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Centre of Research
CO-OPERATIVE INSTITUTE OF MALAYSIA
103, Jalan Templer, 46700 Petaling Jaya, Selangor, Malaysia
Tel: 603-7964 9000 Fax: 603-7957 0434
E-mail: ikkm@ikkm.edu.my

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DHUNDI SOLAR PUMP IRRIGATORS' COOPERATIVE: A PRELIMINARY STUDY

***T. Paranjothi[1], H.K. Mishra[2]**

[1]Agricultural Co-operative Staff Training Institute, Monvila, Kulathoor, Thiruvananthapuram, INDIA

[2]Institute of Rural Management, Anand, 388001, Gujarat, INDIA

ABSTRACT

Innovation, production and productive use of renewable energy is fast becoming a challenging phenomenon for global leaders. Renewable energy will continue to remain a major source for sustenance of civilization. Solar power has showcased the promise of providing avenues for commercial use. This article presents a case of a farmer cooperative in India which uses solar power to operate irrigation pumps to manage their livelihoods. This case also describes the opportunity and challenges in scaling up such attempts.

Keywords: *Renewable Energy; Scale Up; Solar Power*

Corresponding author email: paranjothi.t@gmail.com

INTRODUCTION

Solar power in India is a growing industry. As of 30th April 2017, the country's solar grid had a cumulative capacity of 12.50 GW. India quadrupled its solar-generation capacity from 2,650 MW on 26th May 2014 to 12,289 MW on 31st March 2017. The country added 3.01 GW of solar capacity in 2015-2016 and 5.525 GW in 2016 - 2017, the highest of any year, with the average current price of solar electricity dropping to 18% below the average price of its coal fired counterpart.

In January 2015 the Indian government expanded its solar plans, targeting US$100 billion in investment and 100 GW of solar capacity (including 40 GW from rooftop solar) by 2022. About India's interest in solar power, Prime Minister Narendra Modi said at the 2015 COP21 climate conference in Paris, "The world must turn to (the) sun to power our future as the developing world lifts billions of people into prosperity, our hope for a sustainable planet rests on a bold, global initiative". India's initiative of 100 GW of solar energy by 2022 is an ambitious target, since the worlds installed solar-power capacity in 2014 was 181 GW.

In addition to its large - scale grid - connected solar PV initiative, India is developing off - grid solar power for local energy needs. The country has a poor rural electrification rate; in 2015 only 55 percent of all rural households had access to electricity, and 85 percent of rural households depended on solid fuel for cooking. Solar products have increasingly helped to meet rural needs by the end of 2015 just fewer than one million solar lanterns were sold in the country, reducing the need for kerosene. That year, 118,700 solar home lighting systems were installed and 46,655 solar street lighting installations were provided under a national program just over 1.4 million solar cookers were distributed in India.

In January 2016, Prime Minister Narendra Modi and French President François Hollande laid the foundation stone for the headquarters of the International Solar Alliance (ISA) in Gwal Pahari, Gurugram. The ISA will focus on promoting and developing solar energy and solar products for countries lying wholly or partially between the Tropic of Cancer and the Tropic of Capricorn. The alliance of over 120 countries was announced at the Paris COP21 climate summit. One hope of the ISA is that wider deployment will reduce production and development costs, facilitating the increased deployment of solar technologies to poor and remote regions.

India has inherent strength and environment to harness solar energy for productive, large scale commercial use because of its geographical location. India being a tropical country receives adequate solar radiation for 300 days, amounting to 3,000 hours of sunshine equivalent to over 5,000 trillion kWh. Almost all the regions receive 4 - 7 kWh of solar radiation/sq. mtrs with about 2,300–3,200 sunshine hours/year, depending upon the location. India is challenged by power shortage and inefficient ecosystem in the power generation, transmission and distribution. Electricity losses in India during transmission and distribution have been extremely high over

the years and this reached a worst proportion of about 24.7% during 2010 - 11. India is in a pressing need to tide over a peak power shortfall of 13% by reducing losses due to theft. Theft of electricity, common in most parts of urban India, amounts to 1.5% of India's GDP. Due to shortage of electricity, power cuts are common throughout India and this has adversely affected the country's economic growth.

