

Solar Irrigation for Agriculture Resilience in South Asia (SoLAR-SA) Project

India - Country Project Management Committee (C-PMC) | 4th Meeting

Date: 15 December 2021 | Time: 10:00 AM-12:00 PM (IST)

Venue: Zoom meeting

A) List of attendees

(Attached in annexure 2)

B) Agenda

Welcome remarks

Dr Alok Sikka, Chair of C-PMC and Country Representative of IWMI-India welcomed the respective CPMC members to the 4th SoLAR India-PMC meeting. He highlighted that solar energy in India has been receiving the right impetus in the past few years and will go a long way into building climate resilience, social equitability, gender inclusiveness and groundwater monitoring. He further highlighted that the year 3 annual work plan has been prepared.

Activities carried out since last C-PMC meeting and Year 3 Work plan

Dr Yashodha Yashodha gave a brief update on the activities since the last CPMC meeting that was held in September 2021. The following activities were discussed as under:

Activity 2.2.2

Dr Aditi Mukherji highlighted extensively about the SKY (Suryashakti Kisan Yojana) scheme, which is the largest distributed solar irrigation scheme in the world. There are a total of 94 feeders spread across the state of Gujarat covering about 4500 farmers. She further mentioned the following:

- An agreement has been signed between GUVNL and IWMI at GETRI Vadodara that aims to train ~ 2200 farmers on the aspect of solar panel cleaning and financial bills. This further aims at the impact evaluation of the SKY scheme from a farmer's perspective.
- She further gave an update on the first impressions from the extensive field visit taken up by IWMI researchers across various districts of Gujarat covering the relevant feeders accompanied by visits to the utility offices. She highlighted the importance of motor HP and contracted load, the role of utilities/agencies in explaining the study, the status of the existing groundwater markets, especially in the context of districts

under MGVC (Madhya Gujarat Vij Company Limited), how well the farmers have understood the scheme and if farmers have access to different sources of irrigation.

- **Feeder visits:** IWMI researchers visited the Mahakali feeder under UGVCL (Uttar Gujarat Vij Company Limited), wherein the feedback of the scheme was very positive. Dr Mukherji highlighted that the farmers have been very strategic in this area and have understood the scheme well. Under Ishnav feeder in MGVC, the farmer reviews have been mixed. There are good water markets in the region but not all farmers have understood the scheme well. On the other hand, the rate of selling water has increased after enrolment into the SKY scheme. There have been better incomes in year 2 than in year 1. Under Akash feeder in PGVC (Paschim Gujarat Vij Company Limited), the farmer reviews have been again mixed. There have been many instances of inverter breakdown under this utility with very less income generation, i.e., only 30 farmers have received incomes so far.
- A collaboration with Tel Aviv University is trying to find out the determinants of solar energy generation under the SKY initiative. Yashodha Yashodha and Aditi Sanjay from IWMI and Ram Fishman from Tel Aviv University are involved in this study
- Dr Mukherji gave a brief comparison of PR (Performance Ratio) vs CUF (Capacity Utilisation Factor), with CUF carrying across seasons. She further highlighted on the production being '0' under some feeders. Some possible reasons are SIM-related issues, inverter breakdown, unclean solar panels, etc. UGVCL has been performing the best under this scheme whereas DGVCL has been the least performing DISCOM under SKY
- She gave an update on the quick enumeration of farmers for 41 feeders. In the past two years, two main factors, viz., system downtime and learning effect by farmers were focussed upon. In most of the cases, the generation in year 2 has been better than year 1 with agencies giving better services in year 2 than in year 1. Furthermore, year 2 was a good monsoon year with better water availability.

Year 3 Work Plan

- Dr Yashodha Yashodha presented about the planned activities under year 3 that will include the compilation of data from SEDM portal and data from GUVNL, a survey of utility and agency officials via google forms, farmers household survey, status of informal water markets, etc.

Activity 3.1.1

- **Letter of agreement** between GUVNL and IWMI has been signed. A contracting process is underway wherein GERMI (Gujarat Energy Research Management Institute), Gandhinagar will assist IWMI in training ~ 2200 farmers across 45 feeders in Gujarat. Two major aspects of the training are operation and maintenance (cleaning of solar panels) and reading of financial bills. This training will be conducted in three phases starting mid-Feb/early March 2022. The first phase will be pilot training in five feeders. Phase 2 will include the implementation of the training in 43 feeders and phase 3 will include the delivery of training materials in online format via videos and WhatsApp forwards.

