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Swiss Agency for Development and Cooperation SDC

IWMI
International Water Management Institute

Solar Irrigation for Agricultural Resilience (SoLAR)

Role of solar irrigation pumps (SIPs) in clean energy

Summary Report of Webinar 1

1 February 2021

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List of abbreviations

IWMI	International Water Management Institute
SIP	Solar Irrigation Pumps
SDC	Swiss Agency for Development and Cooperation
SoLAR	Solar Irrigation for Agricultural Resilience
DISCOM	Distribution Companies
RE	Renewable Energy
CEEW	Council on Energy, Environment, and Water
BLDC	Brush Less Direct Current
IGP	Indo-Gangetic Plains
BGEF	Bright Green Energy Foundation

Introduction: The Webinar Series

The IWMI-led Solar Irrigation for Agricultural Resilience (SoLAR) project funded by the Swiss Agency for Development and Cooperation (SDC) organised a series of six webinars from 1-5 February 2021. The SoLAR project aims to generate knowledge to sustainably manage water-energy and climate interlinkages by promoting solar irrigation pumps (SIPs). The project aims to contribute to climate-resilient, gender-equitable, and socially inclusive agrarian livelihoods in Bangladesh, India, Nepal, and Pakistan by supporting government efforts to promote solar irrigation.

Achieving progress in poverty reduction with minimal carbon emission is at the core of the climate and sustainability challenges. This need is particularly acute in South Asia. A further expansion of irrigation holds the promise of pulling small landholders out of poverty. It will also result in significant increases in carbon emissions due to overwhelming dependence on fossil fuel-based groundwater pumping. SIPs offer a 'climate resilient' solution, yet the adoption of the same is slow. Little is also known about the impact of SIPs on groundwater use. In this six-part SDC-IWMI webinar series, some of these more significant questions were explored around energy transition and SIPs in four South Asian countries.

Webinar 1: Role of solar irrigation pumps (SIPs) in the clean energy transition in South Asia

The region in focus for webinar 1 was South Asia which has diverse physiographical settings. The topic was: 'Role of solar irrigation pumps (SIPs) in the clean energy transition in South Asia' and was held on 1 February 2021. The webinar was divided into two significant sections, wherein the first section consisted of presentations by learned scholars, and the second section consisted of a panel discussion. Consequently, this was followed by a question and answer session. There were a total of 224 registrations, 129 attendees. The session had 11 panellists and was moderated by Dr Aditi Mukherji.

Table 1:Schedule for webinar 1

Webinar	**Date & Time**	**Presenters/Speakers**	**Panellists**
Webinar 1	1 Feb 2021 (3:00-5:00 IST)	Dr Rahul Tongia Dr Rohit Chandra Dr Stuti Rawat Dr Anas Rahman	Mr Dipal Barua Mr Ram Dhital Dr Tushaar Shah Ms Maha Qasim

I. Presentations

a) Political economy of the energy transition in South Asia:

Dr Rahul Tongia, Centre for Social and Economic Progress, India, and Brookings Institute presented in this session.

Dr Tongia talked about the three aspects of the energy transition, regulation and pricing and solar energy. This can be elaborated as under:

In the context of the energy transition, decarbonisation is currently the focus of every developmental plan. Even with a lot of renewable energy (RE) growth underway, it is estimated that by 2030, 50% of India's power source will still be a coal-based source. Renewable energy (RE) has become cheap recently and is lower than coal-generated energy. However, the real challenge is balancing supply with a time of demand, given that RE storage is still at a nascent stage for large grid-scale projects.

With respect to regulation and pricing, the energy market in India is regulated by economic, physical, and political factors, wherein the distribution of welfare gains is a vital part of the regulation. Therefore, prices are set keeping those parameters in mind. This means different consumers pay different fees, and a lot of cross-subsidy is inbuilt. There are several supply-side distortions for both fossil fuel and RE. The supply-side distortion for renewable energy mainly comes from the waving of import duties.

Currently, the average cost of electricity supply is around Rs 7.7/unit, but each sector, on average, pays a different price. Only commercial users pay more the cost of supply, while the payment from the agricultural sector is the lowest, yet it consumes 22% of total electricity in the country. In most states, farmers do not pay for electricity, and it is the state government that compensates the utilities for providing free power to farmers. Often, utilities are known to inflate agricultural consumption to hide the losses and balance their revenues from the government subsidy. Compared to other countries, India's share of agrarian electricity consumption is way too high (22%), while global over the upper bound is only 5-6%.

The most pertinent question in solar energy is: Can RE technology reduce these distortions in agriculture? Grid-connected solar is inevitable, mainly because it is tough to go for sizing the panel for pump size exactly. There will always be an excess or deficit; thus, grid connection will be essential to balance this. Additionally, it helps to account for the solar energy at the national grid data. Essential questions emerge given the gird connection. How does the retail and wholesale procurement solar price affect feed-in tariff? How much does the existing distortion affect the RE markets? Once it is individual ownership of solar, who wins and who loses out?