India has been very conscious of the issues related to management of power sector and has adopted various reforms by setting up energy regulatory bodies at the federal and state levels. The Gujarat Energy Regulatory Commission (GERC) for the state of Gujarat charted a roadmap for encouraging production of solar power and synchronizing with the mainstream grid systems. It also encouraged small and household solar power producers through various incentive schemes. The objective of this intervention is to encourage production of solar power and reducing burden on the power grids.

Anand, a district of Gujarat state that gave India its dairy cooperative movement, has now spawned a new cooperative that may well grow into a genre of its own. It has taken advantage of the GERC intervention strategy in renewable energy sector. Promotion of this solar cooperative is possible with the support the International Water Management Institute (IWMI), Anand.

Organization of the article is as follows. In section two, the case of solar cooperative is described. In this section while introducing the cooperative, issues and challenges in establishing its governance and membership process are presented. In section tree the impacts and strategic shift in managing livelihoods of farmer members through technology adoption are discussed. Field studies and interviews were conducted to validate the findings. In section four issues related to the cooperative structure adopted and finding ways to scale up are discussed. In section five concluding statements are made while providing the directions for further research.

THE DHUNDI SOLAR PUMP IRRIGATORS' COOPERATIVE ENTERPRISE (SPICE)

Dhundi Cooperative was registered under the Gujarat Cooperative Societies Act 1961 on 16th February 2016. Initially it was very time consuming and difficult task to identify a village. The team surveyed so many villages but farmers were not ready to experiment with the solar technology. Farmers did not perceive it as a reliable technology. The problem which the Spearhead Team faced while doing this project was clearance of land records of farmers. Land clearance required permission of all the members of family, who have claim on the ownership of land, before connecting their system to the Micro Grid then only they could sell surplus power to the Grid.

There were also some difficulties while registering the solar cooperative because of its unique concept. Preparing by - laws for this cooperative was a big challenge as role of members and

cooperative has to be clearly defined. IWMI helped them in the preparation of bye - laws as well as the registration process. The Department of Cooperation was very sympathetic to the cause.

Initially six (6) farmers of this Cooperative were paying Rs.5, 000 per KW. After seeing the benefits of other farmers, three (3) new farmers were ready to join the cooperative and even paid Rs.25, 000 per KW. Solar pumps of these three (3) new farmers are yet to be connected to the Grid. Revised lower rates offered by the MGVCL are encumbering their connection to Grid. IWMI is persistent with the idea that the same rate should be offered to these three (3) new farmers i.e. Rs. 4.63 per unit.

In early 2016, the world's first ever Solar Pump Irrigators' Cooperative Enterprise (SPICE) began operations in Dhundi Village of Kheda district in Gujarat. Dhundi cooperative represents a novel experiment. Members of this cooperative are using solar power not only to run their irrigation pumps, but also pooling the surplus energy to sell to the Madhya Gujarat Vidyut Company (MGVCL) at Rs.4.63/unit under a 25 - year power purchase agreement (PPA). In addition, IWMI-Tata Programme1 and CCAFS2 offered Rs.1.25/unit as Green Energy Bonus and another Rs.1.25/unit as Groundwater Conservation Bonus, taking the total pay - out per unit to Rs.7.13. 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 Rs.1, 60,000 from energy sales.

The Dhundi SPICE's six (6) solar pumps, having an aggregate capacity of 56.4 kilowatt-peak (kWp), 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, the six (6) farmer - members would use some 40,000 units for watering their seven acres and inject the balance 45,000 units into the grid, grossing over Rs.3 lakh revenues from solar energy sales.

Under the PPA, the six (6) farmers have surrendered their right to apply for grid power connections for 25 years. Solar power for them comes much cheaper than diesel some 7500-8000[3] litres are required for producing 40,000 units equivalent of groundwater pumping and is also more reliable than subsidized grid power that is available for 7 - 8 hours, that too with voltage fluctuations and during night in half of the days every month. Solar power by contrast, is uninterrupted, predictable, available during day time and free of cost.

