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GOOD PRACTICE NOTES ON INSTITUTIONAL INNOVATIONS

FOSTERING GREEN GROWTH THROUGH SOLAR COOPERATIVE

| 2

Holding a vision of Lifestyle for Environment (LiFE), and with a target of net-zero carbon emission by 2070, India plans to usher in a green industrial and economic transition through a movement with an environmentally conscious lifestyle. One of the credible options for a continuous, predictable, accessible and cost-free green energy source is solar power. In the agricultural sector, one of the key innovations in promoting solar irrigation was the initiation of the world's first ever Solar Cooperative – Dhundi Solar Energy Producers' Cooperative Society (DSEPCS) – in Gujarat, India. It addressed several key issues challenging the promotion of solar irrigation by creating a conducive environment, attracting investment, providing technical and consulting services, building capabilities among member farmers, connecting to Madhya Gujarat Vidyut Company (MGVCL) to buy back surplus solar energy, and ensuring an additional source of income for farmers in the region. This helped in popularizing and promoting the use of solar water pumps for bringing irrigation efficiency in the region and replacing electric and diesel pump sets. This intervention has the potential to save a significant amount of power subsidies and to provide additional income to the farming community.

In this Good Practice Note, KK Tripathy and SK Wadkar discuss this notable institutional innovation.

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CONTEXT

India, with a population of 1.4 billion, has surpassed China to become the world's most populated nation. This rise in population, along with impressive economic growth, has intensified energy demands (Figure 1).

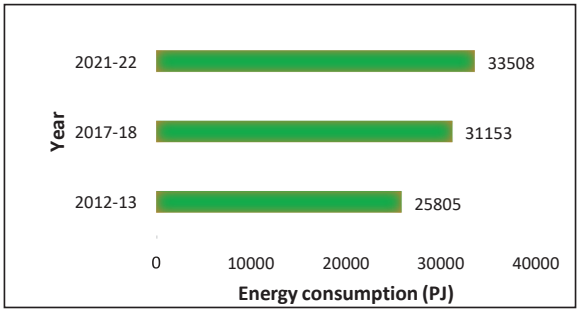

Figure 1. India's energy consumption(in Petajoules)

Approximately 80 per cent of India's energy need is met through coal, oil and biomass. One of the critical challenges faced by India's power sector is the insufficient supply of coal and natural gas, leading to reduced or sub-optimal performance of power plants. India is very dependent on energy imports, especially coal, crude oil and, natural gas. This situation seriously affects the country's energy security, straining the nation's trade balance.

India has enormous potential to harness renewable energy sources. India occupies the fourth position in terms of installed capacity of renewable energy from hydro, wind and solar energy. As of June 2023, India's solar power installations had a combined capacity of 70.01 Gigawatt (GW). The National Institute of Solar Energy (NISE) has estimated India's solar potential to be approximately 748 GW. The Union Budget 2023–24 advocated 'green growth' and offered a policy push for achieving all-inclusive green energy sufficiency. Widely recognized as effective, abundantly available as well as environmentally friendly, solar energy is gradually replacing fossil fuels. Fossil fuels release carbon dioxide contributing significantly to greenhouse gases in the environment, increasing global warming. To ensure a more sustainable and secure energy future for the planet, transitioning to sustainable and renewable energy sources such as solar energy is critical. Box 1 discusses some of the key initiatives taken up by the Government of India for promoting solar energy.

Box 1: Promoting solar energy: Key Initiatives of the Government of India

- **Pradhan Mantri Kisan Urja Suraksha evam Utthan Mahabhiyaan (PM KUSUM)** is a central government scheme aimed at adding 30,800 MW of solar and other renewable capacity by 2022. It consists of three components:
- **Component A:** Installing 10,000 MW of solar capacity through small Solar Power Plants, each with individual capacities of up to 2 MW;
- **Component B:** Deploying 20 lakh standalone Solar Powered Agriculture Pumps;
- **Component C:** Solarising 15 lakh grid-connected Agriculture Pumps.