Discussions and Q&A

Question	Answer
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<p>Divya Kashyap, SDC: Q1. From the results of the emerging studies, are things going to change at the end? Q2. Whether utilities would be interested in understanding the difference of performance in different regions?</p>	<p>Yashodha Yashodha, IWMI - Response to Q1: Training materials will change the perception as O & M and financial bills will be understood better. As it will initially be in the pilot stage, learnings will be understood eventually.</p> <p>Dr Aditi Mukherji, IWMI -Response to Q2: When it comes to cleaning of solar panels, farmers do have an understanding, but they are still not aware of the correct timing of cleaning. Henceforth, more trainings will come up to train the farmers with additional trainings on agri-water management.</p>
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Dr Tushaar Shah, IWMI

- Farmers income has increased even though they are cribbing about the bills from MGVCL. But those farmers have earned as much more by selling water. In aggregate terms, if we take income from water sales, income from energy sale and income from whole irrigation, then for every SKY member it is higher than what it was earlier. Some farmer groups are building media pressure even though they are earning money.
- If you look at the aggregate data on generation, consumption and evacuation, here too the overall consumption has increased. Hence, there is a learning effect that needs better understanding.

Dr Aditi Mukherji, IWMI

- Dr Mukherji agreed with Dr Shah and stressed that the understanding of water markets will get better with the upcoming household survey slated to happen in 2022 which otherwise is difficult to capture from the secondary data available on the SKY data portal. In year 1, the real issues surrounded the maintenance of solar panels.

Dr Yashodha Yashodha, IWMI

- Many farmers have earned over the past two years. The evacuation has been more along with high loan and bill payments. But there is a burden to economise.

Dr Alok Sikka, IWMI

- He agreed with Dr Tushaar Shah and said that if there is an earning then paying bills should not be a problem.

Md Faiz Alam, IWMI

- I agree with the fact that if farmers have increased their market prices, they are earning more, but a lot of farmers retain those sellers and buyers. At the end of the day, someone has to pay higher for the losses incurred. In this process, someone will be at loss, and someone has to pay.

Dr Aditi Mukherji, IWMI

- Dr Mukherji agreed with Faiz. That is the reason, why the qualitative aspect has to be looked at or precisely the water markets. These are initial years with lots of learnings.

R Vala, GUVNL

- He appreciated the analysis given by IWMI researchers. He gave a brief about the PM KUSUM National workshop that was held on the 8th, 9th and 10th of December at GETRI (Gujarat Energy Training and Research Institute), Vadodara. He further mentioned that officials from Assam, Meghalaya, Tripura, Kerala, UP and other states took part in this workshop along with officials from MNRE (Ministry of New and Renewable Energy).
- Regarding injection, income and recovery, out of the 94 SKY feeders in Gujarat, around 91% of the farmers were injecting to the grid and the remaining 9% are on the net withdrawal side.
- Regarding DISCOM-wise performance, UGVCL (Uttar Gujarat Vij Company Limited) is very good with only 2% of the farmers drawing electricity. The next good performer is PGVCL (Paschim Gujarat Vij Company Limited), followed by MGVCL (Madhya Gujarat Vij Company Limited). In DGVCL (Dakshin Gujarat Vij Company Limited), the picture is not good, where over 31% of the farmers are drawing energy from the grid. Based on the energy injection and drawal, it affects their annual income, as the loan repayment component gets deducted from their income.
- On the generation front, there are three stakeholders, viz., farmers, agency and DISCOMs. If the power supply from DISCOMs end is smooth, not many problems arise. It needs to be ensured that the voltage levels are not high as it would affect generation. Agencies have to ensure the smooth functioning of the systems with fast delivery in case of a system breakdown, thereby ensuring the guarantee of generation and CUF. And farmers have to ensure that the panels are clean, and no shadow casting effect of trees or buildings happen. It should also be the responsibility of farmers to reduce consumption. If the consumption is greater than 800 units, then, bills have to be paid.
- He added as to why some feeders are performing good while some are not- when such a scheme is implemented on a large scale, every area is not equal. It depends on socio-economic behaviour, O&M, the ability to understand the whole scheme, etc. He highlighted the problems of pollution, dust, shadowing of trees, etc in the case of DGVCL feeders. During monsoons, the maintenance of feeders can become problematic
- He suggested having a detailed discussion on the training of 48 feeders with DISCOM officials and executive engineers
- To improve upon the functioning of GUVNL, there is a dedicated control room mechanism where problems related to specific feeders are monitored and reported upon. The achieving the designated CUF
- Awareness needs to be created among farmers to reduce their consumption. In areas under DGVCL, where farmers grow sugarcane, the fields are completely flooded as it is a water-intensive crop at the cost of huge energy consumption, i.e., water drawal for 12 hours.
- The executive engineers have to undertake site visits to ensure the performance of the SKY feeders. GUVNL will now switch over to KUSUM scheme (component C). Tenders have been floated for feeder-level solarisation, wherein a central level solar plant is installed to meet the irrigation power requirement for that particular feeder. Some incentives will be given to farmers who are virtually connected to the feeders. This scheme is in the pilot phase, i.e., 5 feeders in UGVCL and 5 feeders in PGVCL.

