Taking advantage of relevant Experiences

Learning from solar power supply in the Sundarban Islands

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Introduction

India has a long-standing record of installing a large number of off-grid solar photovoltaic (PV) systems, under the ambit of a country-wide demonstration programme. However, not many installation programmes have been as successful as the installation in the Sundarban Islands of West Bengal. The Sundarban Islands—largest estuarine mangrove forest in the world—presents a classic case of PV installation and operation from a variety of end-use considerations. This article gives a vivid account of on-the-spot experiences gained by an international team of experts with diverse backgrounds.

Teaming up for a purpose

We had not quite realized who he was, the man, who accompanied us from Kolkata to Namkhana harbour and Moushuni Island in the Sundarbans. At the Bagdanga solar PV power plant, he explained to us the basic setup and operation of the plant. He patiently answered various kinds of critical questions from a group of 24 curious visitors drawn from four continents, some with technical background and others with qualifications in social sciences or business management. This man told us about the ever-increasing demand for electricity on the islands, plans for battery replacement in several of the solar power plants, and an 'entrepreneurial model' for distribution and sale of power from the plants in the future. He mentioned that because of lack of capacity, all those who did not have a connection to the solar mini-grids would get subsidized solar home systems. He also explained why this was a part of West Bengal Renewable Energy Development Agency's (WBREDA) future strategy.

Fifteen years of experience in solar mini-grids: a rare and precious asset

We came to know that our guide, Angshuman Majumder, a divisional engineer with WBREDA, has been involved with the planning and practical work, ever since WBREDA started to supply renewable electricity to the islanders more than 15 years ago. With his experience of solar mini-grids, solar-hybrid mini-grids, and other forms of new and renewable energy power systems, Majumder became our key source of information. Our purpose was

to try and understand the different steps that had been taken, the challenges that had been met, and the lessons that had been learnt on various aspects of local solar power supply. For someone with a strong ownership of the electricity project in question, Majumder was open and self-critical in his approach. These clearly resulted from his commitment, in line with the commitment of other WBREDA staff whom we met during our three week-long visit, to continuously adjust and improve the performance of an emerging technology. Also, their willingness to share experiences seemed motivated by a genuine interest to help establish sustainable renewable electricity systems elsewhere.

Because of our background study, the name that we did know was that of the former director of WBREDA, S P Gon Choudhury. Choudhury is a pioneer in this field and, in fact, a driving force behind the project from the very beginning in 1995/96, until he retired. With funding from the central government (Ministry of New and Renewable Energy, Government of India) as well as from various sources within West Bengal, he played a pivotal role in the development of the system design, the organizational structure, and the implementation strategies for the solar mini-grids in the Sundarbans. The strategies gradually evolved based on actions and experiences. During all these years, Majumder had been working in close association with Choudhury in the process of building and sustaining the mini-grids in these islands, interacting with different actors at the local level, facilitating local participation, involving contractors for the operation and maintenance, organizing the tariff collection, and so on.

There are many who argue that it is difficult to reproduce the success of the installation of solar energy in the Sundarbans, mainly because, in this region, there has been a strong drive and motivation from individuals, which seems to be missing in most other places. But such a drive is, of course, possible to create by other enthusiastic individuals in other places too. For example, in our team from Kenya, which visited the Sundarbans, we had people with a strong wish to do something innovative in the solar energy field in their country, and somebody in the group even started to talk about one of them as the 'Gon Choudhury of Kenya'. It is also clear from the history of technological change in society, for example Thomas Alva Edison and his introduction of electric lighting in New York and Chicago, that we need pioneers to promote new and promising technological solutions and integrate them in the society.