Additionally, the **Grid Connected Solar Rooftop Programme** aims to achieve 40,000 Mega Watts of cumulative installed capacity from Grid Connected Rooftop Solar projects. Moreover, the Development of Solar Parks and Ultra Mega Solar Power Projects scheme targets setting up at least 25 Solar Parks and Ultra Mega Solar Power Projects, with a goal of 40,000 MW of solar power installed capacity by 2023-24.

The Suryamitra Programme, launched by India's Ministry of New and Renewable Energy (MNRE) in 2015, aims to develop skilled manpower in solar energy to meet the increasing demand for trained individuals in

installation, operation and maintenance of solar power systems under the National Solar Mission. The National Institute of Solar Energy (NISE), Haryana coordinates the training, with a target of creating 50,000 Suryamitras by 2019-2020.
The programme spans three months, encompassing 600 hours of training, including classroom sessions, lab practicals, exposure to solar power plants, on-the-job training, soft skills, and entrepreneurship skills. The host institute also assists trainees in finding placement opportunities. As of May 2022, a total of 51,331 Suryamitras have already been trained through this initiative, of which 26,967 Suryamitras got employment.

AGRICULTURAL SECTOR AND SOLAR ENERGY

The Indian agricultural sector uses about 20 per cent of the total electricity consumption, especially for irrigation. In some states the energy utilization for irrigation has been recorded as high as 30-50 per cent of the total electricity consumption. Majority of India's rural areas lack effective access to power networks, thus depriving farmers of a reliable source of electricity, particularly for irrigation. Installation of solar panels is crucial as it provides farmers with access to reliable and secure power supply. 'Solar pumps' are crucial tools which can ensure irrigation facilities where conventional water systems cannot reach, such as India's high-altitude mountainous terrains. The Ministry of New and Renewable Energy reports that the country uses about 20 million diesel pumps and 8.8 million electric pumps for irrigation. Thus, there is a case for promoting solar-powered irrigation to lighten the load on the grid.

SOLAR COOPERATIVES

Rationale

In India, 89.40 per cent of about 140 million farmer households own less than two hectares of land. Majority of them neither have suitable rooftops to install solar panels nor do they have finances to independently install panels at their home or farm.

So, if farmers could be mobilized as cooperatives, it will enable and empower individual farmers to participate in solar energy generation, allow them to invest according to their capabilities, and then receive benefits through collaborativeefforts. It will also ensure economies of scale through bulk purchases of solar panels and equipment, lower installation costs, reduced expenses towards maintenance and operations, etc. Keeping these aspects in mind, the world's first solar cooperative, Dhundi Solar Energy Producers' Cooperative Society (DSEPCS) was established in Gujarat in 2016.

Dhundi Solar Energy Producers' Cooperative Society (DSEPCS)

The DSEPCS was registered on February 16 2016, under the Gujarat Cooperative Societies Act of 1961 in Dhundi village of Kheda district of Gujarat, India. This innovative cooperative was promoted andnurtured principally by the International Water Management Institute (IWMI) under IWMI-TATA Water Policy Research Program and CGIAR - Climate Change, Agriculture, and Food Security Program (CCAFSP).

Meeting with potential farmer members ©Mahesh Parmar

The cooperative's efforts were directed towards increasing access to irrigation using solar pumps and enhancing farm income through adoption of water-efficient technologies such as drip irrigation. The cooperative made a 25-year Power Purchase Agreement (PPA) with Madhya Gujarat Vidyut Company Ltd (MGVCL), ensuring a stable income for farmers without price risks.

Initially, farmers faced difficulty in adopting the technology due to unfamiliarity and anxieties about solar irrigation pumps as compared to traditional diesel pumps. To address these concerns, IWMI together with promoter farmer members conducted field visits and instituted pilot studies to demonstrate the benefits of solar pumps. IWMI helped the farmers in the preparation of bye-laws as well as the registration process.

A timeline showcasing the evolution of DSEPCS is given in Table 1 below.