The Dhundi - pattern SPICE arguably deserves a better feed in tariff than megawatt scale solar power plants or even roof top installations. Megawatt scale plants require large public investments in transmission, whereas in the case of Dhundi, the micro grid was erected by farmers at their own expense. Roof top solar plants, similarly, will ultimately deprive MGVCL of income from its highest paying consumer segments.

In the village there were 282 households and they all belonged to the Darbar Community which includes four (4) sub-castes and most of them were marginal farmers having less than 1 hectare of land. They were members of the Dairy Cooperative Society as well as Tree Growers Cooperative. There were six (6) members who had installed the Solar Plant. Table 1 gives the name of the farmer, area and village. Out of six (6) members three (3) of them had an installed capacity of 8 KW and 3 had 10.8 KW. The capacity of the pump for 8 KW Solar pump is 5 HP and the investment is Rs.7 lakhs. On the other hand for 10.8 KW power 7.5 HP pump and the investment was Rs.9 lakhs. Operational cost for generation is nil. Although, maintenance and technical support of entire solar system of *mandali* will be taken care by the installing agency for next two years but farmers were also trained for basic maintenance of the solar system.

Objectives

a. to draw additional solar energy and increase the sales;
b. to increase irrigation connectivity through solar energy;
c. to increase the income by adopting drip and other water and energy saving technology;
d. to experiment various harvesting and agricultural methods not only to increase income from agriculture but also to experiment transfer of additional solar energy;
e. to adopt new technology to increase solar energy production; and
f. to undertake any other related activities for attaining the main objectives

Governance and Membership of the Cooperative

Membership – Male

i. He should be a resident of Dhundi or residing within 2.5 km from the Society;
ii. He must be a farmer;
iii. He should have one gunta land;
iv. He must have a well;
v. The well should be at least within the minimum distance of 1 km;
vi. He should purchase at least 1 share and pay Rs.51/- as admission fee;
vii. He should be above 18 years of age; and
viii. He should be free from criminal cases, liquor consumption and immoral activities.

Membership – Female

i. She should be a resident of Dhundi or residing within 2.5 km from the Society;
ii. Her husband or son should be a farmer;
iii. The farmer should be above 18 years of age and capable of executing agreement;
iv. Her husband/son should have well;

v. If women farmer does not have land she can become member if her husband/son is eligible for membership not convicted on liquor laws or immoral activities; and
vi. If a women dis-continues membership she cannot join the society again unless the committee approves of her rejoining.

Power Purchase Agreement

The Power Purchase Agreement was made on 2nd May 2016 between Madhya Gujarat Vij Company Limited, a Government Company registered under the Companies Act 1956 and carrying on the business of distribution and supply of electricity in the area of supply and having its Registered Officer at Sardar Patel Vidyut Bhavan, Race Course, Vadodara (hereinafter referred to as "MGVCL" and Dhundi Saururja Utpadak Sahakari Mandali, a cooperative incorporated under the laws of (Gujarat Cooperative Societies Act, 1961), having its registered office at Baliyadev Faliya, Dhundi, Thasra, Dist. Kheda, Gujarat (hereinafter referred to as "Mandali").

The Dhundi Saururja Utpadad Sahakari Mandali is a cooperative society formed in Dhundi village near Thasra where farmers are being assisted to acquire Solar Photovoltaic System (comprising of Solar Irrigation pump) (hereinafter referred to as "Solar System") by International Water Management Institute (IWMI), Anand under IWMI-Tata Water Policy Programme. The Solar system of 100 KW was set up for the member farmer's own use in their agriculture land for irrigation at Village Dhundi Ta. Thasra, Distt. Kheda, Gujarat, connected with MGVCL's grid at 415 Voltage level for injection of surplus energy into the MGVCL grid at interface point.