Action points:

1. To conduct a meeting with the concerned engineers of the DISCOMs to assess the training needs. He further mentioned that MD, GUVNL desires IWMI to be a part of the KUSUM scheme.
2. IWMI to fix a meeting with Shamina Hussain, MD, GUVNL.

Groundwater related- studies

- Md Faiz Alam presented in this session (activity 1.2.2) and he spoke on the need to understand the impact of upscaling solar irrigation on sustainability of groundwater
- He mentioned the policy question on what the possible impacts of large-scale adoption of SIPs on GW resources would be. The expected output will be to understand the evidence-based assessment of the likely impact of large-scale SIP adoption on groundwater sustainability
- Updates from the last meeting: census of farmers have been carried out that was followed by the selection of farmers. Data is being collected on a monthly basis for monitoring and installation that will help in generating a GW-energy relationship and validation and create a regional groundwater modelling. This will help in understanding future scenarios.
- Four feeders have been selected, viz., Parmeshwar and Gadhiya in Botad and Ishnav and Pachalipura in Anand. The census happened for 370 farmers, out of which 160 farmers have been monitored. 30 flowmeter installations have been done and 3 databases have been generated. The instrumentation readings for ultrasonic feeders have not been accurate, henceforth field installations have been increased in the last two months.
- A comparative analysis on the cropping pattern of Botad and Anand was presented. In Botad, it is predominantly cotton and for Anand, the major crop is paddy. There are extensive water markets in Anand. Drip irrigation is common in Botad whereas surface irrigation is common in Anand. The pump flow rates are lower in Botad than in Anand. The pump flow rate per energy consumption will give the per unit of energy per water use. Past data will be taken to derive the energy discharge relationship which will help to understand the future trends of GW abstraction, i.e., on the consumption front.
- Higher Hp Pumps will use greater energy. Preliminary results show that farmers using lower Hp pumps use much higher energy whereas farmers using higher Hp pumps are energy efficient.
- Factors like age, service, depth and type of pumps are also important for understanding efficiency. In terms of water consumption, this will help in deriving a relationship between water abstraction and energy consumed.
- Scope of future work: monitoring will be continued, and the work will be expanded in North Gujarat to compare the usage of solar vs non-solar farmers and to develop a groundwater abstraction-energy relationships based on Kharif and Rabi 2020-21 season and Kharif 2021-22.

Q&A

Q: RC Jain, GWRDC: What is the preliminary assessment of groundwater resources? How is it impacting the resources?

A: Md Faiz, IWMI: No preliminary idea as of now as the Kharif season had recently ended and cotton is not yet harvested, hence the water use has not been compared. Better insights on groundwater

consumption will be gained after February 2022, i.e., after the Rabi season. Post which it will be evident if there has been any specific water use.

Discussions

RC Jain, GWRDC

There is a need to focus on groundwater sustainability as groundwater is not quantified or economised. Understanding GW sustainability is necessary for resources management.

