SOLARISATION *of* AGRICULTURE

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A woman at Dharnai Tolla works in a fields. A solar-powered micro-grid is now supplying electricity to the village.

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Solar Powered Street Light in Dharnai Village in India
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Solarisation of Agriculture

Agriculture is a power intensive sector and farmers predominantly rely on diesel and electric pumps for irrigation. However, the scale of use of diesel and electric pumps in the sector lead to severe economic and environmental problems. Diesel pumps depend on exploitation of fossil fuel resources, cost state on diesel subsidies, increase fuel cost for farmers and emit toxic fumes that pollute the environment and affect human health. On the other hand, electric pumps, which operate on subsidised or free electricity supplied by state governments also largely depend on fossil fuel, rake up enormous bills to state DISCOMs (electricity distribution companies), are erratic, and contribute to ground water depletion on account of excessive use of pumps. While the need for irrigation in today's increasingly unpredictable climatic conditions is indisputable, diesel and electric pumps are not sustainable long-term solutions.

In this scenario, the central and state governments are exploring possibilities of solar-based irrigation which has zero fuel costs for farmers, brings down the electricity consumption in the agricultural sector, can potentially light up the farmer's house, and in grid-connected cases even feed surplus electricity back to the grid. In addition to selling surplus electricity to the grid, farmers earn extra income from the pump through sale of water to neighbouring fields. The central and state governments are also expecting solar irrigation schemes to provide relief to state DISCOMs and reduce the subsidies that states are currently providing for electricity to the agricultural sector. It is necessary to note that only 48 per cent of India's net sown area is irrigated and solar irrigation systems have the potential to increase access to irrigation.

Solar irrigation is a crucial part of India's efforts to transform towards renewable energy and achieving India's target of 175 GW of renewable energy by 2022, 100 GW is solar-based.[1] According to an August 2018 report by Institute for Energy Economics and Financial Analysis (IEEFA), "the government of India could achieve 38% of its renewable electricity-generation target just by shifting from conventional pumps to solar irrigation pumps."[2] Deployment rates of solar irrigation pumps are however still low. Of the total 29.93 million agricultural pumps, 0.13 are solar powered, 8.80 are diesel powered and 21 million operate on grid connected electricity[3]. Going ahead, the transition from conventional pumps to solar-based pumps is dependent on the implementation, success and challenges of the central and state policies and schemes that promote solar irrigation.

[1] Press Release. 19 July 2018. Press Information Bureau. Ministry of New and Renewable Energy.
http://pib.nic.in/newsite/PrintRelease.aspx?relid=180728
[2] India: Vast Potential in Solar-Powered Irrigation. August 2018. Institute for Energy Economics and Financial Analysis.
http://ieefa.org/wp-content/uploads/2018/08/Indias-Vast-Potential-in-Solar-Powered-Irrigation-.pdf
[3] India: Vast Potential in Solar-Powered Irrigation. August 2018. Institute for Energy Economics and Financial Analysis.
http://ieefa.org/wp-content/uploads/2018/08/Indias-Vast-Potential-in-Solar-Powered-Irrigation-.pdf

India's Solar Policy Framework

India's Ministry of New and Renewable Energy (MNRE)[4] started the Solar Pumping Programme in 1992. Till 2014, the ministry reports that 13,964 solar pumps were installed across the country. The high capital costs of solar panels, access to highly subsidised electricity, and a lack of awareness have meant that the number of solar irrigation pumps as compared to the total number of pumps in the agricultural sector are unsubstantial. The costs of solar irrigation pumps begun coming down in the last decade allowing programmes to become more viable and scalable. Phase II of Jawaharlal Nehru National Solar Mission (JNNSM), announced by the Central Government in 2012, prioritised Solar Photovoltaic (SPV) water pumping systems for irrigation and drinking water and set a target for distribution of 25,000 SPV pumps (or solar irrigation pump) by 2017.[5] In 2014, the Ministry for New and Renewable Energy (MNRE) increased the target to 1 lakh SPV units for 2014-15 and 10 lakh units by 2020-21.[6] The government is currently implementing Phase III of the Mission, which set a total target of 118 MWp (megawatt peak) of solar power capacity by March 2020.[7] As on October 2018, MNRE declared that 1.96 lakh solar irrigation pumps have been installed.[8]

In February 2018, the Central Government announced the Kisan Urja Suraksha Evam Utthaan Mahabhiyan (KUSUM) scheme which aimed to install grid-connected solar power plants of up to 2 MW in rural areas, install standalone off-grid solar irrigation pumps for irrigation needs of farmers, and solarise existing grid-connected irrigation pumps to make farmers independent of grid supplied electricity and enable them to sell surplus solar power. The Scheme was approved by the Cabinet Committee on Economic Affairs in February this year and proposed 10,000 MW of decentralized grid-connected renewable power plants, 17.50 lakh standalone solar irrigation pumps and solarisation of 10 lakh grid-connected irrigation pumps. The government intends to implement distribution of solar irrigation pumps at full scale while piloting the other two components before scaling up. With regard to the solar pump components, the scheme proposed central financial assistance (CFA) of 30%, state government subsidy of 30% and contribution from beneficiary farmer of 40%, including a bank loan of about 30%[9]. The estimated cost of the entire project is approximately Rs 1,40,000 crore over a 10-year period, of which the central government is set to contribute Rs. 48,000 crore. [Refer footnote for KUSUM guidelines.[10]]

[4] The Ministry of Non-Conventional Energy Sources was formed in 1992 and renamed MNRE in 2006.
[5] Jawaharlal Nehru National Solar Mission Phase II – Policy Document. December 2012. Ministry of New and Renewable Energy.
https://mnre.gov.in/file-manager/UserFiles/draft-jnnsmpd-2.pdf
[6] Letter. 22 September 2014. Ministry of New and Renewable Energy.
https://mnre.gov.in/file-manager/UserFiles/Scheme-for-Solar-Pumping-Programme-for-Irrigation-and-Drinking-Water-under-Offgrid-and-Decentralised-Solar-applications.pdf
[7] Order. 07 August 2018. Ministry of New and Renewable Energy.
https://mnre.gov.in/sites/default/files/schemes/Off-grid-%26-Decentralized-Solar-PV-Applications-Programme-Phase-III-for-FY-2018_19-%26-2019_20.pdf
[8] Press Release. 10 December 2018. Press Information Bureau. Ministry of New and Renewable Energy.
http://pib.nic.in/newsite/PrintRelease.aspx?relid=186228
[9] Press Release. 19 February 2019.Press Information Bureau. Cabinet Committee on Economic Affairs (CCEA)
http://pib.nic.in/PressReleaseIframePage.aspx?PRID=1565274
[10] Office Memorandum. 13 March 2019. Ministry of New and Renewable Energy.
https://mnre.gov.in/sites/default/files/webform/notices/NoticeInvitingCommentsonGuidelines.pdf

Experience So Far

Despite its advantages of decentralisation, zero fuel costs, lower environmental costs, and increased income to farmers, implementing solar irrigation pumps at a large-scale pose challenges. A major concern is over-use of ground water and migrating to water-intensive cash crops on account of zero fuel costs and/or to make up the capital contribution by farmers. This poses real threat to already depleting ground water tables in several regions. Secondly, given the heavy capital costs in solar irrigation pumps, states are providing a subsidy of about 70-95% to encourage farmers to adopt the transition. While states will potentially benefit from lesser electricity subsidies, concerned governments will have to efficiently analyse the long-term cost benefit quotient of their heavily funded schemes to ensure success. Thirdly, not all state schemes have taken off as planned. For instance, the Bihar state government's Bihar Saurkranti Sinchai Yojana (BSSY) did not find takers as the pumps provided under the scheme were found to be too small by the farmers.