The MGVCL agreed to connect the (mention Solar Rooftop Plant including location and installed capacity as appropriate) Solar System to its Distribution System at the interface Point (11KV Kotaria Feeder, Transformer TC0004, Pole KTR0004/027, Dairy Faliya). The Mandali agreed to inject a surplus electricity in the MGVCL's Distribution System from the Facility through the Distribution System of MGVCL.
The Mandali agreed to the terms and conditions for connectivity of the facility to the MGVCL's Distribution System as per conditions of this agreement and in compliance with the applicable policy/rules/regulations/codes (as amended from time to time) which includes:
i. Government of Gujarat Solar Power Policy 2015;
ii. Central Electricity Authority (measures relating to Safety and Electric Supply) Regulations 2010 ;
iii. Indian Electricity Rules, 1956;
iv. Central Electricity Authority (Technical Standards for Connectivity of the Distributed Generation Resources) Regulations 2013;
v. Central Electricity Authority (Installation and Operation of Meters) Regulation 2006; and

vi. Electricity Supply Code & Related Matter Regulations and Distribution Code Regulations of GERC

Eligible Period

The eligibility period of the Agreement will be twenty five years (25) from date of commencement of commercial operation by the solar power generator or the lifespan of the plant, whichever is earlier, for the purpose of injection surplus power in KGVCL grid.

Eligibility

a. Member shall set up the solar system its own land or premises in his legal possession;
b. Member needs to consume electricity in the same land or premises where solar system is set up;
c. Member of Mandali has to meet the standards and conditions as specified in GREC regulations/supply code/CEA Regulations and provisions of Government of Gujarat's Solar Power Policy 2015 being integrated into grid/distribution system;
d. Member of Mandali shall not be eligible for conventional agricultural connection till the agreement is in operation or in force. Mandali is required to pass a resolution that all the members of the Mandali shall not seek conventional agricultural connection from MGVCL in the same premises. The resolution needs to be signed by all members of the Mandali; and
e. Mandali has contracted capacity of solar for 100 KW and capacity of 56.4 KW of six (6) members is ready for commissioning Mandali shall ensure that balance capacity shall be commissioned by 31st July 2016. MGVCL shall pay for the surplus energy as per clause of the agreement for the capacity commissioned as on 31st July 2016.

The solar energy generated by the members is used for irrigating the crops. Earlier these farmers were using diesel pumps and also depended on diesel operators. Apart from using solar energy for irrigation purpose they were providing water to the farmers in the neighboring fields and getting income of Rs.250 per biga. The farmers were evacuating the electricity to Madhya Gujarat Vij Company Ltd (MGVCL) and getting Rs.4.63 per unit. Apart from this they were also getting Rs.1.25 per unit as Green Energy Bonus and Rs.1.25 per unit as Water Conservation Bonus.

All the six (6) households were provided with meter at home. The name is written in the meter and the payment is made every month to the Cooperative. The Society pays a rent of Rs.150/- every month where the meters are also fixed in the Office. The Secretary of the Society is paid Rs.1500/- and the President is an honorary worker.

Operations

i. The Society meter reading will be used for making payment to the farmer in case there is a difference between the individual and society's meter reading, the society's meter reading will be considered.
ii. In case of loss, repair and maintenance, the responsibility lies with the member from the farm to Society's boundary.
iii. In the case of repair, the Society will bear 25% expenditure for repair if sufficient funds are available. It will be treated as sanctioned, if the same is approved by two third (2/3) majority.
iv. Every member can transfer minimum 500 units KW annually. Defaulter members will be fined. If a member is not able to give 500 units to the grid he will lose his voting right next year.
v. Secretary's salary will be decided at the commencement of the financial year.
vi. The contribution of member for meeting the maintenance and other expenditure will be decided at the commencement of the financial year. For financial year 2016 - 17 every member had paid Rs.50/- per month.

The Strategic Shift in Managing Livelihoods of Farmers

The spread effect of organizing this Solar Energy Cooperative are:
i. Sixty (60) neighboring farmers are able to get water for irrigating their lands.
ii. The Government of Gujarat savings is Rs.13 lakhs to be spent on infrastructure for electricity given to the farmers.
iii. Balanced ground water use is ensured. In India all of us are aware that the ground water potential has been completely exploited in various parts of the country.

Out of total solar energy generated, 30 per cent is used for irrigating the farm land and 70 per cent is evacuated to MGVCL.