Table 2:Q&A with Dr Rahul Tongia

Sl no	Questions	Answers
1.	Often agriculture is blamed for the poor financial performance of DISCOMS, but there is some evidence that DISCOMs use poor feeder governance on irrigation supply to hide their flaws. Is there any 'causal analysis' to understand what can be a good starting point for improving feeder level energy governance for DISCOMS and farmers?	Metering is technologically doable. It boils down to who wants this data and at what frequency? It all boils down to DISCOMS and who uses information because data talks about the compliance levels. But having them is always good.
2.	Thank you for an excellent presentation, Rahul. I just wanted to know your opinion on what the best way is to track captive SIP? Do you think Remote Monitoring units are better or reliable enough to gather data?	Maharashtra (Prayas and others) has done good studies on this. I think transparency (feeder monitoring real-time, public) is one critical step.
3.	If grid-interactive solar is the way forward, then why do we even need solar pumps in the first place? With essentially zero electricity fees, what are the incentives for small farmers to pay for solar pumps?	In the daytime, there is good quality electricity which is not possible with conventional systems. That's the key question. But there are more nuances, including ones of getting 'non-remunerative consumers off the system. Plus, you can give them an incentive to save power if they earn from the feed-in. But there are then huge equity issues. Grid interactive is essential due to the issue of right sizing and variance of output and demand.
4.	Rahul, I think it is a complex issue. Although	It need not align both ways - only one

	diesel is costly and polluting, no other pumps offer the flexibility it does. For example, there are only 9 million diesel pumps and 22 million pumps. The diesel pumps irrigate more areas because it is portable, and it can be hired by anyone. From a farmer's point of view, what matters is what can provide him water immediately. Thanks for the presentation. You mentioned the non-requirement of batteries for SIP: this can only happen if you assume that similar solar peak hours are available daily.	way is enough. Grid 'surplus' is for agricultural use, especially during the day. This might work in net metering but not where farmers are using it exclusively for irrigation.

b) Challenges in the energy transition, with a focus on solar energy:

Dr Rohit Chandra, Indian Institute of Technology, Delhi presented in this session.

Farmers are not treated as consumers, instead kept as an interest group. Therefore, it is a question of political discourse. Thus, farmers come into the picture in the context of the energy transition.
Acute financial distress makes DISCOM a terrible decision, and it further breaks the whole energy market. Until these acute distresses of DISCOMS have been removed, it is difficult to make an energy transition very quickly in agriculture. Recently, a few experiments have been done to remove these inefficiencies at DISCOMS, one of which is privatization.

It can be anticipated that inevitably, the DISCOMS will be privatised, or a parallel institution would be created to manage the energy systems. In the coming days, in some advanced states, this might be the case. Given the inefficiencies, many DISCOMS in the country is not able to manage the current demand and future planning and absorb signals coming in from the RE sectors.

Substituting from one technology to another might also lead to equity distributional effects. It may be understood as an elite capture. Therefore, this needs to be captured in the design of the programme. It all boils down to the capacity of the DISCOMs. State-level experimentation is something to be encouraged for RE in the country. States need to be considering the incentives for farmers to invest in RE, given the electricity is already free. I think this will be challenging for DISCOM to get the innovative

design to convince the farmers to make a shift.

Table 3:Q&A with Dr Rohit Chandra

Sl no	Questions	Answers
1.	Are the financial packages for DISCOMs to infuse cash into these insolvent companies or bail out the banks who have lent to DISCOMs and IPPs who supply to DISCOMs? Since 1993, this is the sixth financial package to DISCOMs. Unless fundamentals of distribution are addressed, it seems unlikely that financial restructuring can turn around the sector. Appreciate your views.	Firstly, bailing our DISCOM is always there in India; this has been the case in the country all the time. This time it comes with the stringent condition of 1/4th of the money to cooperate with the state. Secondly, the money will go to states/DISCOMs first with significant conditions, but the banking system's ultimate goal. We cannot hope to have a functional power system without a well-functioning banking system. So, you could consider it an indirect bailout of sorts.
2.	Under component C of the PM-KUSUM scheme in India. The models are suggested as 1) Solarisation of existing pump. 2) Solarisation with mandatory energy efficient (BLDC) pump replacement 3) solarisation of agriculture feeder. Among these, option 2 is the best practical solution to the farmer and DISCOM too. Could anyone highlight it?	It depends on the present situation in each of the states. For example, in a state like Chhattisgarh, where the farmer gets more than 12 hours of power supply for agriculture, a farmer will be reluctant to adopt a solar-only pump.
3.	Given the over-abstraction of water in several countries using expensive diesel pumps, is there not a severe risk that solar-powered pumps could accelerate the abstraction way beyond recharge levels?	The fear that comes to my mind is that while using solar energy is unchecked in agriculture instead of diesel and other energy resources, unchecked volumes of water are likely to be drawn up from the already depleting and severely stressed water levels in North India.

c) Emissions from irrigation pumps in South Asia: The case of Black Carbon:

Dr Stuti Rawat, Education University of Hong Kong presented in this session.