The experience of solar irrigation pumps in India has shown that there is no standard one-size-fits-all solution, and state governments and environmental groups are currently experimenting with several business models. Going forward, with the announcement of KUSUM by the central government and the proposals for scale-up of solar irrigation pumps by several state governments, it is imperative that adequate assessment is conducted to understand and assess the existing models and strategies to ensure improved practices.

This report examines solar irrigation pump models implemented in five select case study states of Bihar, Gujarat, Tamil Nadu, Maharashtra and Odisha. While state policies and implementation of schemes are examined for all five all states, some of the case studies also examine models implemented by non-state organisations. In addition to BSSY, the Bihar case study provides an assessment of the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) implemented "pay-as-you-go" non-grid solar irrigation model in Vaishali. The Gujarat case study looks into the government's recent Suryashakti Kisan Yojana (SKY) policy and the IWMI-TATA implemented grid-connected solar irrigation model in Dhundi. The Tamil Nadu case is pertinent primarily for its implementation of the solar village (nearing completion) in Irumbai. The Maharashtra case study showcases the Mukhyamantri Saur Krishi Vahini Yojana which aims at solar power generation through small plants to ensure power supply for farmers. The Odisha study is important as it shows the states Soura Jalanidhi scheme which provides micro solar irrigation pumps to benefit small farmers.

Examining different models in each of the five states, by both state bodies and non-state organisations, the report presents information on the advantages, challenges and their impact on agriculture and the farming community. However, many of the schemes and models have only been implemented in the recent past and therefore does not provide definitive assessments. The information and preliminary analysis presented here do not draw conclusions but are meant to further deliberations on experiences of different models and strategies.

Children play with water as it gushes out of the solar powered pump at Bishunpur Tolla, Dharnai village
© *Vivek M. / Greenpeace*

CASE STUDY 1: Bihar

State Policy & Programmes

In 2012, the Bihar government launched the Bihar Saurkranti Sinchai Yojana (BSSY), a scheme for solar irrigation, to address the lack of adequate irrigation in the state. The scheme which aimed to target small and marginal farmers provided 2 kWp solar panels with small pumps. The Bihar Renewable Energy Development Agency (BREDA), the nodal agency for the BSSY, provides a 60% subsidy in addition to the 30% subsidy provided by Ministry of New and Renewable Energy (MNRE), taking the total subsidy to 90%. The pumps were however found to be too small to suitably irrigate land. An IWMI-TATA policy document reported that "beneficiary farmers complained that due to small size, it takes them twice as long to irrigate a bigha (1 acre = 1.6 bigha) compared to diesel or electric pumps; also increasing labour costs."

The vendors who have been short listed by the state to supply under the scheme are Tata Power Solar Systems, Jain Irrigation Systems, Veddis Solar, Claro Energy, and Rajasthan Electronics Instruments. While farmers can decide the size of the pump and whether it is AC or DC, they cannot decide on the company as BREDA allocates districts to companies. A policy report by IWMI-TATA pointed out that this arrangement can potentially ensure that regardless of performance, companies are assured of supply orders.[11] According to the information presented in the report, after sale service provided by the companies has been poor. Contrary to the claim that they resolve problems within 48 hours, it takes around three weeks. In certain examined cases, it even took three to five months. The report also mentioned that the price for solar pumps under BSSY seemed inflated in comparison to price of pumps in states like Gujarat.

According to VASFA, a non-profit organisation that implements irrigation projects in Vaishali district of Bihar, the BSSY scheme has failed to make an impact. VASFA contends that the process of application for receiving the subsidy is unduly long and ultimately only a select few, who are chosen through lottery, are granted the subsidy. Also, as compared to 19.38 lakh applications from farmers for diesel subsidies during the previous season, 22.93 lakh farmers applied for the subsidy in Bihar during the 2019 rabi season.[12] This indicates an increase in the use of conventional irrigation pumps.

Pay-as-you-go Solar Irrigation Model

GIZ[13] has been experimenting with different service delivery models in the eastern parts of India. GIZ piloted a service delivery model of pay-as-you-go in Vaishali district of Bihar.[14] Envisioned as a community-based model, it involves sharing a solar pump within an irrigation water-sharing group of farmers. The GIZ pilot collaborated with a local organisation, VASFA[15], to implement its pilot solar irrigation project in Vaishali district. So far, this collaboration has resulted in the

[11] Can solar pumps energize Bihar's agriculture? Water Policy Research Highlight. IWMI-TATA Water Policy Program.
http://www.iwmi.cgiar.org/iwmi-tata/PDFs/iwmi-tata_water_policy_research_highlight-issue_03_2016.pdf
[12] As rollout of solar-pump scheme is delayed, Bihar offers higher diesel subsidy to farmers. 24 April 2019. Business Line.
https://www.thehindubusinessline.com/economy/agri-business/as-rollout-of-solar-pump-scheme-is-delayed-bihar-offers-higher-diesel-subsidy-to-farmers/article26934675.ece
[13] The Renewable Energy Component of Indo-German Energy Programme (IGEN-RE) is a bilateral cooperation project with the Indian Ministry of New and Renewable Energy (MNRE) carried out by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) on behalf of the German Federal Ministry for Economic Cooperation and Development (BMZ). Launched in 2010, the project aims to promote renewable energy in rural areas. For more information please visit our website: *www.igen-re.in*.
[14] Community-Based Service Delivery Model Through Solar Irrigation Pump. June 2018. Akshay Urja.
https://mnre.gov.in/file-manager/akshay-urja/june-2018/Images/28-31.pdf
[15] VASFA is a community based organisation which works for the upliftment of agricultural labourers, small and marginal farmers, rural youth, women, landless labour artisans and disabled persons in Vaishali, Muzaffarpur, East Champaran, West Champaran, Saran & Patna.
For more details, refer *http://vasfa.org.in/activities.php.*

implementation of three fixed solar irrigation pumps and five portable solar irrigation pumps. The entire project has been on an experimentation basis and VASFA anticipates to conduct an analysis of the pilot in mid-2019.

VAISHALI BACKGROUND

Like most other places in Bihar, the average ground water level in the Vaishali region is 20 to 30 ft. However, farmers report that bad rains in the last decade have lowered ground water levels causing worry to local residents. Farmers in the region claim that the ground water level has decreased by 10 ft and that several ponds and other water sources have dried up. The area has a small amount of irrigation through canals and the remaining is irrigated through diesel and electricity operated tube wells. Where neither is possible, farmers solely depend on rainwater for cultivation.