Alok Sikka, IWMI

The pumping behaviour is being looked into and the energy-discharge relationship will supplement. Most of the measurements got delayed because of field travel restrictions arising out of Covid-19. After 6 months, there will be a better understanding of pumping behaviour. He further mentioned that IWMI will only look into the consumption patterns and not look into groundwater assessment.

Aditi Mukherji, IWMI

The household survey will be carried out in March 2022 and the cropping patterns will be compared for SKY farmers (before and after). There has not been any extensive groundwater saving but the farmers have had better understanding of the SKY scheme from year 2. Faiz's study will be replicated in North Gujarat and others that will help us conclude better. As of now, there has been no major changes in the cropping patterns.

A quick assessment of Chief Minister's Saur Krishi Vahini Program in Maharashtra- IRMA

- Professor Saha and his team presented on the quick assessment of the Chief Minister's Saur Krishi Vahini Program (CMSKVP) in Maharashtra. He briefed about the scheme, the objectives therein, the expectations from the scheme and the advantages and disadvantages of the scheme
- Basic premise: these will be grid-tied and will be built by the solar developers/entrepreneurs. Consequently, power will be procured by the DISCOMs under long-term Power Purchasing Agreements (PPAs)
- This scheme will be implemented all over Maharashtra across six regions, viz., Nashik, Pune, Aurangabad, Amravati, Nagpur and Konkan divisions. The two main implementing agencies are MSEDCL (Maharashtra State Electricity Distribution Company Limited) or Mahavitaran and MSPGCL (Maharashtra State Power Generation Company Limited) or Mahagenco. The departments of Revenue, Agriculture and Tribal Development are involved in the implementation and monitoring. MoU route and competitive bidding are the two modes of project implementation
- Responsibilities of utilities:
 - Mahagenco will sign a tripartite PPA with SPD (Solar Power Development) and MSEDCL for 25 years
 - MSEDCL will provide evacuation facility
 - MEDA will register and provide validity gap funding (VGF) for the infrastructure
 - SPD will develop the project including O&M for a period of 25 years
- Advantages:
 - It will create a win-win situation
 - There will be a daytime power increase

- T&D losses will be reduced
- It will improve the overall efficiency of the power system
- Rationale of the study:
 - The rationale behind the study is to promote decentralised solar systems given the huge potential of solar energy in the country. Therefore, there is a need to assess the win-win claim of the scheme and the benefits accrued by the various stakeholders (farmers, government, installers and entrepreneurs)
 - This study will be carried out over a period of 9 months while coming out with a research paper as a key output.
 - Four sets of research questions will be looked into:
 1. The actual progress in physical and financial terms in implementing the CM Saur Krishi Vahini Program.
 2. The extent to which the original assumptions have been validated
 3. The experience of farmers benefitting from solar feeders
 4. The effectiveness with which solar pumps are used for lift irrigation and how it is rented out to farmers.
- Methodology and approach of the study will look into the following:
 - Purposive sampling of feeder plants
 - Primary survey, FGDs in study villages and control villages
 - Data analysis viz., grid availability, efficiency, CUFs, generation losses of selected plants
 - Stakeholders' interactions
- Pune, Aurangabad, Nashik & Dhule, Wardha, Amravati and Palghar will be the respective districts from each division selected for this study.
- The team members further mentioned about the progress made in MSKVY. A literature review has been carried out and as of February 2021, solar feeder projects have been approved in Nashik, Amravati, Nagpur, Aurangabad and Pune. 1826 MW of the project has been sanctioned, wherein two-thirds (1213 MW) has been implemented by Mahavitaran and one-third (613 MW) has been implemented by Mahagenco. A map showcasing the circle-wise PPA has been executed by private players through the bidding route as of October 2020 was presented. Another map showcasing the circle-wise installed and commissioned projects by EESL through the MoU route was presented. A total of 163.49 MW has been commissioned.
- The team further spoke about the private players involved in MSKSY across various districts. The advantages to the farmers, DISCOMs, government and off-grid SIPs under this scheme were laid out briefly.

Q&A

Q: Aditi M, IWMI: Can we get some data to understand the groundwater consumption? KUSUM (component A) is the Maharashtra scheme and KUSUM (component C) is the Gujarat scheme. How it incentivises farmers to use and not use groundwater? If there has been any change in the GW behaviour from the farmers' end, then it will be a very useful study for the team.