Benefits to Farmers

Dhundi farmers not only find solar pumps decidedly preferable to expensive to run diesel pumps they used for irrigation so far, but also better than subsidized grid power they have hankered after. Grid power in Gujarat is better than in other states but it still comes for only 7 - 8 hours each day with frequent interruptions and voltage fluctuation, and is supplied during nights for half the days in a month (Shah and Verma 2008). Irrigation at night is irksome, hazardous, costly and wasteful; so farmers abhor night power supply. Solar power, in contrast is uninterrupted, predictable, available during day time and free of cost. Initially, farmers were worried about the land-footprint of solar panels; but they are already experimenting with a range of high value

crops such as spinach, carrots, garlic, turmeric, beet and some medicinal plants that grow well under panels. Some also grew paddy underneath panels.

No wonder that IWMI and CCAPs are flooded with requests from farmers from near and a far to form similar cooperatives. Farmers are excited by the idea of 'growing' and selling solar energy as a cash crop that needs no seeds, fertilizer, pesticides, irrigation and backbreaking labour, and has a ready buyer at their door-step at an assured price. Income from the solar crop is free of risk from droughts, floods, pests and diseases. Moreover, with MGVCL's 25-year contract, they face neither price risk nor market risk. All that SPaRC need is land for erecting panels; and that too can be put to alternative economic uses.

High capital investment in solar panels is the major deterrent. However, convinced of these many benefits of SPaRc, farmers are now willing to invest more in solar pumps. The first six members of Dhundi SPICE contributed only Rs.5, 000/kWp towards the capital cost of solar pumps, the balance subsidized by IWMI/CCAPS research grant. This is not surprising; they were neither sure whether solar pumps will deliver enough water nor whether MGVCL will actually pay for the surplus power farmers evacuate to the grid. Now that both these doubts are put to rest, four new farmers joining the cooperative have contributed Rs.25, 000/kWp, nearly 40 per cent of the total investment. A solar pump is viewed in Dhundi not only as an irrigation asset but also an income-generating asset that has potential to deliver 'climate-proof' risk free income stream. 'Solar crop' offers them better income insurance than any other crop.

Reducing Carbon Footprint of Tubewell Irrigation

The biggest bonus of SPaRC is in making India's groundwater irrigation climate-smart. Around 2005, groundwater pumping in India was estimated to emit some 14.38 million metric tons (mmt) of carbon. 11.09 mmt by electric pumps and 3.29 mmt by diesel pump sets; for lifting every 1000 m^3 of groundwater, an electric tubewell emits 5.5 times more carbon than a diesel tubewell. This is largely because electric pumps are used to pump groundwater from greater pumping depth while diesel pumps become unsuitable for deep groundwater. Deep tubewells, benefiting from farm power subsidies, are the worst carbon culprits. According to IFPRI calculations, India's deep tube wells irrigate only 4.1 million of the 31 million ha under electric pump set irrigation; but account for nearly 2/3rd of carbon emission from electric pump sets (Shah 2009). Solarizing electric tubewells has the potential to eliminate the carbon footprint of our gigantic groundwater economy, and reducing India's annual carbon emissions by 4-5 per cent.

IMPACT STUDY

A field survey was undertaken on 2nd May 2017 by visiting the Office of International Water Management Institute located near the Institute of Rural Management, Anand (IWMA) and a visit to the Society on 3rd May 2017 with the officials of the IWMA to find out and gather firsthand information about the functioning of the Solar Energy Cooperative Society. This village is situated about 47 kms from Anand. Out of six (6) farmers, four (4) farmers were available for interaction.

The name of the member and the extent of land are presented in Table 1. The area varies from 0.55 acres to 1.35 acres.

Table 1: Details of Solar Plant and Owner/Consumer

Sl. No	Name of System Owner/ Captive User	Land Area (in Acres)	Cap (KW)
1.	Pravinbhai Punjabhai Parmar	0.925	8
2.	Kiritbhai Budhabhai Solanki	1.35	8
3.	Ramabhai Salambhai Chavda	1.025	8
4.	Udabhai Vagjibhai Chavda	0.55	10.8
5.	Laxmanbhai Savjibhai Parmar	1.975	10.8
6.	Fudabhai Savjibhai Parmar	1.2	10.8
Total		7.025	56.4

Source: Power Purchase Agreement (2016)

Discussions were held with the farmers and their views were solicited and the same is presented below:

