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SCALING FOR  
IMPACT**



Photo by IWMI

**SUCCESS STORY**

**Scaling of Grid-Connected Solar Irrigation Pumps: Key Lessons from India**

**Innovation Name**

Solar Power as a Remunerative Crop (SPaRC): From a farmer level pilot to a national level scheme of grid-connected solar irrigation pumps enhancing farmers' income

**Location (Country/Region)**

India



**Lead centres**

International Water Management Institute

**Contributing Initiative/s/  
Bilateral project/s**

IWMI-Tata Water Policy Program  
Solar Energy for Agricultural Resilience

**Innovation Type**

Service Practice

**Current Innovation Readiness Level**



Proven Innovation

**Current Innovation Use Level**



End-Users/Beneficiaries (II)

**Scaling Dimensions Achieved**

Scaling Up Scaling Out Scaling Deep

**Challenge Addressed**

Knowledge & Information Systems

**Enabling Environment Methods**

Co-designing, Conferences, workshops and field visits, Difference-in-difference

**SDG Targets**



**CGIAR Impact Areas**



Solar irrigation pumps are promoted extensively in the Global South as a beneficial technology that provides multiple benefits like alternative water access, decentralized energy access, GHG mitigation while simultaneously improving irrigation energy access for farm households. Recent studies highlight that gains from emission reduction might be overestimated, and perverse incentives could lead to groundwater overexploitation, as evidenced in some regions. Grid-connecting solar pumps and offering attractive power buyback options could incentivize achieving multiple objectives: reducing farm power subsidies, reducing technical losses, and encouraging judicious use of groundwater through income from surplus energy sales. Policy instruments like feed-in tariffs, conducive legal frameworks, and complementary investment in grid infrastructure can enable upscaling the adoption of grid-connected solar pumps in different geographies. However, effective implementation of grid-connected solar pumps requires addressing information asymmetry between farmers and electric utilities through transparent monitoring protocols and capacity building programs to bridge information and capacity gaps among farm households.

**Context and Ambition**

The International Water Management Institute (IWMI)-Tata Water Policy Program (ITP), a co-equal partnership between Tata Trusts and IWMI, successfully demonstrated the feasibility of grid-connecting solar irrigation pumps with attractive power buyback clauses as an alternative model for solarization in groundwater-stressed regions. The demand for daytime farm power supply, coupled with the state's push for green energy transition in agriculture, led to the model being scaled out under the Suryashakti Kisan Yojana (SKY) scheme. Digital platforms (like the SKY app) were developed by the government to share information with farmers and electric utilities on the generation and sales of surplus electricity to the grid. Despite the scaling, information gaps remained among stakeholders, particularly farmers, regarding the specifics and financial benefits of SKY, operation and maintenance of solar pumps, and the use of digital platforms for managing generation and sale of surplus power. These information and capacity gaps in turn led to limited energy savings and a failure to replicate the gains witnessed in field pilots. Limited capacities of distribution companies (DISCOMs) in engaging with farm households required the development of training programs and modules to address information gaps about the scheme, as well as the maintenance and utilization of assets.



Members of DSUUSM solar irrigation cooperative.

Photo by IWMI

### Creating the Enabling Environment for Scale

IWMI pilot-tested the technical viability of grid-connected solar pumps in Thamna village in central Gujarat. The pilot demonstrated the feasibility of using “Solar Power as a Remunerative Crop” (SPaRC) by selling surplus power to the grid and generating income. The potential for scaling grid-connected solar pumps was further examined through the establishment of a solar irrigators co-operative: “Dhundi Saur Urja Utpadak Sahakari Mandali” (DSUUSM) in central Gujarat. The solar irrigation co-operative DSUUSM entered into a 25-year agreement with the local DISCOM to sell surplus power. Organizing the solar irrigation co-operative demonstrated an institutional model that reduced transaction costs and ensured improved operations and maintenance of grid-connected solar pumps. IWMI also offered a clean energy and groundwater conservation bonus to farmers for three years in the form of some additional money per unit electricity sold to DISCOM along with the tariff that they were getting from the DISCOM. This was provided to nudge farmers toward sustainable groundwater use, in addition to offering training and capacity building programs on day-to-day tasks such as the maintenance of solar pumps, energy saving tips, and presenting information about the water-saving technologies. The success of Dhundi was later replicated in another pilot project in Mujkuva in central Gujarat in partnership with the National Dairy Development Board (NDDB).

The success of the pilot project later influenced the design of the Government of Gujarat’s SKY scheme. IWMI supported the SKY by helping identify feeders to be solarized in central and western Gujarat and

organizing the potential beneficiaries into solar irrigation co-operatives in ten feeders. SKY offered a bonus feed-in tariff (FiT) toward loan repayment for seven years, inspired by the financial design of DSUUSM. Similarly, the upfront payment was capped at 5% to increase enrollment. SKY later inspired Component C1 of the Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan (PM-KUSUM) scheme, focused on individual pump solarization which allows farmers to install SKY like grid-connected solar pumps and help them earn income through energy sales.

