International Water Management Institute

SE4RL Solar Energy for Rural Livelihoods

IWMI-TATA Water Policy Program

Benchmarking Solar Pump Performance

Off-Grid Solar Irrigation Pumps in Eastern and Central India

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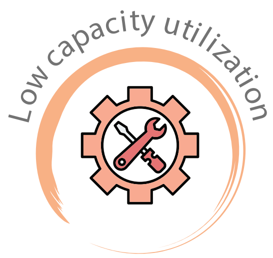
Context

In 2012-13, when the IWMI-Tata Program (ITP) first started working on solar-powered irrigation, we believed that these can transform the energy-starved and (relatively) water-abundant agrarian economies in eastern and central India by delivering high-quality, zero-marginal-cost energy for irrigation. A lot has changed since then. While solar pumps have been expanding – thanks to several government and non-government initiatives – their expansion in this region has been somewhat slow. Except for Chhattisgarh (and its *Saur Sujala Yojana*), most states in eastern and central India have witnessed sluggish expansion of solar irrigation. Even more surprising is the data from the GIZ-supported survey of ~1000 solar pumps which found that solar pumps in Odisha and UP operated for only 15-41 days (100-300 hours) in a year, compared to surveyed solar pumps in Rajasthan and Tamilnadu where they were operated for 130-178 days (750-1050 hours) annually (GIZ 2021).



Over the last several months, ITP researchers and partners have been undertaking field work in eastern and central India to understand the drivers of performance and impact of solar irrigation pumps. We've covered plains of north Bihar – where Aga Khan Rural Support Programme, India (AKRSP-I) has established several off-grid solar irrigation entrepreneurs with support from IWMI/CCAFS, Axis Bank Foundation, and several others (in Muzaffarpur, Samastipur and Vaishali). We've surveyed several community and private entrepreneur operated solar irrigation systems in East Singbhum and neighbouring districts of Jharkhand. We spoke with a few users of Khethworks' MicroSIPs – powered by 340 watt-peak solar panels for a 1-HP-equivalent discharge – supported by CInI in tribal Odisha. We've also covered a few solar enterprises established by Oorja with support from Aga Khan Foundation (AKF) and Sustain Plus Energy Foundation (SPEF) in Bahraich, eastern UP.

Solar pumps are expensive capital assets and almost all of them are deployed with some grant support, direct or indirect, government or non-government. While we did meet some exceptionally enterprising operators and user-groups, most of these systems are not able to take full advantage of the energy generation capacity of the installed solar array. One reason for this – we hypothesize – might be the way these systems are financed. In most cases, the primary objective is to deliver 'clean and affordable energy access to the poor' – not necessarily with the objective of recovering or profiting from the capital invested. However, once access has been delivered, it is imperative that efforts be made to ensure that the deployed assets yield the highest 'social return on investment' for farmers and for society.

Benchmarking: Scope and Parameters

As part of the IWMI-CInI collaborative action research initiative SE4RL (Solar Energy for Rural Livelihoods), a benchmarking study is proposed to understand the drivers of performance and impact of off-grid solar irrigation pumps. The benchmarking exercise will initially be undertaken in three geographies – Bahraich and Barabanki (eastern Uttar Pradesh), Muzaffarpur and Samastipur (north Bihar) and East Singhbhum (Jharkhand) – and can later be scaled out to other districts in the region.

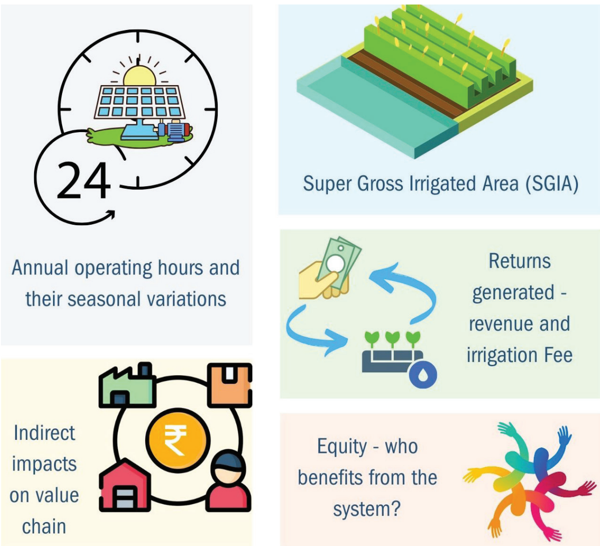
SE4RL has concluded agreements with AKRSP-I and Oorja for data and field support in Bihar and UP. SE4RL is also in the process of recruiting consultants who will oversee this work in the states. We expect to cover roughly 300 off-grid solar irrigation systems that have been operational for more than 12 months. The benchmarking exercise will include a census of all these systems. For each system, data on the following parameters will be collected:

a) ***Annual Operating Hours:*** This is the primary indicator of performance of an SIP. The operating hours across the three major cropping seasons (*Kharif*, *Rabi* and Summer) will be estimated based on RMIS data (where available) and/or survey of pump operators. The seasonal variation in operating hours would enable us to identify peak usage hours and compare the performance of solar pumps to conventional pumps.

b) ***Irrigated Area:*** The performance of an irrigation system can be measured by the expansion of irrigated area as well as the increase in frequency of irrigation.

Solar irrigation pumps incur zero marginal cost for additional pumping hours, and hence are expected to increase both frequency and the gross irrigated area. We will use the concept of "Super Gross Irrigated Area" (SGIA) to assess their performance in this regard. If an acre of land is irrigated once in Kharif, three times in Rabi and five times in Summer, this is measured as (1*1) + (1*3) + (1*5) = 9 acres of SGIA. This metric enables us account for changes in cropping as well as irrigation intensity.

c) ***Revenue and Irrigation Fee:*** Solar pumps entail huge capital investment but have very low operational cost. This mimics a high flat rate tariff regime for electric pumps, which have driven competitive irrigation service markets in several parts of the country. With this parameter, we will map the returns the systems are able to generate. Where the users are required to pay a non-trivial irrigation service fee, we hypothesize that the operators will face higher performance pressure and users will demand better quality irrigation service. Where the systems



have been deployed with high subsidies, our null hypothesis is that the system will under-perform due to lack of incentives and the tendency for 'satisficing' behaviour as opposed to the 'maximizing' instinct of entrepreneurs with higher private equity.

Photo credit: IWMI

d) ***Irrigation Operations:*** We will also survey to understand the operation and practices adopted by the operators and farmers. Who runs the system, who manages the distribution network, who maintains records, how long does it take to irrigate an acre of land… and so on. The last parameter can be an indicator of the relative efficiency of the system. Systems that can irrigate more area in less time can service larger command area, with lower labour cost. Efficient, time and labour-saving operations should be the hallmark of high performing systems.

e) ***Equity:*** An important benchmark of performance is 'who benefits from the system' – who are the beneficiaries – men or women, small or large farmers, tribal or non-tribal, and so on. To understand this, we will conduct FGDs and or interviews of irrigators as well as non-beneficiary / non-participating farmers in the vicinity of the scheme.

f) ***Indirect Impacts on Value Chains:*** Finally, the impact of SIPs is unlikely to be limited to the crop economy. We will also try to undertake a qualitative assessment of the spill-over impact of SIPs on village water security, allied value chains (dairy, fisheries, animal husbandry), local labour economy and rural livelihoods in the village.

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