Stuti highlighted the carbon emission aspects of diesel pumps and how solar irrigation will be best in mitigating this. Diesel irrigation is prominent in South Asian agriculture. However, there are black carbon emissions from these diesel pumps. If the black carbon emitted from the diesel irrigation is mitigated, there are more significant benefits in terms of health and atmospheric brown clouds in Asia.
Over 10 million diesel pumps operate in the Indo-Gangetic plain (IGP) of Asia. Over time there has been a sharp increase in the diesel pumps in this region. The impact of these pumps was estimated by considering the number of diesel pumps operated, annual pumping hours, diesel consumed per hour, and an emission factor.

The study estimates show that between 1980 and 2013-14, annual carbon emission from 1 hp pump has quadrupled. Indian states of IGP have the highest black carbon emission (6 to 12.4 Gg), followed by Pakistan (2.5- 4.9 Gg) and Bangladesh (3 – 6.1 Gg) and lowest in Nepal (0.5Gg). That means diesel irrigation contributes to 5.9% of India's total black carbon emission, similarly, 5.5% for Bangladesh, 2.5% for Pakistan, and 1.2 % for Nepal.
Given the substantial contribution of diesel irrigation to carbon emission, the country needs to shift from a polluting energy source to a cleaner energy source. This is where the importance of solar irrigation comes.

Table 4:Q&A with Dr Stuti Rawat

Sl no	Questions	Answers
1	Is shifting off diesel via solar a 'no-brainer'? Why or why not?	A shift from diesel is needed, given the health and climate impacts. But among the possible non-polluting renewable options available and concerning the South Asian context, solar energy is the most realistic option currently available. Is it Pareto-optimum? Maybe not. But it does appear to be Pareto superior in comparison to diesel-powered pump sets.
2	It is true that diesel pump operation	This is something that needs to be considered.

	contributes to a high carbon footprint? However, if the idea is to replace them with SIP in grid-connected regions (like eastern India), then the life cycle cost assessment is essential. Solar panels production has the highest carbon footprint among all the energy sources.	Another participant- Basant Maheshwari, mentioned a similar point as well. As Rohit had discussed previously, perhaps in the experiment of models happening right now, we will find something that can bring us closer to balancing these trade-offs.
3	Solar irrigation is an excellent example of solving a 'wicked problem'. We solve one problem (energy and emission) and potentially create another problem (overuse of groundwater). Another issue to consider is that manufacturing solar panels also involves carbon emissions. Also, we need to think of how we will manage the solar panel waste after they become non-functional. The challenge for us is how we develop a 'win-win' situation.	This is again something that needs to be considered. As Rohit mentioned, in the experiment of models happening right now, perhaps we will find something that can bring us closer to balancing these trade-offs.

d) Indian DISCOMS and the lure of solar irrigation pumps:

Dr Anas Rahman, Council on Energy, Environment, and Water (CEEW), presented in this session.

Anas walked through the experience of solar irrigation across different states of India. Agriculture consumes about 22% of electricity and contributes only 3% of the revenue. The deficit is usually covered through cross-subsidy and power subsidies. A number of demand management strategies has been put in place, like rationing of electricity, metering, etc. Still, there is a political constraint to raise the price of electricity and metering in all the states.

Solar pump irrigation is a supply-side solution to the issue India is facing. It provides the daytime supply of electricity and reduces the subsidy. The focus was given to the grid-connected individual solar model and feeder solarisation model.

In the individual grid connect model – existing pumps will be solarised by getting subsidies from the

states, wherein pumps run on solar power, and excess energy will be sold to the grid at a specified buyback tariff. This helps to reduce state subsidies on electricity and is a source of additional income to farmers. These models have been piloted in three states- Karnataka – (Surya Raithemitra), Andhra Pradesh (Grid connected BLDC pumps) and Gujarat (Suryasakti Kisan Yojana). Each of them with different design and faces several challenges. No state has figured out the ideal way of balancing the incentive subsidy and buyback tariff.

In the case of feeder solarisation, the whole feeder is energised from the decentralised solar power plant. In this, farmers get daytime reliable solar power and reduce transmission losses. Two pilots have been on this – Maharashtra (Mukhyamantri Sura Krishi Vahini Yojana) and Karnataka (Solar farmer scheme). However, the main challenge is land diversion near the feeder and tariff getting low around Rs. 3/kWh, which disincentivises decentralised plant investment compared to the enormous power plants. None of the states has moved to the market model. The current models are unsustainable, and there is a regulation on groundwater extraction that is still going to be an issue that needs to be considered before scaling it up.