Table 1. Timeline of the evolution of DSEPCS

Year	Major events
2015	• Informal discussion organised by IWMI with Dhundi villagers about the formation, memberships, and activities of proposed cooperative in this emerging sector; • Field pilot study conducted by IWMI to underscore the benefits of environmental-friendly activities; • Installation of solar panels at Member Farmers' agricultural fields; • Start of using solar pumps to pump water from members' own borewell, for irrigating theirs and neighbouring farmers' fields.
2016	• Formal registration of the cooperative under the Gujarat Cooperative Societies Act 1961; • Design of governance model for smooth operation of the cooperative; • Establishment of grid infrastructure; • Long-term Power Purchase Agreement (PPA) signed with the Madhya Gujarat Vidyut Company Limited (MGVCL) for 25 years; • Installation of cooperative energy meter; • Provision of water conservation bonus and green energy bonus by Promoting Institution (i.e., IWMI); • Joining of three new members, taking up the total number of members in the cooperative to nine.
2017	• PPA signed for three new members
2018	• End of bonus offered by IWMI after 2 years
2023	• Installation of pipeline for easy availability of pumped water in farmer's field

FUNDING

IWMI provided initial financial assistance under the TATA Water Policy Research and CCAFS Project. The initial cost for the first 56.4 kilowatts peak (kWp) solar pump and micro-grid installation was about INR5,065,000 (USD 60,965.89). This initial cost was inclusive of Solar Irrigation Pumps costing INR 3,499,400 (USD 42121.23); and a Microgrid with other peripherals worth INR 1,565,600 (USD 18,844.66). IWMI and six promoter member farmers of the Cooperative contributed INR 4,600,000 (USD 55,368.82) and INR 465,000 (USD 5,597.07), respectively. After seeing the advantages experienced by the promoter farmer members, three new farmers expressed their willingness to join the cooperative with a financial contribution of INR 25,000 per kilowatt power.

IWMI facilitated equitable provision of a uniform rate to all member farmers, specifically amounting to INR 4.63 (USD 0.056) per unit sale of energy. Members of this cooperative use solar power not only to run the irrigation pumps, but also to pool the surplus energy for sale to the MGVCL at INR 4.63 (USD 0.056) per unit under a 25-year PPA. Initially, IWMI's project offered INR 1.25 (USD 0.015) per unit as Green Energy Bonus and another INR 1.25 (USD 0.015) per unit as Groundwater Conservation Bonus, taking the total payout per unit to INR 7.13 (USD 0.086). In May 2016, the Dhundi Cooperative received their first payment for solar energy sales. And by December 2016, the cooperative had already earned more than INR 160,000 (USD 1926.49) from energy sales.

Solar panels in a members' farmer field ©DSEPCS

INSTALLED CAPACITY OF THE SOLAR PLANT

The DSEPCS has six solar pumps, having an aggregate capacity of 56.4 kilowatt-peak. The cooperative can potentially generate nearly 85,000 units (kilowatt-hours) of energy annually, assuming an average 5 units per KW daily over 300 sunny days. Of these, six farmer members use 40,000 units for irrigating seven acres of their land and put in the remaining 45,000 units into the grid.

Solar power is much cheaper than diesel power. It is estimated that 7500-8000 litres of diesel are required for producing 40,000 units of power for equivalent groundwater pumping. 24x7 power supply through solar energy is more reliable than subsidized grid power that is available for 7-8 hours.

STAKEHOLDERS AND THEIR ROLES

The roles played by the four key stakeholders associated with DSEPCS are presented in Table 2.

Table 2: Stakeholders and their roles

No.	Actors	Roles
1	**Farmers**	The farmers are the primary stakeholders of DSEPCS as they own the land where the solar panels are installed. To be a member, the applicant should have a minimum of 0.025 acres of land with a well, at a distance of one kilometer (km) from the Society, and should purchase at least one share and pay an admission fee of INR 51. They are expected to actively participate in decision-making processes to avail benefits from the Solar Photovoltaic System.
2	**Madhya Gujarat Vidyut Company Limited (MGVCL)**	MGVCL is the electricity distribution company that signed a PPA with DSEPCS. This agreement allows the cooperative to inject surplus energy into the MGVCL grid from the 100 KW solar system set up on farmers' land.
3	**International Water Management Institute (IWMI)**	IWMI, under the IWMI-Tata Water Policy Programme, provides financial support to farmers in acquiring the Solar Photovoltaic System, including pumps and solar panels. They have contributed approximately 40 lakhs to the project.
4	**Gujarat Energy Research and Management Institute (GERMI)**	It provides technical support, training, and capacity-building initiatives for the members and staff, and also supports IWMI in its initiatives.