A: IRMA team: This aspect has already been put up as one of the research questions.

Presentation by ATREE

- Anjali Neelakantan, Centre for Social & Environmental Innovation (CSEI), ATREE presented briefly on the scope of solar irrigation.
- A preliminary theoretical decision framework has been developed by ATREE. Solar irrigation is being introduced in a context where irrigation access is skewed. She focussed on the 'Goldilocks dilemma' of groundwater, wherein too much or too little irrigation could be a problem. The rainfed farmers and the farmers that irrigate using GW co-exist in the same villages
- Solar irrigation systems are introduced as supply side and demand side interventions. Under the current design, farmers are offered a feed-in-tariff with net metering that forces them to choose between selling the electricity to the grid or pumping groundwater
- The study will help in identifying the existing knowledge gaps. The first knowledge gap is how access to solar irrigation impacts groundwater abstraction. Secondly, what is the predicted ratio of electricity sold vs used in pumping change in different feed-in tariffs. Thirdly, how the GW pumping will compare with water recharge or GW availability.
- This study will be addressed as an agent-based modelling approach. When solar irrigation is introduced in an area, the farmers are given the choice to grow particular crops (less-water intensive) and increase their water use efficiency. Additionally, they may buy or sell surplus water or invest in different water technologies like drip or sprinkler. She further mentioned that the collective impact depends on the cumulative decision by thousands of farmers in a particular region.
- To understand these knowledge gaps, five research questions have been identified, viz.,
 - The different types of farmers in a region
 - Crops grown by different types of farmers before and after solar irrigation for different FiT scenarios
 - Water application to a crop before and after solar irrigation for different FiT scenarios
 - The total GW abstraction before and after each scenario.
 - If the total abstraction increases, will it result in a substantial decline in the water table?
- The modelling framework is theoretical. ICRISAT's district level data set will be used to understand the %age of land area under different types of crops. Tumkur district will be taken up as a case study for this decision-making framework and the primary crops grown in the region are- fingermillets or Ragi; arecanut and paddy. The different modes of irrigation will be understood for these crops
- Two possible transition pathways would be plotted, i.e., for rainfed farmers and high water-intensity farmers. Two scenarios will be available for rainfed farmers, viz., no change in the area of cultivation and the purchase of excess water for protective irrigation. Secondly, for high-water intensity farmers, three scenarios will be considered, viz., no change in the area of cultivation, switching to a lower water intensity crop and adopting water technologies like drip irrigation
- Crop water production functions (CWPF) will be estimated to identify the optimal amount of water required for maximum crop productivity. This can be arrived at by converting CWPF into a demand curve for groundwater while the FiT serves as the supply curve. The intersection will determine the different trade-offs adopted by farmers
- Using crop water requirement and effective rainfall, the irrigation water requirement will be arrived at. If the irrigation needs increase, it will lead to depletion of groundwater resources
- GW recharge will be estimated by using principal GW maps provided by CGWB

- Tumkur district has been taken up as a case study where a farmer predominantly grows paddy using standard flood irrigation technique. Three possible transitions have been envisioned. In the first scenario, the farmer uses 50% of flood irrigation and 50% of solar; in the second scenario, the farmer uses 50% of SRI technique and 50% of solar. In the third scenario, the farmer completely switches to solar farming
- All these transitions are economically remunerative to the farmers
- To understand the GW impacts, a agent based model will be applied to do the following:
 - To estimate the demand-supply curves for GW for six crops (May 2022)
 - To visualise GW recharge at a district level in India using 10 year average rainfall, nationwide (May 2022)
 - To compare district wise abstraction and recharge before and after solar irrigation for six different types of districts (June 2022)
 This will be a completely theoretical framework that will be helpful in understanding long-term implications.