Table 5:Q&A with Dr Anas Rahman

Sl no	Question	Answer
1	Under component C of the PM-KUSUM scheme in India. The models are suggested as: 1) solarisation of the existing pump. 2) solarisation with mandatory energy efficient (BLDC) pump replacement 3) solarisation of agriculture feeder. Among these, Option 2) is the best practical solution to the farmer and DISCOMS too. Can anyone highlight it?	It depends on the present situation in each of the states. For example, in a state like Chhattisgarh, where the farmer gets more than 12 hours of power supply for agriculture, a farmer will be reluctant to adopt a solar-only pump.

II. Panel Discussion

Tushaar Shah:

- The progress of solar irrigation aspects is moving faster than expected, especially in India. The number of solar pumps is at 60% per year; by this rate in 2030, the solar pumps might crowd out. But the worrying aspect is groundwater abstraction, as solar pumps might have a profound

impact on the irrigation economy. A more concerning part is the nature of the discussion/debate about solar irrigation policies kept in silos. There are four groups of stakeholders in the irrigation economy in India: DISCOMs, politicians, irrigation/groundwater department, and agricultural department.

- DISCOMS are motivated by the financial health and subsidy they receive. When DISCOMS cannot supply energy that is demanded in agriculture, they can achieve it now by giving it out solar pumps. Besides, dealing with farmers is full of hassle. Thus, DISCOMs are trying to figure out scalable models such as grid-connect solar pumps or feeder solarisation.
- For politicians, the vote bank is an essential consideration in developmental activities. When they realise that grid-connected solar can give cash to the hands of the farmers, they get attracted to promote such schemes. Interestingly, the irrigation and agricultural departments are nowhere in the picture. Probably these stakeholders are not consulted. Since solar irrigation involves tube well and producing food using water, this sailor needs to break to have a holistic perspective. Since groundwater is such a large part of the agricultural economy, solar irrigation policy needs to consider the profound impact of solar pumping on water and agricultural production. Before writing about the rise of solar, the model's design should be worked upon further, considering a fair balance between subsidy and buyback tariff to have sustainable solar irrigation.

Dipal Chandra Barua:

There are 21 solar irrigation (35kW) pumps installed by Bright Green Energy Foundation (BGEF). Technically it is feasible to do; the marginal cost for farmers is lower relative to diesel. But when it comes to the collation of fees from the farmers, it is not as expected. Probably, we will be encouraging the commercial crop and the fee collection to manage the investment cost will be equally challenging.

Table 6:Q&A with panellists

Sl no	Questions	Answers
1.	In developing countries like Pakistan, if you have land rights, it's your opportunity to take out groundwater as much as you want through solar. I want to quote an example of my province Baluchistan, where monitoring isn't possible; during summer, people switch	Maha Qasim: In the Punjab province, the Government has introduced significant subsidies for installing solar irrigation pumps, which are tied to subsidies for installing drip irrigation. Farms with drip irrigation systems can buy solar irrigation systems at a price 80% cheaper than farms without drip

	on their motor pumps from morning till 5 pm. In the future, we will face water shortages if this continues, so how and what policies should be initiated to overcome this behaviour?	irrigation.
2.	Dr Dhital, thank you for your valuable insights. I want your views on the options (concerning net metering) of connecting a community-owned Mini-grid system (integrated with SIP) to the grid? How is the feasibility in terms of technical viability, tariffs? Is the Nepalese grid ready to accommodate mini grids into the national grid, especially in rural areas of Nepal?	Theoretically, it is possible. The country has not done enough work to calculate the right size for these small scale mini-grids.

Top takeaways from the webinar, and how and whether SoLAR future work can address them?

Takeaway 1: Coordination among the energy, water, and the agricultural department is essential

Takeaway 2: Since a few pilots have been done on grid-interacted solar pumps, a project like SoLAR should dig out the findings in Gujarat, Andhra Pradesh, and Karnataka.

Takeaway 3: A feasible and technical option for grid-connection for Nepal needs to be developed considering safety and security sides.

Takeaway 4: Experimentation needs to encourage at the state level to find out suitable models for the local conditions

Takeaway 5: Build trust with farmers to increase the demand for solar irrigation. The soft part of the project needs to be focused on as well.

Takeaway 6: Challenges and downside exist in all the new technology, but as long as the Pareto solution

is there, it should be considered.

Takeaway 7: We have historically worked on the demand side; there needs to be an arrangement to fix the legacy problem. A relatively marginal foot forward should be worked on to solve future problems.