual;
- Finance: Suggestion to include a list of ideal finance products into the manual;
- Set-up: Suggestion to include a tool for baseline analysis on farm conditions into the manual (what is required and how to assess?);
- Set-up: should focus on calculation aids for set-up rather than too technical issues;
- The manual should also refer to risks that need to be considered by the farmers.

In terms of design and layout requirements, the manual will be a joint publication by the donor group involved in this project, which needs to be reflected. GIZ offered to send examples of similar documents to GFA.

11 Discussion and next steps

Finalisation of the Report and Manual

With respect to the **Stocktaking and Analysis Report**, it was agreed that a new draft version, incorporating feedback made to date and draft country case studies, should be written and circulated for commenting by the **end of April 2015**. The Report is to be finalized and available for download by mid-May, in time for the international workshop *What prospects for solar-powered irrigation systems (SPIS) in developing countries?*, May 27th to May 29th 2015 at the FAO Headquarters in Rome. An abstract / summary of approximately 10 pages shall be prepared for circulation at the workshop.

Participants furthermore agreed that a draft concept of the **manual**, containing a general outline, contents and a list of included tools shall be prepared until mid-May, with the option to present on the state of developments at the Rome workshop. It was agreed to prepare a draft version of the manual and tools until the end of June.

With regards to the coordination of activities with GFA and ah Advice International, Annette von Lossau will take the lead for GIZ / Powering Agriculture.

Dissemination of developed materials

Participants decided to actively promote materials via existing communication channels within GIZ / Powering Agriculture (newsletters, DMS, fact sheets, intranet articles, etc.) as well as involving external partners, including IFC and FAO, in dissemination. It was furthermore agreed that a two-page overview of the study will be prepared for publication. Discussions on dissemination will be continued involving additional partners. GIZ aims to provide some further feedback and inputs on the dissemination approach within +/- 4 weeks after the workshop.

Piloting of the manual

Regarding the piloting of the manual and tools, participants noted considerable interest from GIZ programs, in particular from India. Despite potential benefits in terms of coordination / communication, it was, however, agreed that the focus in this matter should not exclusively lie on GIZ initiatives and that discussions would not least have to accommodate interests of Powering Agriculture partners USAID, SIDA, Duke Energy, and OPIC. Furthermore, a focus on English speaking countries was suggested to avoid having to invest time and resources into the translation of materials.

Development of training materials / trainings

During the course of the workshop, participants displayed a clear interest in the development of training materials and trainings on the basis of Report and Manual. It was, however, concluded that this process should be preceded by a piloting of the manual, to incorporate findings and results from the field into training development. Participants highlighted the possibility that training materials and trainings could be developed into a GIZ product.