Land owning patterns in the regions vary widely between 0.2 acres to 20 acres. The majority of farmers are however marginal to small farmers and the average land holding is about 1.5 to 2 acres. The prominence of diesel pumps in the region have ensured that a large number of farmers cultivate two to three crops in a year. In the post monsoon Kharif season, paddy and maize are cropped while in the winter rabi season, wheat, mustard, potatoes, vegetables, and pulses are cropped. Between these two main seasons, from March to June, zaid (summer) crops which primarily include moong and vegetables are cultivated. Few wealthier farmers also cultivate tobacco.

JLG solar panel at Vaishali

In 2014, GIZ began to implement this service delivery model in Vaishali district of Bihar. GIZ contracted Claro Energy for supply of pumps and maintenance services. Claro Energy provided VASFA with two 5 HP AC solar submersible pumps manufactured by Shakti Pumps along with solar panels with a capacity of 4.8 kW for each pump. While the entire cost was borne by GIZ, the ownership of the asset lies with VASFA, which is also in-charge of implementation, technical support and operational issues. Apart from testing the community-based model, the pilot aimed to reduce dependence on diesel pump for irrigation in the area and to promote the site for technology demonstration to farmers of neighbouring districts.

VASFA had an on-going irrigation project in Vaishali taluk which operates 23 tube wells in the region. In two of these wells, located in Lalpura village and Baniya village, VASFA replaced the diesel pumps with solar irrigation pumps. In Lalpura village, the solar irrigation pump scheme has 40 beneficiary members, whereas in Baniya village, the scheme has 23 beneficiaries. In both areas, the tube well is installed at a depth of 200 feet. The solar panels in Lalpura village are fixed due to lack of space while the panels in Baniya are rotatable to ideally track solar radiation.

Both these solar irrigation pumps are managed and operated by farmers groups. The farmers sharing the solar pump either need to have their land adjacent to the water pump or within the catchment area of the pump. Each group has a group leader elected from within itself for oversight and collection of service charges and an operator for daily operation of pump. Water is sold to group members on priority and then to surrounding farmers for a service charge based on the quantum of water delivered. The sequence in which members and non-members receive water in a particular day is decided by the group leader. Data analysis by GIZ also shows that the solar irrigation pump in Lalpura village is predominantly used by members of the group. The service charge to be collected is decided by the group and the charge for non-members is slightly higher than that for members. Both group members receive water at Rs 30 per hour, and non-members hire the services of the pump at Rs 50 per hour. The collected money is used for salary of the operator and the rest is deposited with VASFA for maintenance of the asset. The catchment area of the pump is about 40 acres. The areas nearer to the pump are serviced through canals and the remaining areas are serviced through delivery pipes. The experience of both groups with Claro Energy has so far been positive.

Pay-as-you-go Model through Bhoomi Heen Kisan scheme

Following the success of the two solar irrigation pumps, in 2017, VASFA approached the State Bank of India (SBI) for a loan of Rs 2,70,000 lakhs to install one solar irrigation pump for irrigation and fishery in Haharo village. The loan was sought under the Bhoomi Heen Kisan scheme[16] of the Reserve Bank of India and NABARD. As per the requirement of the scheme, a Joint Liability Group (JLG) with five members from Haharo was formed. The financial viability of the loan

[16] Notification. 13 November 2014. Reserve Bank of India.
https://www.rbi.org.in/Scripts/NotificationUser.aspx?Id=9336&Mode=0

was based on irrigation of lands belonging to members, renting out pump services to neighbouring farmers and annual leasing of the ponds for fisheries. The scheme involved a 50% subsidy from the Ministry of Renewable Energy and NABARD. VASFA also made a financial contribution of Rs 1,50,000 for the construction of the tube well and provided the bank guarantee for the loan. After scrutinising the application and visiting the project site, SBI sanctioned the loan amount in November 2017. GIZ collaborated to provide technical support and VASFA was the lead implementing agency.

The solar irrigation pump was installed with a tube well at 200 ft below ground, a 5 HP DC pump supplied by Claro Energy and manufactured by Shakti Pumps, and rotatable solar panels. The pump has a catchment area of 40 acres. The pump comes with a 5 years warranty period and the experience of the group with the company has so far been positive. Whenever required, the company has provided good service and technical support. GIZ's pay-as-you-go service delivery model was replicated in this village.

Unlike the solar irrigation pump projects in Lalpura and Baniya, where the entire cost was borne by GIZ with the assets owned by VASFA, in Haharo, the five-member JLG not only owns the pump but also has to repay a sizable loan amount. A considerable portion of the repayment money was to come from leasing the three artificially dug ponds for fisheries. The ponds are filled through seasonal rains and supplemented by water from the solar pump. However, until now the ponds have not had adequate water to be leased out. The groundwater level in the region has been impacted on account of poor rains and any amount of water pumped into the pond sinks into the ground, keeping the pond barely shallow with water. As a result, the group has been finding it difficult to repay loan instalments.

DETAILS	LALPURA VILLAGE	BANIYA VILLAGE	HAHARO VILLAGE	PORTABLE PUMP
Year of installation	2014	2014	2017	2016
Tube well	200 ft	200 ft	200 ft	Employs bore wells
No. of beneficiaries	40	23	5	-
Pump capacity	5 HP	5 HP	5 Hp	2 HP
Pump type	AC submersible	AC submersible	DC	DC
Pump manufacturer	Shakti Pumps	Shakti Pumps	Shakti Pumps	-
Certification	ISO certified	ISO certified	ISO certified	Experimental stage
Panel capacity	4.8 kW	4.8 kW		6 panels of 44.6 volts
Panel type	Fixed	Rotatable	Rotatable	Fixed
Supplier	Claro Energy	Claro Energy	Claro Energy	Claro Energy
Catchment area	40 acres	40 acres	40 acres	15 acres
Predominant crop	Vegetables	wheat, paddy cereals	Wheat, cereals	-
Financed by	GIZ	GIZ	JLG & VASFA	GIZ
Asset ownership	VASFA	VASFA	JLG	VASFA

Portable Solar Irrigation Pumps

In 2016, GIZ provided VASFA with five portable solar irrigation pumps for the purpose of exploration and demonstration. The portable pumps are 2 HP DC pumps supplied by Claro Energy and the solar panels are manufactured by Alpex Company. The pump and its solar panels are installed on an e-rickshaw, which can also be operated on solar energy.

The pumps are hired for a service charge from VASFA by farmers who have provision for a bore well. The approximate cost is Rs 5 per 1000 litres of water. These portable pumps have elicited positive reaction from the public and continue to be in high demand in the area.

Analysis of Models

Throughout its five years of experience with solar irrigation pumps, VASFA has engaged with Claro Energy who has supplied pumps manufactured by Shakti Pumps. Discussions with VASFA team indicate that the DC pump has displayed stronger ability for water capacity than the AC pump. Also, while the AC pump requires a stable 440 volts power to operate and therefore experiences turbulence, the DC pump can operate even during fluctuations. While the 5 HP pump provides a 3-inch delivery of water and the 2 HP pump provides a 2.3-inch delivery of water. The team reported that deciding the water. The team reported that is based on the required catchment area and water demand. Rotatable panels which track sun rays have shown marginally better performance than fixed panels.