Member No.1: Shri Pravinbhai Punjabhai Parmar

He is the President of the Society and a very active village level worker and owns five (5) Bigas of land. He has a family of eleven (11) members and cultivates paddy, bajra, wheat, rajma, tomato and vegetables. He has two milch animals (buffaloes) and is also an active member of the Dairy Cooperative.He is able to supply milk @Rs.45/- to Rs.55/- per litre depending on the fat content. He also earns from the MGNREA. He also has experience of 30 year and was actively involved with an NGO engaged in development. He gets work for about 100-150 days in a year and earns Rs.189/- per day. Before starting this venture he was using diesel pumps. There were lot of problems and had to spend on its maintenance and repair. He has his own house. He took the lead for forming the Society and while discussing with him he mentioned that it was very difficult to organize the society and to convince the farmers.

However, after constant persuasion they could organize the Society. He has purchased a tractor and used it for cultivation.

Member No.2 – Shri Laxmanbhai Savjibhai Parmar

He has about 5 Bigas (black soil) and has a family of six (6) persons. He owns a buffalo.

Member No.3 – Shri Fudabhai Savjibhai Parmar

He is a very old person aged about 70 years and he owns four (4) Bigas. There are seven (7) persons in his family and he has been a member of the Society for the last 20 years and he is also the Director of a Credit Society. He has two (2) buffaloes and two (2) bullocks.

Member No.4 – Shri Udabhai Vagjibhai Chavda

He is aged 42 years and has 3.75 Bigas. His family consists of ten (10) persons. He owns two (2) cows and two (2) buffaloes and he is able to produce 6.5 litres of milk per day. A very interesting thing that was observed during the visit to his farm was that there is no wastage of water, as he is able to pump water directly from the well to the field. It is common knowledge that there is lot of wastage of water while pumping water from the well to the fields. He is also selling water to the neighboring farmers and earning out of it.

WAY FORWARD

a. The International Cooperative Alliance Asia Pacific as a part of its advocacy mandate needs to disseminate the concept of solar energy cooperatives after undertaking an intensive study of "Dhundi Solar Power Irrigators' Cooperative, Anand" and then popularize the model in Asia Pacific Region.
b. The National Cooperative Union of India (NCUI) which is the Spokesman of the Cooperative Movement in India played a vital role in pushing the Government of India to amend the Multi State Cooperative Societies Act 1984 based on the Model Act (1991) and also introduce Constitution Amendment Act (2011) [of course could not be fully implemented due to litigation] and propagate the idea of Solar Energy Cooperative at the national level in liaison with the Government of India and draw an Action Plan for implementation.
c. The NCUI should prepare and then make available literature on Solar Energy Cooperatives in English and Hindi. The State Cooperative Unions shall translate into vernacular language and give publicity for organizing Solar Energy Cooperatives.
d. The State Cooperative Unions/Federations in each State have to promote the formation of solar energy cooperatives based on "Dhundi Solar Power Irrigators' Cooperative Society Model" of course with modifications.
e. Workshops and campaigns at national and state level may be undertaken.

The above Action Plan is suggestive and may be modified in accordance with the ground realities prevailing in each State.

CONCLUSION

All of us are aware that Dr. V. Kurien, Milkman of India was instrumental in nurturing the Dairy Cooperatives in India popularly known as Anand Model. Dr. Tushaar Shah is the Chief Architect of Solar Energy Cooperative who promoted it through International Water Management Institute, Anand and he has drawn inspiration from Anand Model. His efforts have replaced the diesel pumps used by farmers in Dhundi village.

The IWMI is planning to do one more pilot project in grid-connected village where they will encourage owners of electric-connected irrigation pumps to adopt solar pumps. The larger idea behind this entire project is to promote solar pumps as an alternative to electric-pumps, which has the potential to save whopping amount of government subsidy given on electricity usage on agriculture connection and yield additional income for the farmers. The seed sown by Prof. Shah needs to be nurtured, expanded and replicated in the country. Thus we can ensure balanced water usage, protect the environment, and benefit farmers as part of our efforts to attain Sustainable Development Goals (SDG) envisioned by United Nations.

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