Viewing a solar mini-grid for the first time: a dream come true

To us, the field visit to the solar mini-grids in the Sundarbans, in the vast delta of the holy river Ganges, was a very exotic and exciting experience. We had first heard about the WBREDA solar power plants in 2003. As a Norwegian student, Kirsten Ulsrud did her field work in New Delhi in order to study some of the experiences of key people who had been involved in the implementation of solar energy activities of different kinds in India. Some sources told her about a promising model for the use of solar PV technology in the rural areas—small solar power plants with local electricity grids distributing the power to people. Their advantages were that the users did not have to be responsible for the capital investment and the maintenance of the systems, as they usually have to for the solar home systems. These systems also made it possible to supply a little bit of electricity for few income generating activities.

Ulsrud wanted to pursue a research project, whereby Indian experiences on solar mini-grids could be studied in-depth by a multidisciplinary team, so that other upcoming solar energy efforts in other places could take advantage of these experiments and experiences. After spending some time on developing research ideas, writing proposals, putting together a team of researchers and practitioners from different countries, and raising funds for the research and travel for many people, we, the Solar Transitions research team, finally went to Sundarbans for the first field visit along with guests from various countries. Thereafter, we were to do some field work in two of the islands as smaller research teams.

Sitting in a boat, on the way to Moushuni and Sagar Islands in the Sundarbans, there was a strong feeling of excitement in some of the passengers, because after studying about village-scale solar power plants for so long, we were going to see it for the first time. Now the time had come for actually getting there and finding out what had happening and the current situation in the 'solar villages'. In fact, it felt rather unreal—and for everyone most of the things were very exotic, even for our colleagues from India—the wooden boat, the group of people from four continents with so much to talk about despite very different backgrounds, the landscape of flat islands encircled with mangrove forests and high embankments, the extreme tide-differences, and the image

that we had of this region from Amitav Ghosh's book, *The Hungry Tide*. There was also a small, underlying concern that our fascination with the success stories on solar mini-grids in the Sundarbans would lead to some kind of disappointment, as we cam face to face with the reality on the ground. Maybe some of our illusions and hopes for finding suitable working models for implementing and organizing off-grid solar power supply would be broken.

Why are we interested in India's experience?

The research done in India is the first part of the research activities for the Solar Transitions team, comprising researchers and practitioners from Kenya, India, Norway, and Austria. The second part is the transfer and adaptation of the Indian experiences to Kenya, through action-oriented research. India and Kenya have been selected for the research pursuit, because they are amongst the leading countries within decentralized, distributed use of solar electricity, even though solar electricity still constitutes a very small fraction of the overall electricity supply in both these countries. In Kenya, the diffusion of systems has to a large extent been market driven, while in India, the government has actively promoted solar technology. Partly due to this, India has a higher diversity in terms of the various types of systems, including a significant number of solar mini-grids. The solar energy activities in Kenya are mostly concentrated on the use of very small household systems, although some larger systems are installed at schools and tourist camps, and the government is gradually becoming more involved in the solar energy efforts. In Kenya, the solar home system market is thriving. The Indian experiences were of special interest for the Solar Transitions research team, that is, the implementation, organization, use and socio-economic impacts of village scale, solar powered mini-grid systems. Until now, these experiences have practically been unknown to the Norwegian and Kenyan solar and renewable energy actors, who find them highly relevant for many developing countries.

Why have we chosen to study the solar mini-grid cases in the Sundarban Islands?

We were aware that the WBREDA solar mini-grids in the Sundarbans were not the only ones that we could have studied, since solar mini-grids exist in many other places in India, including Lakshwadeep Island, Chhattisgarh, and other areas. In all these places, actors have made use of the government support systems and other funding opportunities to develop such activities and systems. We are also aware of the recent Norwegian projects that are being implemented in cooperation with the Indian government. It would have been relevant to investigate all of these projects. However, we are convinced that given the long-term experience, and the gradual, dynamic changes in the way the population and involved stakeholders both relate to and influence the solar power supply, the Sundarbans is a very useful and interesting case and a good source of knowledge and information. There has been a steady growth in activities during these years, lessons have gradually accumulated, and the effects of the strategies have been emerging and becoming more and more visible. In addition, to the Sundarban experiences, the activities that have taken place in Chhattisgarh, during the last five years, is also very interesting and some information is also being collected from there.