The two key advantages mentioned by farmers are lowered cost of irrigation and convenience. Unlike solar pumps, operating a diesel pump required regular supply of fuel, which necessitated trips to the market for purchase. With regard to operational costs, a diesel pump costs about Rs 100 (fuel cost) per hour while a solar pump costs Rs 30-50 (service charge) per hour. Though the extent of land served in an hour depends on the type of crop, on an average irrigating 1 acre of land requires the pump to run for about 8 hours. Cost comparison between diesel pump and solar pump shows that irrigating through solar brings down the cost by half. Solar pumps require seasonal maintenance costs owing particularly to damage of the service/delivery pipes, which are made out of thin plastic, prone to damage with use.

Another significant challenge is that there is sufficient solar radiation to operate solar pumps between 8.30 am and 3.30 pm. Lalpura village[17] which cultivates a considerable amount of vegetables requires irrigation in the early morning and the evening. Also, most farmers prefer to complete work by noon owing to scorching heat in the afternoons. Additionally, between November and February, the solar irrigation pump cannot be depended upon owing to insufficient solar radiation. According to Nilanjan Ghose of GIZ, during peak season between October and May when the water requirement is highest, the 5 HP solar pump does not meet the water requirements.[18] Therefore, farmers continue to use electric and diesel pumps in addition to

[17] For factsheet on Lalpura solar irrigation plant refer *https://energypedia.info/images/3/3c/Case_Study_India-_Lalpura.pdf*

[18] Community-Based Service Delivery Model Through Solar Irrigation Pump. June 2018. Akshay Urja. *https://mnre.gov.in/file-manager/akshay-urja/june-2018/Images/28-31.pdf*

solar. However, data analysis (between 2014 and 2017) for Lalpura village by GIZ has shown that about 50% of the village's irrigational needs are met by the solar irrigation pump.

To its credit, the pay-as-you-go model not only provides assured access to irrigation for group members and other farmers, the structure of the management that is based on shared decision making brings increased autonomy and empowers group members. In this model, the solar pump is meant to be shared between a fixed number of beneficiaries along with renting out of services to other farmers. The management of the pump is overseen by a member nominated as the leader. All operational and financial decisions are made by the group members. While this community engagement is a step in the right direction, the pilot initiative with the three pumps have shown that group management can be riddled with issues ranging from inefficiency to corruption.

For the three pumps implemented by GIZ, the entire financial cost for the pumps was borne by GIZ which results in a situation where the farmers group does not own the solar pump set. Also, the financial model implemented here is that of an aid and therefore is not scalable. Conversely, the JLG implemented solar irrigation through the Bhoomi Heen Kisan scheme which ensured that the ownership of the pump stayed with the group members. However, despite financial assistance from VASFA and the MNRE subsidy, the loan amount is significant and group members are struggling to pay instalments.

CASE STUDY 2: Gujarat

State Policy & Programmes

The state government launched the Suryashakti Kisan Yojana (SKY) in June 2018, a solar power scheme for farmers to generate electricity for their captive consumption and sell surplus power to the grid to earn revenue.[19] This scheme offers solar panels to farmers with an existing electricity connection. While the state and Central governments subsidies are to cover 60% of the cost, the farmer is required to pay 5%, while 35 % will be provided as an affordable loan. The scheme is for a duration of 25 years, split as seven and 18-year periods. Farmers will earn Rs 7 per unit for the first seven years and from then on for 18 years, they will earn Rs 3.5 per unit of electricity sold to the grid. The scheme also proposed the setting up of separate feeders for agricultural solar energy consumption. With an estimated cost of Rs 870 crore, the pilot project which aims to cover 33 districts covering 12,400 farmers will set up 137 such feeders. The scheme, if successfully implemented across the state, will benefit the state government financially on savings from providing subsidized power to the farmers. The state currently provides electricity to farmers at about 50 paise per unit.[20] A farmer will have to give up her/ his connection of subsidized power in addition to investing in a solar project.

By promoting grid-connected pumps, SKY incentivises solar irrigation for farmers, ensures maximum utilisation of units, generates electricity for the state and reduces the financial burden faced by DISCOMs. Additionally, selling of surplus electricity discourages over-use of water for irrigation. The scheme however faces challenges on account of the capital investment required of farmers as it can take up to five years on an average for farmers to repay the loan.

Prior to SKY, the Gujarat government had provided subsidy for off-grid solar irrigation pumps. In 2014, the government had announced that it would provide solar irrigation pumps to 1,000 farmers. The plan provided 3-5 HP submersible pumps at an average cost of Rs 6 lakh per unit to the government.[21] According to an October 2014 news report, the solar irrigation pumps were to be provided to “those who have already applied for regular agriculture electricity connection as on March 31, 2014” for a payment of Rs 5,000 per HP (Rs 1,000 per HP for tribal farmers).[22] An April 2018 news report stated that the state government has distributed nearly 4,000 solar irrigation pumps to farmers.[23]

Grid-connected Solar Irrigation Model

After successfully completing a pilot programme called Solar Power as Remunerative Crop where a grid-connected solar irrigation pump was installed in Thamna village of Anand district in Gujarat in 2015, the International Water Management Institute (IWMI) in collaboration with the Tata Trust[24] initiated conversation with farmers in Dhundi village. After several discussions, in late 2015, farmers from Dhundi visited the project site in Thamna. Despite hearing first-hand accounts of the solar irrigation pump, many villagers did not trust the economics of the scheme. However, six farmers came on board the experiment.

[19] Gujarat launches SKY Scheme for farmers to generate solar power. 23 June 2018. Business Line.
https://www.thehindubusinessline.com/news/national/gujarat-launches-sky-scheme-for-farmers-to-generate-solar-power/article24242176.ece
[20] Gujarat farmers can now produce, sell solar power under Suryashakti Kishan Yojana. 23 Jun 2018. Live Mint.
https://www.livemint.com/Industry/Yo4kUy3NeBkdU293IJ3rMO/Gujarat-farmers-can-now-produce-sell-solar-power-under-Sury.html
[21] 1,000 Gujarat farmers to get solar pumps for irrigation from state government. 13 October 2014. DNA.
https://www.dnaindia.com/india/report-1000-gujarat-farmers-to-get-solar-pumps-for-irrigation-from-state-government-2025542
[22] 1,000 Gujarat farmers to get solar pumps for irrigation from state government. 13 October 2014. DNA.
https://www.dnaindia.com/india/report-1000-gujarat-farmers-to-get-solar-pumps-for-irrigation-from-state-government-2025542
[23] Gujarat govt mulls connecting farmers using solar powered pumps to grid. 18 April 2016. Business Standard.
https://www.business-standard.com/article/economy-policy/gujarat-govt-mulls-connecting-farmers-using-solar-powered-pumps-to-grid-116041800825_1.html
[24] A Gujarat farmer who supplies power to grid. 13 June 2015. Business Standard.
https://www.business-standard.com/article/economy-policy/a-gujarat-farmer-who-supplies-power-to-grid-115061200812_1.html

DHUNDI BACKGROUND

The village of Dhundi located in Kheda district has about 300 families and 1,500 people. The average land holding in the village is between one and two acres and most farmers cultivate three crops a year. While paddy is the staple in the kharif season, wheat, rajgira (amaranth or red millet) and vegetables are cultivated in the rabi season and bajra and mooong are cultivated in the zaid months. Tomatoes are cultivated here in large quantities. There is a small extent of canal irrigation for fields that are situated close to the river. There are over 40 diesel pumps in the village that cater to irrigation needs throughout the year. Owing to issues with land records, farmers in the village could not receive electricity for irrigation purpose, thereby depending wholly on diesel. Farmers rent the diesel pump facility for about Rs 120 per hour. The ground water level in the village is 30-35 feet and tube wells are installed at a depth of about 100 feet.