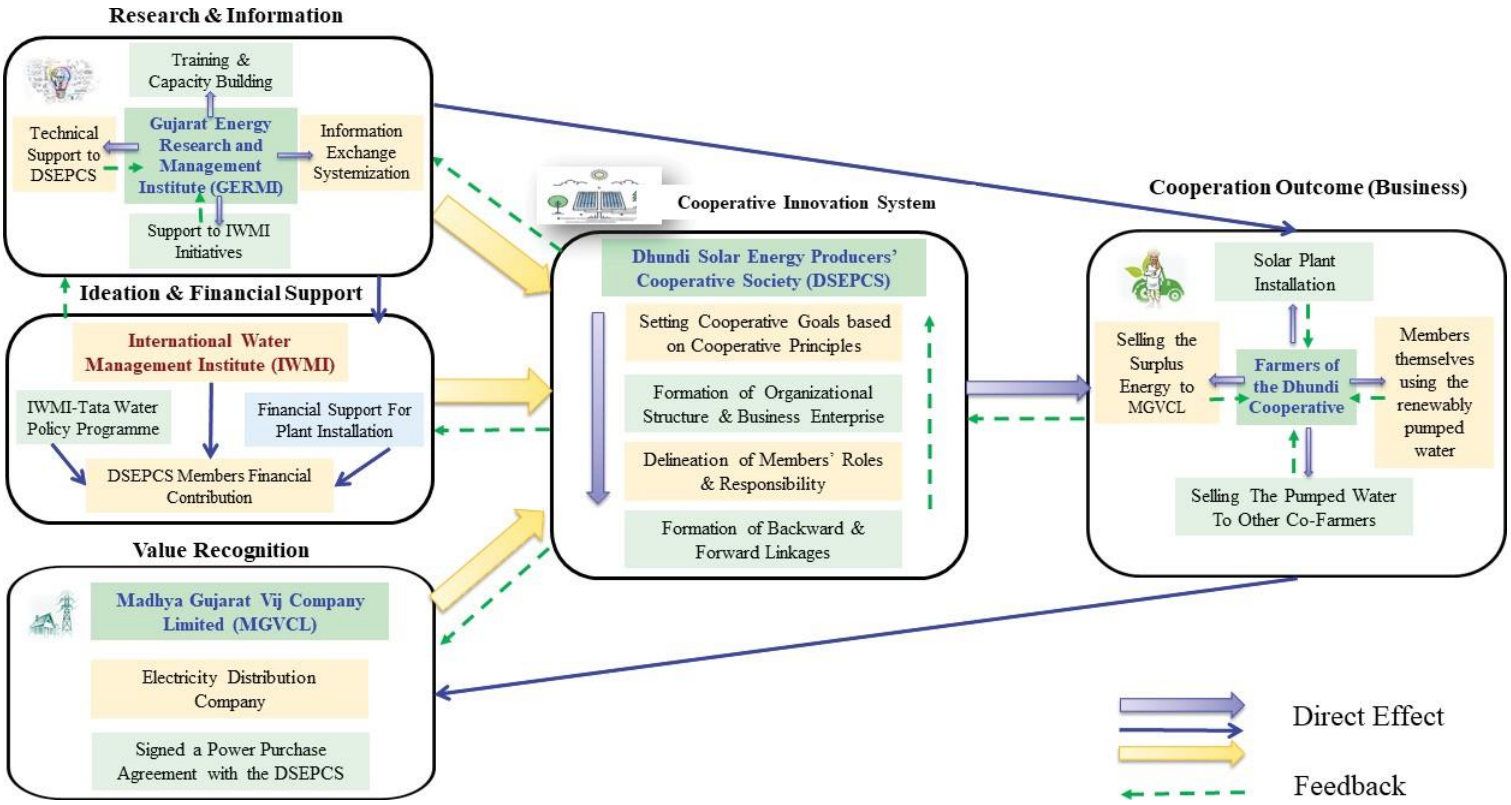

Figure 2: Dhundi Solar Energy Producers' Cooperative Society's model

MEMBERSHIP, GOVERNANCE AND MANAGEMENT

To be a member, a farmer must fulfil the following conditions

Criteria for Male Members:

The farmer must:

- own 0.025 acres of land with a well;
- reside in Dhundi village or within a 2.5 kilometers radius;
- buy at least one share and pay Rs. 51as admission fee;
- be at least 18 years old and free of any criminal convictions, alcohol use, or immoral behaviour.

Criteria for Female Members:

The farmer must:

- have 0.025 acres of land either owned by self or in her husband/son's name with a well;
- reside in Dhundi village or within a 2.5 kilometers radius;
- attain the age of 18 and be capable of executing an agreement.

The society follows a democratic decision-making process, involving active participation and input from all its shareholders. Key decisions regarding the society's operations, projects, and investments are made collectively through discussions, consultations, and voting.

First-time use of solar power for irrigation purposes ©DSEPCS

Important matters are often discussed in regular general body meetings, where members share their perspectives, and decisions are taken based on consensus or majority agreement. The society has an elected management committee comprised of the president and the secretary responsible for overseeing its day-to-day operations and implementing decisions. The management committee of the cooperative is also responsible for guiding and preparing perspective/long-term plans and to represent collective interests of the members. The solar energy projects were designed, planned and implemented by technical professionals of GERMI throughout the early stages of project development with financial support under the IWMI-TATA Water Policy Program. They examined the feasibility of adding solar panels with suitable capacity and developed solar energy-driven irrigation systems based on the cooperative's and its members' individual needs. Gujarat Energy Research and Management Institute have empowered the members through training and capacity-building programs, thereby enhancing their understanding and skills in solar energy utilization, solar panel operation, and pump operation and maintenance.