In the proposal that led to the funding of the Solar Transitions research project, which has now allowed us to do research on the Sundarban solar mini-grids, says, "through the years of experience with the implementation and social organization of these solar power plants in the Sundarban Islands, a considerable amount of learning has undoubtedly taken place. This project aims to contribute to the understanding of success factors and lessons learnt in the process of implementation and use of these solar power plants as well as how such experiences can be transferred and adapted to other communities and countries, developing their solar energy sector as well as their distributed energy provision in general."

The organizational details matter

In our social science led research, we are interested in learning about as many aspects as possible of these solar power systems—how they are designed in the technical sense, how the operation and maintenance is organized, how the subscription and tariff collection works, which solutions have been developed for an effective load management, which economic model has been used, what funding sources are available, and what kind of cost recovery has been aimed at. We look at how all this has worked, and why, and what adjustments have been done in the programme in order to successfully meet the challenges. We also want to learn about how the electricity supply is perceived by and works for the customers. Who are, and who are not customers, and why. How the electricity supply is linked to opportunities for income generation, improved health and education services, access to information and communication opportunities, and so on. Here, a central element is to explore the linkages between the ways the

energy supply is organized and the impacts it has on the local socio-economic development. The role of the framework conditions is also part of the research questions.

The research is being undertaken by an international and interdisciplinary group of social scientists, technical solar energy experts, and stakeholders from development and solar energy agencies. The project has five partners from Kenya, four partners from Norway, one from India, and one from Austria. Through action research, the project will facilitate interaction amongst the researchers and three local communities in Kenya, as well as renewable energy actors, NGOs, and policy-makers in the process of the 'South–South–North' learning on social and technological innovations. The interdisciplinary and the diverse backgrounds of the team members help covering a diversity of aspects of the solar power supply, and this approach is considered crucial for understanding the systems at large.

Field work

We did field work in six villages with solar mini-grids in Sagar and Moushuni Islands in Sundarbans. These were Mrityunjoynagar, Natendrapur, Kaylapara, and Khashmahal in the Sagar Island and Bagdanga and Baliara in the Moushuni Island. We also visited the diesel-wind-biomass gasifier hybrid mini-grid in Gangasagar in Sagar Island. The mini-grids had installed capacities from 25–120 kW each, and each of these systems supplied electricity to 80–300 customers through local electricity grids, for 2–5 hours per night. At optimal performance, the systems supplied five hours of electricity each night, but the batteries, which are a weak technical part of this kind of technological solutions, were now ready for replacement in many of the plants, so therefore, the supply was for a shorter duration. In Mrityunjoynagar, the plant was not working at the time of the visit. In each of these power plants, there are one or two operators. They are responsible for switching the power supply on and off (starting from 1800 hours), keeping record of the power sent out, and generally supervising the system (charging and re-charging), which to a large extent is controlled automatically. Also, they are responsible for maintenance, including the cleaning and maintenance of PV plant/solar panels and maintaining battery banks, for example, by topping up with distilled water. These operators also take care of the maintenance of distribution lines and other parts.

Local politicians and teachers had been involved in the planning of the power plants, and the main involvement of local stakeholders goes through the Beneficiary Committees (BC), which has been set up for each plant, whose members represent the customers. They also have the responsibility to look after over-drawal of power by the customers. Customers either have a three or a five flat point contract based tariff, and consumption is not metered. Currently, connection rates are Rs 1000 for three points and Rs 1500 for five points. Monthly tariff is between Rs 80–130, respectively. In comparison, households we met without electricity connection said they spend anywhere from Rs 18–194 on purchase of kerosene for lighting per month, with spending of Rs 100 being quite common. In the Sagar Island, revenue collection is handled by an Energy Cooperative, whereas in Moushuni Island, a man has been hired to do the revenue collection.