Subsequently, the Dhundi Saururja Utpadak Sahakari Mandali (Dhundi Solar Pump Irrigator's Cooperative; henceforth referred to as the cooperative) was set up in December 2015 in with six members. The Cooperative was to implement six grid-connected solar irrigation pumps with a total capacity of 56.4 kWp that can ensure irrigation and evacuation of solar power to utility grid. The cooperative was formally registered in February 2016 and is deemed to be the first solar cooperative in the world. To ensure that surplus power generated is metered, a mini grid infrastructure was erected in the village in April 2016. The farmers also gave up their right to apply for subsidized farm power subsidy.

The IWMI project required each of the six farmers to pay Rs 5,000 per kVA installed as their contribution. On this basis, for an 8 kVA solar panel, farmers had to pay Rs 40,000 and for a 10.8 kVA solar panel, farmers had to pay Rs 54,000. The decision on the size of panel and pump was left to the farmers. Three farmers chose 5 HP pumps with 8 kVA solar panels and three others opted for the 7.5 HP pumps with 10.8 kVA solar panels. The total contribution by the members was Rs 3,75,000 and the remaining Rs 13,84,000 was put in by the IWMI-Tata project. The contract for supplying machinery, installation and maintenance was given to Shashwat Cleantech, which installed pumps manufactured by Kirloskar and solar panels manufactured by Goldi Green.

While the pumps have a catchment area of 30-40 acres, they mainly serve about 10 acres as serving further areas requires longer carrier pipes increasing the maintenance cost. The carrier pipes are made out of plastic and requires to be changed every six months. All panels installed here are rotatable to track sun rays. Electricity supply to the village is 24/7 with one power cut a month for maintenance purposes.

In May 2016, the cooperative made a Power Purchase Agreement with the Madhya Gujarat Vij Company Ltd (MGVCL) for purchase of electricity for 25 years at the rate of Rs 4.63 per kWh. In addition to this, since August 2016, IWMI provides the solar irrigation pump owners in Dhundi with Rs 1.25 per kWh as Green Energy bonus and with Rs. 1.25 per kWh as Water Conservation bonus. This supplementation provided by IWMI took per unit cost of electricity sold by Dhundi pump owners to Rs. 7.13. Both MGVCL and IWMI transfer the money for the evacuated electricity on a monthly basis to the cooperative's account which is then transferred to the owners through cheques. The farmers were entitled to receive the IWMI bonus for a period of two years and this ended in May 2018.

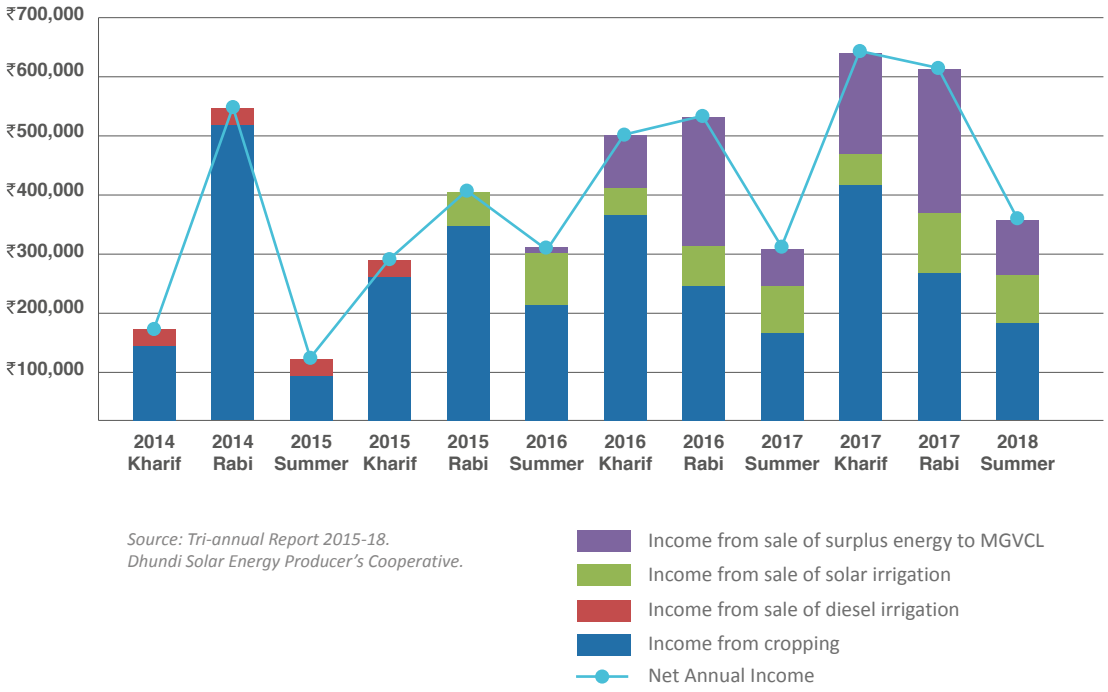
The evident success of this pilot encouraged three more farmers to join the cooperative in September 2016. IWMI do not however have adequate financial resources to provide the three farmers with a scheme similar to the one offered previously. The three farmers were therefore required to pay Rs 25,000 (five times the previous cost) per kVA installed. But while the pilot project which installed an 8 kVA solar panel for a 5 HP pump and a 10.8 kVA solar panel for a 7.5 HP pump, the experimentation phase lead to the realisation that a 5 kVA panel was adequate for a 5 HP pump. The contract for supplying machinery, installation and maintenance was given to Shashwat Cleantech. All three farmers were supplied with 5 HP AC submersible pumps with 5 kVA solar panels; a total capacity of 15 kWp. The pumps were manufactured by Falcon Pumps and the solar panels were manufactured by Goldi Green. The Cooperative got a power purchase agreement for the three new members in August 2017. However, MGVCL negotiated a lower price of Rs 3.25 per kWh, against the earlier price of Rs 4.63 per kWh, for the energy evacuated by the three new members. The three farmers are entitled to a similar bonus from IWMI for a period of two years.

"The benefits from this project have been multi-fold. Use of diesel has almost come to an end in our village. The income that the cooperative members earn from sale of water and electricity has substantially improved our lives. Other farmers in the village are also getting water at lower prices from the nine members"

- Praveen Parmer, Leader of the Cooperative

Analysis of Model

The nine solar pumps are used for irrigating own fields, renting pump service to neighbouring farmers for a service charge and feeding surplus electricity to MGVCL. Between January 2016 and May 2018, the Cooperative generated 2.04 lakh units of solar power.[25] About 37% of this generated electricity was utilised for irrigation and 63% was sold to MGVCL. The net income of the Cooperative members had increased by 33% in 2016-17 (as compared to the previous year) and 58% in 2017-18. Solar irrigation is also economical to non-member farmers who rent services. While renting diesel pump services costs a farmer Rs 500 for irrigating a bigha of land, solar irrigation costs only Rs 250. Farmers also stated that irrigating through solar pumps reduced the time spent irrigating per bigha. It is also necessary to note that renting out irrigation services at Rs 250 per bigha pays the pump owner Rs 12 per kWh which is far more than what the farmer gets from MGVCL and IWMI put together. This will ensure that Cooperative members utilise the pumps for irrigation as a priority and only feed electricity to grid when there is surplus. A graph of income trends of Cooperative members is provided below.