CAPACITY DEVELOPMENT

The DSEPCS has implemented a range of impactful interventions aimed at empowering its member farmers through training, technical visits, and consultancy services. Recognizing the potential of solar energy in agricultural sustainability, the cooperative has conducted comprehensive training programs, equipping farmers with the knowledge and skills required to harness solar power effectively. Regular technical visits by experts provide on-ground support and troubleshooting assistance, ensuring the seamless operation of solar-powered systems. Some of the interventions are:

- Participation of the members of cooperative in Suryashakti Kisan Yojana, a revolutionary initiative of Gujarat State's Power Sector, since 2018. Through the scheme, the member farmers are encouraged to generate electricity for their captive consumption and sell the surplus to the government via grid and earn additional income;
- The Secretary of DSEPCS is involved in imparting training to other farmers/trainees associated with Agricultural Technology Management Agency (ATMA), a decentralised agency responsible for strengthening the extension system. Furthermore, the DSEPCS members are engaged in providing consultancy services to other non-member farmers, giving them necessary knowledge on solar plants and solar operated pumps;
- Facilitate visits of students, researchers, farmers, etc., to the site. More than 660 onsite visits have taken place so far.

Orientation of farmer members and potential members by Secretary ©DSEPCS

Exposure visit by ATMA officials and their trainees ©DSEPCS

IMPACT

Exactly two years after the launch of DSEPCS, nine farmers have become successful solar entrepreneurs. In May 2016, the Dhundi Cooperative received their first payment for solar energy sales. And, by March 2022, the cooperative had already earned turnover of INR 1,120,332 (USD 13,489.41) and profit of INR 250,067 (USD 3,010.94) from energy sales. Moreover, 60 neighbouring farmers can get water for irrigating their lands due to the interventions of this cooperative.