Despite the scaling efforts, SKY faced operational challenges due to a limited understanding of the financial benefits, capacity gaps in day-to-day maintenance activities of solar pumps, limited awareness of digital platforms developed under SKY, and high feeder losses. To address the capacity and information gaps and facilitate the scaling of SKY beyond initial targets, training programs and modules were designed and administered in collaboration with local partners by IWMI under Solar Energy for Agricultural Resilience (SoLAR-SA) Project funded by Swiss Agency for Development and Cooperation (SDC).

### The Intervention and Actions

IWMI began the effort toward sustainable scaling of solar irrigation in groundwater-stressed regions by demonstrating the technical feasibility of selling surplus power to the grid by solar pump users in Thamna village in central Gujarat. Scaling the innovation required the design of financial and institutional models, which were piloted through the world’s first solar irrigators co-operative, comprised

***“We would like to adopt SKY as it will provide day-time electricity and potential additional income”***

- **Satishbhai Patel**, Vishnupura farmer and SKY non-eligible farmer in the Uttar Gujarat Vij Company Limited (Distribution Company) service area

*“There are still many unresolved issues with SKY Scheme implementation. The farmers’ training was helpful but the core challenges related to feeder maintenance causing voltage fluctuation and frequent burnout of the inverters on top of frequent theft of hardware are frustrating us. We requested certain changes in the implementation strategy such as allowing consolidated adoption of the solar systems to reduce maintenance issues.”*

- **Piyushbhai Bhakta**, Rupwada farmer and SKY adopter in the Dakshin Gujarat Vij Company Limited (Distribution Company) service area

of ten farmers, in Dhundi village in Central Gujarat. The pilot was supported by the CGIAR Climate Change, Agriculture and Food Security (CCAFS) program. The pilot demonstrated the viability of “Solar as a Third Crop” for smallholders while simultaneously meeting their irrigation needs. The provision of clean energy and groundwater conservation bonuses increased the financial viability in the initial stages. The co-operative model was replicated with NDDDB in Mujkuva and later in the SKY scheme in ten feeders.

The scaling of the innovation was facilitated by bundling long-term loans with Solar Irrigation Pumps scheme, with an additional FiT of USD 0.039 per unit for seven years, financing the repayment in the future. The grid integration of SIPs ensured day-time power supply, provided incentives for sustainable groundwater management, and reduced electricity subsidies.

Training programs were designed and implemented in partnership with local stakeholders like DISCOMS and the Gujarat Energy Research and Management Institute to address information gaps, improve the scheme’s efficacy, and increase future enrollment.

Grid-connected SIPs were scaled up through SKY in Gujarat and later through PM-KUSUM across India. IWMI has strongly advocated for grid-connecting solar pumps in multiple forums. IWMI partnered with multiple stakeholders, including local DISCOMS and NDDDB, in demonstrating the feasibility of grid-connecting solar pumps through field pilots. Field visits

were organized for government officials to interact with solar irrigation co-operative members to understand their feasibility and impact. IWMI has been a technical partner for individual pump solarization for the Gujarat Energy Development Agency (GEDA) and the Uttar Pradesh New and Renewable Energy Development Agency (UPNEDA).

### Results and Impact

The SKY scheme in Gujarat successfully solarized 91 agricultural feeders, benefiting over 4,000 farmers across the state. This initiative provides farmers with reliable day-time power access and the opportunity to earn additional income by selling surplus solar energy back to the grid. This surplus sale option has also encouraged farmers, particularly those in water-stressed regions of north and west Gujarat, to optimize their groundwater use for irrigation. Farmers participating in SKY have generated an average annual additional income of over USD 257 from electricity sales, which represents approximately 43% of their income from crops.<sup>1</sup> Furthermore, SKY farmers consume significantly less power on average than their non-SKY counterparts, a consumption gap that has continued to widen over time.

### Reflection and Learning

Scaling grid-connected solar pumps requires capacity building of farmers, as grid-connected solar is a relatively novel technology. Other essential factors



Training of SKY farmers in DGVCL.

Photo by Shaishav Raj, GERMI

<sup>1</sup>Varshney, D., Mukherji, A., Sharma, K., Banerjee, A., Sikka, A. (2026). Solar irrigation and just energy transitions in agriculture: Insights from evaluation of Gujarat’s SKY program. Energy Policy, Volume 210. <https://doi.org/10.1016/j.enpol.2025.114999>.



## Partners

- Tata Trusts
- Swiss Agency for Development and Cooperation
- Gujarat Energy Research and Management Institute
- CGIAR Research Program on Climate Change, Agriculture and Food Security



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include investment in grid infrastructure, attractive feed-in tariffs, conducive legal frameworks, and after-sales services.

The project demonstrates strong performance in affordability and inclusivity, but its sustainability is currently contingent on external support which includes 65% of the total investment as loan taken by Government of Gujarat on behalf of farmers.

The innovation was made affordable to end-users because the upfront payment requirement was low. Furthermore, the financial burden was managed by linking subsequent payments to the farmers' income generated from surplus energy sales to the grid. This design also enhanced inclusivity by making the technology accessible to a wider range of farmers.

In terms of sustainability, the model significantly reduced infrastructure costs by undertaking scaling and upgrades at the feeder level, thereby minimizing transmission losses and expenses. Moreover, by incentivizing both energy and subsequent groundwater conservation, the scheme effectively minimized negative environmental trade-offs. However, it is important to note that the innovation is not financially sustainable in its current form without ongoing government subsidies.

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