Source: Tri-annual Report 2015-18. Dhundi Solar Energy Producer's Cooperative.

[25] Tri-annual Report 2015-18. Dhundi Solar Energy Producer's Cooperative.

For all nine solar pumps that were installed in Dhundi, Shashwat Cleantech was given the contract for installation and maintenance. The Cooperative reports that the company has provided support whenever required, both over telephone and through trips to Dhundi. In 2017, when three of Kirloskar's pumps malfunctioned, Shaswat Cleantech transported them to their workshop, repaired them and installed them back. This experience and the fact that Falcon's pumps have so far not malfunctioned has lead the Cooperative to determine that they are of better quality than Kirloskar ones. In 2017, a spark in one of the solar panels caused malfunctioning and Goldi Green came for inspection, took back the panels and installed new ones. Since then, there have been no other issues with the panels.

This grid-connected solar irrigation model implemented by IWMI-TATA not only ensures assured access to irrigation and electricity, it also provides the farmer with the dual economic benefit of selling surplus electricity to the DISCOM and selling water to farmers. This has resulted in substantial economic benefit to the nine cooperative members in Dhundi. However, a large portion of the equipment cost was borne by the project, without which the project may not have been viable.

Members by the installed solar panels, Dhundi

Nightschool of Barefoot College in Tilonia/Rajasthan using solar powered batteries.
© *Marcus Franken / Greenpeace*

CASE STUDY 3: Tamil Nadu

State Policy & Programmes

The Tamil Nadu government launched a scheme in 2012-13 and 2013-14 to provide 5 HP AC solar irrigation pumps (non-tracking type) to farmers. It provided a subsidy of 80%, of which 50% assistance is provided under National Agricultural Development Programme (NADP) and 30% is from MNRE.[26] According to the Department of Agricultural Engineering, the scheme was proposed with the objective to ensure energy security to the farmers for irrigating the crops with no recurring expenditure, to promote non-conventional energy in agriculture sector, to improve the water use efficiency by judicious use of irrigation water and thereby achieving improvement in agricultural production and productivity of the crops under this system. [Refer footnote for solar irrigation pump related TN Government Orders.[27]] In this period, out of a target of 2,500 pumps, the state installed 2,293 pumps in agricultural fields. The state extended the scheme in 2016-17 and sanctioned 500 solar pumps with a similar subsidy of 80%.

Based on the success of the two phases, in July 2017, the state government announced that it would provide 1,000 off-grid solar irrigation pumps with a 90% subsidy if farmers agreed to close their application for farm connection.[28] The projected cost of this programme was approximately Rs 50 crore. Under this scheme, the State government provides 5 HP, 7.5 HP and 10 HP pumps to farmers across the State. The scheme incorporates a 40% state government subsidy, 20% subsidy from MNRE, 30% subsidy per cent from Tamil Nadu Generation and Distribution Corporation (TANGEDCO) and farmer's contribution of 10%.

In September 2018, the Tamil Nadu government announced that it would distribute one lakh grid-connected solar irrigation pumps at an estimated project cost of Rs. 13,500 crore.[29] The effort attempted to reduce the financial burden of providing subsidised electricity. The plan incorporated the 30% subsidy from the central government, 10-20% as contribution from the farmer and the remaining provided by the state government. While Tamil Nadu Generation and Distribution Corporation (TANGEDCO) will purchase the electricity, Tamil Nadu Energy Development Agency (TEDA) will aggregate power from all systems and enter into a power purchase agreement with the state utility for the aggregated quantity. This plan for grid-connected solar pumps is however yet to be implemented.

Solar Village Model

While Auroville Consulting (AVC) conceived the project and prepared the project proposal, the TEDA came on board the project as the implementing agency. In October 2010, the Government of Tamil Nadu, vide G.O. (MS) No.65 dated 30.10.2015, sanctioned a pilot project for the installation of 170 kW grid connected solar power plant at Irumbai for (24x7) uninterrupted electricity scheme under the State Innovation Fund. TANGEDCO and Tamil Nadu Innovation Initiatives (TANII) are collaborating partners while AVC provides project management services to TEDA for the project.

[26] Refer *http://www.aed.tn.gov.in/English/solar-eng.html*
[27] Refer *http://www.tn.gov.in/go_view/searchresult/solar*
[28] G.O.(Ms). No.217. 31 August 2017. Government of Tamilnadu. *http://cms.tn.gov.in/sites/default/files/go/agri_e_ms_217_ae1_2017.pdf*
[29] TEDA to install 1 lakh solar farm pumps. 21 September 2018. The Hindu.

IRUMBAI BACKGROUND

The plan for a solar village in Tamil Nadu began in 2015 with AVC, a unit of the non-profit organization Auroville Foundation, spearheading the initiative. Irumbai village, located in Vanur Taluk in Villupuram district, was selected for the pilot as the region experiences frequent and long power cuts and is located 4 kms away from Auroville, making it ideal for implementation and monitoring. Irumbai currently faces regular, long power cuts. In November 2018, The New Indian Express quoted an Irumbai resident as stating that the village experienced power cuts at least thrice a day. The objective of this pilot initiative was to initiate solar villages, i.e. energy neutral villages, in Tamil Nadu and alongside make it energy efficient by installing energy efficient appliances. Once completed, Irumbai will be the first solar village in the state.

The objectives of the project are two-fold: one, to solarise the village and secondly, to replace electrical appliances such as lights and fans with energy efficient appliances. This pilot initiative is set to demonstrate that rural areas can be provided with 24x7 uninterrupted electricity in a sustainable manner and therefore become a model that can be replicated on a large scale. AVC and TEDA have audited Irumbai and collected various energy related data including consumption rate, consumption pattern, and growth rate of population and energy needs. Based on this data and taking into account the assumed consumption for five years, the required capacity was deemed to be 170 KW. Also, Irumbai is currently registered as a rural feeder. However, for a village to generate and run on solar power and to feed excess power to the grid there will have to be continuous power supply. To ensure this, once the Irumbai Solar Village project is completed, Irumbai village will be categorised as an urban feeder to ensure uninterrupted power supply so that surplus production is metered.

"To demonstrate that 100% of electricity requirement in any village could be met through solar power, Irumbai Village in Villupuram District has been selected for this purpose on a pilot basis and Government order has been issued to this effect for installing 170 KW capacity Grid connected Solar Power Plant at a total cost of Rs.206.1 lakhs."