The solar cooperative has made two specific impacts on member farmers. These include:

- **Additional Income for Farmers:** The MGVCL is currently buying excess solar energy from this cooperative's members for INR 4.63 (USD 0.056) per unit over a 25-year PPA, in addition to using it to power their irrigation pumps. Initially, there were concerns about the land-footprint of solar panels. But eventually farmers started experimenting by growing high-value crops such as garlic, turmeric, spinach, carrots, medicinal plants, etc., beneath the panels. The farmers also gain by selling water to other farmers in the area.
- **Reduced uncertainty in farming:** Solar pumps are being considered as a preferable alternative to subsidized grid power and expensive diesel pumps. Solar power is predictable, consistent, available during the day, and less costly. The cooperative has inspired Government of India's Kisan Urja Suraksha evam Utthan Mahabhiyan (KUSUM) scheme and Government of Gujarat's Suryashakti Kisan Yojana.

Irrigation pipeline installation ©DSEPCS

Replication of the Model

This model was replicated in Mujkuva village, Anand (Gujarat) in 2016-17 with the support of IWMI and National Dairy Development Board (NDDB). Eleven farmers formed a cooperative, installing 10 horsepower (HP) and 15 HP solar pumps for irrigation. They signed a 25-year agreement to sell surplus power at INR 3.24 (USD 0.039) per unit. NDDB covered 50% of the solar pump costs, ensuring financial viability.

CHALLENGES

DSEPCS faced several challenges in the initial days of its inception. Some of these were:

- Difficulty encountered during registration as it was the world's first solar cooperative, which lacked established precedents;
- Formulating the bye-laws proved challenging, likely due to the innovative nature of the cooperative and its focus on solar energy;
- Initially, farmers were hesitant to embrace the benefits of solar pumps, making their community mobilization challenging;
- The substantial initial capital investment required for installing solar panels posed a significant challenge during the early stages. Furthermore, some farmers were skeptical about the reliability of solar pumps as compared to traditional irrigation methods.

Moreover, implementing solar energy infrastructure demanded considerable land usage, raising concerns about land availability and usage rights.

However, DSEPCS could successfully address these challenges and it has now set a precedence for future solar cooperatives and thus promoting

sustainable energy solutions in the region.

LESSONS

- **Importance of institutional innovation in scaling up solar irrigation:** One of the great lessons resulting from this case is the need for mobilising farmers as a cooperative to adopt green technologies that are costly for individual small farmers to adopt on their own. Though solar irrigation technology has multiple benefits for farming and the environment on its own, it cannot get widely diffused and adopted unless institutional and policy innovations that can support technological innovation goes along with it. Therefore, pilot testing and learning from institutional innovations are critical for upscaling new knowledge. Even small, unique institutional innovations, like the one in Dhundi, can have a significant impact on policy making. When successful models are showcased, policymakers are more inclined to support and implement similar projects on a larger scale.

- **Partnerships:** The sustainability of projects, such as the DSEPCS, relies on consistent support and interventions from relevant support institutions. Establishing and maintaining such initiatives require ongoing assistance and collaboration and contribution from institutes like the International Water Management Institute and CGIAR program on Climate Change, Agriculture, and Food Security.

Visit of IWMI and GERMI Officials and technical team ©DSEPCS

END NOTE

The Dhundi Cooperative demonstrates how innovations in technology, community institutions and clean energy policy push taken together can help transform agriculture and rural livelihoods. It also highlights the potential for creating a more sustainable and prosperous future for farmers while being mindful of environmental concerns. By adopting initiatives like the Dhundi Solar Cooperative, we can work towards achieving the Sustainable Development Goals (SDGs) set by the United Nations. The cooperative's actions directly advance two SDGs: Affordable and clean energy (SDG 7) and Climate Action (SDG 13) for a better world.

CITATION

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Good Practice Notes Series

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There is a growing recognition on the importance of institutional innovations in promoting more efficient and productive collaboration among the various actors in AIS. The publication of this series of Good Practice Notes by APIRAS and APAARI is an attempt to document cases of institutional innovations that are currently transforming agrifood systems.

The TAP-AIS project

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