Discussions and Q&A

- **Veena Srinivasan, ATREE**, suggested having a workshop in January 2022 on the above-mentioned topic to synergise better. This study will be aimed at arriving at a suitability map.
- **Dr Alok Sikka, IWMI**, agreed that once farmers switch onto the solar system they will be incentivised better. This will help in water conservation and switching to water conservation crops.
- **Question by Divya Kashyap, SDC**: We are looking at certain pathways, which we expect will impact the behaviour or how the water use will change. However, the experiment from Gujarat does not seem to reflect that. How are we going to look at that? Considering we are looking at this as a typology across India, are similar studies available from other locations in India so that your study could be better informed?
- **Answer by Dr Aditi Mukherji, IWMI**: To the best of our knowledge, the other studies that CEEW and Prayas are doing, hardly any of it goes to crop choice or cropping pattern. In the mini workshop that we will take part will make it clearer through consultations with other organisations. The energy allocations through SKY have gone up by 40%, so the farmers are not making those hard decisions to change cropping patterns.
- **Dr Alok Sikka, IWMI** agreed to what Dr Aditi pointed out. If the farmers won't reap any benefits out of a crop change, then it becomes very hard for them to change their cropping patterns. It becomes especially tough from a long-term perspective. The crop diversification is yet to catch up. Unless, it is a remunerative trade off, farmers are not going to change their cropping patterns.
- **Veena Srinivasan, ATREE**: This is why we are focussing on building a model nationwide considering all these factors. We would also like to be informed about the field learnings, as looking into empirical data has not been our mandate so far. Hence, there is a need to harmonise each other's learnings.
- **Question by Yashodha Yashodha, IWMI**: Is it possible to also incorporate the scenario of including solar irrigation with an attractive package? What could be the profitability at different levels?
- **Answer by Veena Srinivasan, ATREE**: Anjali has already mentioned, but we will define it more as we progress further.

Closing remarks

- Dr Alok Sikka thanked everyone for their presence in this lively and constructive discussion. The presentations were well laid out. With upcoming field trips, there will be better insights to share after six months.
- Dr Aditi Mukherji mentioned about the importance of field trips and how they have been instrumental in understanding the data better.

Meeting notes prepared by Ms Zeba Ahsan, IWMI.

Annex 1: Agenda

Sl no	Agenda	Presenter	Allotted time
1.	Introductory remarks	Dr Alok Sikka	5 mins
2.	Activities carried out since last C-PMC and Year 3 work plan	Dr Aditi Mukherji	15 mins
	Activity 2.2.2: insights from field, solar energy generation	Yashodha	10 mins
	Activity 1.2.2: Groundwater related studies	Md Faiz Alam	10 mins
	Activity 3.1.1: Farmers training	Yashodha/Aditi Mukherji	5 mins
3.	Discussions on findings		15 mins
4.	IRMA: A quick assessment of Chief Minister's Saur Krishi Vahini Program in Maharashtra	Prof Uday Shankar Saha, IRMA	10 mins presentation+ 5 mins discussion
5.	ATREE: Solar irrigation suitability and typologies across India	Anjali Neelakantan, ATREE	10 mins presentation + 5 mins discussion

Annex 2: List of participants

Sl no	Name	Role	Institution	Attendance
1	Dr Alok Sikka	Chair	IWMI Country representative	Yes
2	Rajendra Vala	Member	Representative of GUVNL	Yes
3	Veena Srinivasan	Member	Representative of ATREE	Yes
4	Anjali Neelakantan	Invitee	Representative of ATREE	Yes
5	Divya Kashyap	Member	SDC Representative	Yes
6	Dr Ratan Jain	Member	Representative of GWRDC	Yes

7	Dr Tushaar Shah	Member	IWMI	Yes
8	Nilanjan Ghose	Member	Representative of GIZ	No
9	Prof Uday Shankar Saha	Invitee	Representative of IRMA	Yes
10	Dr Yashodha Yasdodha	Member Secretary	IWMI	Yes
11	Dr Aditi Mukherji	Member	IWMI	Yes
12	Aditi Sanjay	Invitee	IWMI	Yes
13	Md Faiz Alam	Invitee	IWMI	Yes
14	Zeba Zoariah Ahsan	Invitee	IWMI	Yes

Abbreviations: ATREE is Ashoka Trust for Research in Ecology and the Environment; GIZ is Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH; GUVNL is Gujarat Urja Vikas Nigam Limited; GWRDC is Gujarat Water Resources Development Cooperation; IRMA is Institute of Rural Management Anand; IWMI is International Water Management Institute; SDC is Swiss Agency for Development and Cooperation

Annex 3: Photo Section