The informants in our research team included operators and other staff at the solar mini-grids and hybrid mini-grids including tariff collectors, the Sagar Rural Energy Development Cooperative, village beneficiary committee members, schools and school hostels (boarding schools), families and businesses with or without connection to solar mini-grids, companies supplying solar power systems, contractors for operation and maintenance, and state agency staff, such as WBREDA. Other types of informants were people on a waiting

THE SOLAR TRANSITIONS PROJECT

The full name of the Solar Transitions project, which is funded by the Research Council of Norway, is 'Village-scale solar power plants, transfer of social and technological innovations between India and Kenya'. The project was initiated by the University of Oslo, the Department of Sociology and Human Geography, Faculty of Social Sciences, and lasts from 1 April 2009 to 1 April 2013.

THE SOLAR TRANSITIONS PARTNERS

The partners are Camco, Kenya; African Centre for Technology Studies (ACTS), Kenya; Integrated Energy Solutions, Kenya; Norwegian Church Aid East Africa, Kenya and Norway; SunTranser, Kenya; The Energy and Resources Institute (TERI), India; Inter University Centre of Technology, Work, and Culture (IFZ), Austria; The University of Oslo, Norway; Noragric at the University of Life Sciences (UMB); and SWECO Norway AS, Norway.

list for connection or subsidized solar home systems, people who could not afford to get connected, people who had their own solar home systems, and local governing bodies.

Insights from the research

After the first field excursion for 24 people from Kenya, Norway, Austria, Brazil, and India and the subsequent field work in the islands for this team, the research is still in progress, but preliminary findings are emerging. While the research findings will be presented exhaustively at a later stage, here, we wish to highlight a few points based on our immediate observations. It is very clear from the field work in the villages in the Sundarbans that many positive results have been achieved by the involved actors in the village-scale solar power supply. Families and small businesses have received an opportunity to modify their everyday life in a way that they would otherwise not have had. They now use a little light for some hours every day, charge their mobiles, and watch television, and this represents a major shift. In fact, people's positive experiences with solar electricity has produced a demand that is becoming too big for the existing systems to meet. At the same time, it is clear that the task of providing stable electricity has been, and remains, challenging. Some difficulties are partially created by the technical limitations, especially in the battery technology, which also produces challenges in terms of the social organization, operation, maintenance, and user friendliness of the power plants. For example, too quick discharging can damage the battery, and this increases the need for preventing the customers from drawing more power than what is stipulated in the contract. Furthermore, the operator has to make some unpopular decisions sometimes, in terms of turning off the power supply earlier than what the customers expect, so as to protect the battery bank.

In other words, there are technical aspects in the systems that make the social aspects (maintenance, operation, expectations of paying customers) more complicated than they could have been, if some of the technical elements had reached an advanced stage. When the quality of power supply reduces, the contract with customers is also jeopardized and non-payment may result, as had happened in several villages during the last year. However, there was a good record for tariff collection and payment for most of the years that the power plants had been in operation. As a means to meet such challenges embedded in the technically weakest part of solar systems, which also requires care in operation and maintenance, WBREDA is planning to use a new type of contract for the maintenance of the inverter, charge regulator, and battery, and the use of the best available charging and discharging regulators and advanced inverters to avoid some of the battery problems. They also underlined their financing philosophy, which regards batteries (also replacement) as investment in line with PV cells and other installed equipment. This is subsidized by the central authorities and thus, financially separated from operation and maintenance costs, which are supposed to be covered by customers through the collection of tariffs.

Furthermore, as indicated, it is also a challenge to meet everybody's demands and needs, and to ensure that the energy is used in an efficient way. It is also not so straightforward to create an equitable, practical, and locally based system for tariff collection. Because of these and similar challenges and WBREDA's willingness to share them and adjust their procedures, there is much to learn from the Sundarban experience for those, who would like to implement similar systems in other places, like our Solar Transitions team hopes to manage in Kenya.