Policy Note 2016-2017, Energy Department Government of Tamil Nadu

https://www.thehindu.com/news/national/tamil-nadu/teda-to-install-1-lakh-solar-farm-pumps/article25000326.ece

The financial plan was devised such that TEDA would put in 90% of the finances and the remaining 10% would be put in by the District Collector on behalf of the people of Irumbai. This was done to ensure the participation and ownership of the local people. Being part stakeholders of the projects (10% stake), an equivalent portion of the revenues is set to go back to the village. The module in which the village will receive the financial dividends from their ownership is yet to be clearly determined. Some of the possibilities under consideration are that the profits be routed to the village panchayat or to a dedicated team created for this purpose which can use it for benefit of the entire village. Out of the total budget of Rs 2.10 crore, TEDA has released Rs 30 lakhs to TANGEDCO for laying new LT (low tension) lines and a new transformer. The electricity generated from this plant could be priced approximately at Rs 3.11 per unit.[30]

The replacement of lights and fans are currently underway. The replacement of fans has been completed and a total of 193 energy efficient fans have been installed in the village. While every house received one unit, community buildings such as school, temple, and community centres received two to four units. The BEE 5-star rated fans consume 28 watts at the highest speed setting, and are estimated to yield 9% in annual energy saving in the village. The replacement of lights is yet to be undertaken. Additionally, the municipal motor pumps have been replaced with energy efficient pumps.

For the purpose of installing 170 KW grid connected solar photovoltaic power plants (without battery), 2.5 acres of grazing land in the village has been selected. TEDA is currently in discussion with the state government to obtain the required land. In 2018, the New Indian Express reported that "little progress has been made on the ground since then (2015) owing to lack of communication between all government bodies concerned and delay in processing of paperwork."[31] The tender for soliciting vendors is currently on hold by TEDA due to delays and the 2019 Lok Sabha elections. The tender is set to be opened post June 2019. AVC expects that the project will be completely installed and operational before the end of the year.

This project is not fully implemented, and therefore it is difficult to properly assess the model. However, in a region which faces severe power shortage, the solar village promises assured access to electricity to residents of Irumbai. The model for solar village in Irumbai also incorporates a community ownership component which not only ensures financial returns from the project to the village but also establishes a sense of ownership and identity for the people of Irumbai.

Audit of Irumbai village

[30] Cause List - Cases posted for 18-09-2018. 12 September 2018. Tamil Nadu Electricity Regulatory Commission.
http://www.tnerc.gov.in/hearsched/2018/CauseList-18-09-2018.pdf
[31] First solar village of Tamil Nadu yet to light up. 0 November 2018. The New Indian Express.
http://www.newindianexpress.com/states/tamil-nadu/2018/nov/05/first-solar-village-of-tamil-nadu-yet-to-light-up-1894442.html

Solar panels atop Panchayat Bhavan, Dharnai village
© Vivek M. / Greenpeace

CASE STUDY 4: Maharashtra

State Policy & Programmes

The Maharashtra government operates the Atal Solar Krushi Pump Yojana (ASKP) which provides farmers subsidy up to 95% for solar irrigation pump set. The scheme was launched in October 2018 with a target of distributing 7,000 solar pumps to farmers to irrigate about 14,000 ha of land.[32] With an allocated budget of Rs 239.92 crore, the scheme aimed that 25% of solar pumps will be of 3 HP (1,750) and 75% of pumps would be of 5 HP (5,250). Farmers with less than 5 acres of land are required to pay 5% (or about Rs 12,000) for a 3 HP pump and farmers with more than 5 acres of land are required to pay Rs 30,000 to get 5 HP pump. The state also reserved 13.5% of pumps for farmers belonging to the scheduled caste (SC) and 9% for those belonging to scheduled tribes (ST). To encourage farmers to utilise the scheme, the government also recently declared that the government will provide two LED bulbs, a DC fan and a mobile charging socket.[33]

Despite such efforts, the response to the solar pump scheme from the farmers in Mahastratra has been tepid. In this context the government has attempted to focus on the Mukhyamantri Saur Krishi Vahini Yojana (MSKVY) which aims at solar power generation through small plants to ensure 12-hour power supply for agricultural pumps across the state and cheap electricity for farmers. The Mukhyamantri Saur Krushi Vahini Yojana or Chief Minister Agricultural Solar Feeder Scheme was notified by the state government in June 2017[34] with the objective of supplying power to farmers during day time through solar power projects. Subsequently, the Maharashtra State Electricity Distribution Company Limited (MSEDCL), the implementation agency for the scheme, floated tenders for procurement of 1,000 MW of solar power through competitive bidding process from small, 2 to 10 MW projects. MSEDCL plans to implement approximately 10 MW per taluk.[35] Under this scheme, the state has implemented two 2 MW AC solar projects, under PPP mode, in Ralegan Siddhi in Parner Taluka of Ahmednagar District and in Manjarda in Yavatmal Taluka in Yavatmal District.

Solarisation of Irrigation through Small Power Plants

In 2017, the state government of Maharashtra approached the panchayat of Ralegan Siddhi and proposed the implementation of a solar power project in the village. The region is in the drought-hit parts of Maharashtra and cultivation has been severely impacted in the last decade. The promise of uninterrupted day time supply of power to the village for irrigation purposes gathered support to the project the village Panchayat granted its permission to the project.

[32] Maharashtra Atal Solar Krushi Pump (ASKP) Yojana – 7000 Agriculture Pumps to Farmers. 05 October 2018. Sarkariyojana.com.
https://sarkariyojana.com/maharashtra-atal-solar-krushi-pump-askp-yojana-7000-agriculture-pumps-farmers/
[33] Maharashtra farmers to get sops for using solar pumps. 03 January 2019. Business Line.
https://www.thehindubusinessline.com/news/national/maharashtra-farmers-to-get-sops-for-using-solar-pumps/article25901808.ece
[34] Resolution. 14 June 2017. Government of Maharashtra.
https://www.maharashtra.gov.in/Site/Upload/Government%20Resolutions/English/20170614120608031O.pdf
[35] Order. 17 July 2018. Maharashtra Electricity Regulatory Commission.
http://www.mercindia.org.in/pdf/Order%2058%2042/Order-178%20of%202018-19072018.pdf

RALEGAN SIDHI BACKGROUND

Ralegan Sidhi village has a population of about 450 families and 3,000 people. The land holding of farmers varies between 1 and 20 acres, with an average land holding of 3-5 acres. Most farmers also rear cattle. The farmers who have wells in Ralegan Sidhi cultivate two crops while others cultivate one rain-fed crop a year. In the rabi season between June to November, bajra, moong and vegetables like cauliflower and brinjal are grown and in the kharif season, wheat, jowar, and channa are cultivated. The area is home to a deer population which pose threats of damaging crops.

The region's inadequate irrigational facilities along with bad rains have negatively affected agriculture. The ground water level in the area surrounding the village is about 80-100 feet and bore wells and tube wells are operated at 150 to 250 feet. In 2018, reducing ground water tables induced the Gram Sabha to seal about 250 bore wells which went below 200 ft deep. The village faced regular power cuts alternatively lasting eight hours during day in one week and eight hours during night in the next. Given that farmers here rely on electric pumps rather than diesel pumps, this severely affected cultivation patterns.