Society and technology develop in mutual interaction with each other

As pointed out in the social science research, new technological systems (like for example decentralized solar power supply) gradually develop and take shape through a long-term process, where the users of the technology, as well as the technology implementers, suppliers of the technical equipment, and other actors who are involved, gradually develop the way the technology is organized and used. This process is influenced by the preferences, needs, and actions of the involved actors, and how people also adjust themselves, their habits, and preferences to the opportunities and limitations of the technology. Through such mechanisms, technology and society develop together in a process of common evolution at various social levels, and a constant interaction between human beings and technical equipment takes place.

In the case of Sundarban Islands, we can see such an interaction between technology and society, for example, in the dynamics between power supply and growing demand. Such dynamics become very visible in the off-grid power

supply systems, where the installed capacity locally is what you can use. In the Sundarbans, after the early stages of the implementation processes in the villages, when the implementers first worked to get a sufficient number of people interested to connect to the power supply, the interest soon exploded. Most of those, who have applied for connection after the capacity of the power plants was saturated, have ended up on a waiting list. For the Sagar island, however, there are plans to connect the island to the main grid of West Bengal so as to meet the present, high demand. In Moushuni island, people's chances of getting new connections are little, because there are few plans to extend the existing power supply. Here, solar home systems are considered by WBREDA as the means to achieve full coverage, and a subsidy scheme was just being commissioned at the time of our fieldwork.

Thus, consumption increases over time because more people want a connection. At the same time, all those who already have electricity supply find innovative ways of using more than the ascribed kilowatt-hours, (either through charging practices or drawing more electricity from each of the light/electricity points than what has been mentioned in the contract. In any case, every customer's demand is also rising with time. The total increase in demand demonstrates electricity's popularity. The solar power supply, although providing power only for some hours in the evening, has meant a significant change in peoples' lives. The fact that businesses and families want more of this good reveals that they find electricity to have some distinct financial and social advantages.

Somebody must take the risk and be the pilot

Prior to our field work, we had wondered as to what extent we would gain access to the more difficult sides of the implementation, operation, and use of the solar power plants and mini-grids in Sundarbans. Sagar has been described as 'the Solar Island' due to the 13 solar plants it hosts. Would our findings support a corresponding 'sunshine story'? Our previous experiences had told us that there are always challenges involved in technology transfer. But since Angshuman Majumder and his colleagues are hoping that their information and experience can contribute to the general progress in the field of solar power supply, they saw it as important to share both their positive and negative experiences.

Our immediate conclusion is that some of the factors that have led to the success of the solar power project in the Sundarbans have been WBREDA's focus on including local groups in the process and applying a financing model, that has ensured poor people's access to affordable, renewable electricity. However, one also needs to mention the implementer's monitoring and awareness of the pitfalls and their willingness to change practices along the way. They have created the solar power systems with a considerable amount of trying and failing (learning) and some of the lessons during the 15 years have been learnt the hard way. It is tough work to be pioneers of new technological solutions. But without such dedicated efforts, new technological systems do not develop. And it is important to make the knowledge and experience available for others who plan to attempt to implement solar or other renewable energy supply in off-grid, village scale systems. This is what the Solar Transitions project aims to contribute. WBREDA is now in the process of upgrading many of the Sundarban power plants and thus, renew the organizational business models for their operation and the distribution of electricity, and the results of these ongoing efforts and experiments will be interesting to follow.

THE RESEARCH

The Solar Transitions project investigates factors that influence poor people's access to solar energy solutions, as well as the role of solar energy supply for climate adaptation and poverty reduction. The project also facilitates social learning processes for the creation of social and technological changes. The research focuses on two aspects of socio-technical learning. First, the project concentrates on how to implement and socially organize local energy supply with solar energy in ways that benefit people, including marginalized groups, and embeds the technology in local communities and climates. Secondly, the project initiates and analyses a process of South-South transfer of social and technological innovations between India and Kenya.