Sangam Advisors, a company listed in the Bombay Stock Exchange, was awarded the project in 2017 for design, engineering, manufacture, supply, erection, testing and commissioning of two 2 MW solar projects in Ralegan Siddhi and in Manjarda.[36] [Sangam Advisors was acquired by Waaree Energies in 2016[37] and the company has been renamed as Sangam Renewables in 2018.] The two public private partnership (PPP) projects are developed on a build, own, operate (BOO) basis. The projects were required to be commissioned within 3 months.[38] Both pilot projects of 2 MW grid interactive solar PV power plants have been implemented. The rate of electricity for agriculture from the Ralegan Siddhi project is Rs 3.55 per unit, which is the standardised rate for electricity to the agricultural sector in the state.

"Everybody needs electricity. This project has done us good by providing regular supply. The biggest advantage is that now we get full power between 6 am and 6 pm. After 6 pm, we get single fuse for residential purposes."

Amol Zende, Resident, Ralegan Siddhi

[36] Sangam Advisors receive two LoAs from MAHAGENCO. 28 June 2017. United News of India.
http://www.uniindia.com/sangam-advisors-receives-two-loa-from-mahagenco/business-economy/news/914438.html
[37] Waaree Energies installs solar rooftop panels at Growel's 101 Mall. 22 August 2016. Equity Bulls.
https://www.equitybulls.com/admin/news2006/news_det.asp?id=191914
[38] Letter. 27 June 2017. Sangam Advisors.
https://www.eqmagpro.com/wp-content/uploads/2017/07/Sangam-Advisors.pdf

The 2 MW solar power projects are connected to the agricultural feeder, meant to provide electricity for agricultural purposes. While the Ralegan Siddhi plant began generating power from September 2018, its installed capacity as of May 2019 is only 1.5 MW. The site for the project is situated atop a small hillock to prevent shadows and for maximum radiation. However, a portion of this land is sloped and not ideal to locate solar panels. Ten acres of private arid agriculture land was leased for 30 years from a family of three brothers for the project. Currently, villages of Ralegan Siddhi, Pimpalner and Vadule benefit from uninterrupted electricity supplied through the project.

The Maharashtra government has taken a proactive approach to solarisation of irrigation in the state. The response to its scheme to provide subsidy for medium-sized solar irrigation pumps to farmers has been low. While the state government can continue the scheme with required alterations, it is implementing an alternate scheme which builds small solar plants to ensure power supply for agricultural pumps in regions where the response to single solar irrigation pumps have been low. Both these schemes ensure better access to electricity for irrigation.

"The project ensures power supply, and that is a boon for us. We are even considering another small plant in the village so that a few more villages can benefit. However, we are also facing bad rains and drought situation. Ground water levels in the region are currently low and we have to wait for the next rain to raise the water levels."

Dadabau Gajre, Farmer, Ralegan Siddhi

Solar panels at Ralegan

Girls from the Jalka village in Maharashtra, enjoy the shade under the newly installed solar panels that power the fans in their school.
© Peter Caton / Greenpeace

CASE STUDY 4: Odisha

In 2018, the Odisha government launched the Soura Jalanidhi scheme to benefit farmers for irrigation through micro solar pumps. The first phase of the scheme focusses on areas which are facing severe energy and water crisis and aims to cover about 5,000 farmers in 2018-19. The state government has promised to extend the scheme to the entire state in subsequent phases. The implementing agencies of the scheme are the Department of Agriculture & Farmer Empowerment (DA&FE) and Odisha Renewable Energy Development Agency (OREDA).

The scheme recognises that though the state has rich land and water resources, the productivity is low when compared to other states on account of poor irrigation facilities. The Soura Jalanidhi scheme aims to help farmers by providing irrigation for their own fields and by allowing them to sell irrigation services to neighbouring farmers.

Small and marginal farmers having a minimum of 0.5 acres of cultivable land and a dug well are covered under the programme. Under the scheme, farmers can avail 0.5 HP solar irrigation pumps with 500 wp (watt peak) solar panels, which are suitable for light irrigation. With an estimated budget of Rs 27 crore, the state government is providing a subsidy of 70-90%, depending on requirement and choice of farmer. The scheme provides 90% subsidy for a 0.5 HP DC surface pump and a 70% subsidy for a 0.5 HP AC or DC submersible pump.

Sl. No.	TYPE OF PUMP	Total cost (in INR)	Farmer's Share (in INR)	State Subsidy (in INR)	% of State Subsidy
1	0.5 HP Solar DC Surface Pump	59,454	5,454	54,000	90%
2	0.5 HP Solar (AC or DC) Submersible Pump	76,257	22,257	54,000	70%

Upon availing the scheme and depositing their share with OREDA, farmers can select the model and a vendor from OREDA's empanelled vendors. OREDA has allocated each district to one or two companies. The vendors under this scheme include Karma, Solex Energy, Jain Irrigation, Shakti Pump, Jain Irrigation, Shakti Pump, Rotomag, Gupta Agro, and Topsun. Prior

[39] Solar pumps bring relief to smallholder farmers in Rayagada. 10 May 2017. Village Square. *https://www.villagesquare.in/2017/05/10/solar-pumps-bring-relief-smallholder-farmers-rayagada/*

to installation, the vendor is required to select site, and check feasibility of adequate water and suitability of pump. The vendor is also required to provide the beneficiary farmer with the necessary training to operate the pump. The scheme covers for annual maintenance for a period of 5 years with the chosen vendor.

Information on implementation of the scheme are not yet available. However, an official with Jain Irrigation informs that as of May 2019, the company has installed 380 micro pumps in 15 districts. The official reported that while farmers have responded positively to the scheme and would like to avail the benefit, the state government is currently only rolling out limited subsidies, thereby keeping the numbers low.

Abundant groundwater and adequate solar radiation in most parts of Odisha could translate into the success of the scheme that promotes micro solar pumps of 0.5 HP. It is also necessary to note that micro solar pumps have been successfully piloted for small land holdings in Bishama Katek and Muniguda blocks of Rayagada district in Odisha by a non-profit organisation.[39] The Soura Jalanidhi is however, relatively new and details on its implementation are not yet available. Given its model of micro irrigation at a lower capital cost, the success of this scheme could hold valuable learning for other Indian states. It is therefore necessary to understand the challenges and performance of this model as the scheme unfolds in the coming years.

Bihar farmers with an early prototype of a small solar water pump used for irrigation.
© *Daniel Müller / Greenpeace*

Comparison of Key Indicators across models in the five states

State / Model	Bihar		Gujarat		Tamil Nadu		Maharashtra		Odisha
	BSSY	Vaishali	SKY	Dhundi	2012-13 scheme	Irumbai	ASKP	MSKVY / Ralegaon Sidhi	Soura Jalanidhi
State / non-state	State scheme	Independent pilot project	State scheme	Independent pilot project	State scheme	Independent pilot project	State scheme	State scheme	State scheme
Implementing agency	BREDA (dev. agency)	GIZ, VASFA (pvt. Institution)	PGVCL, UGVCL, MGVCL & DGVCL (discom)	IWMI-TATA (pvt. Institution)	TEDA (dev. agency), TANGEDCO (discom)	TEDA (dev. Agency), TANGEDCO (discom)	MSEDCL (discom)	MSEDCL (discom)	OREDA (dev. agency)
State scheme / project	Scheme	✗	Scheme	✗	Scheme	State project	Scheme	State project	Scheme
Total subsidy / breakup [State-S; Central-C; Discom-D; Farmer contribution-F; Loan-L]	S – 60% C – 30%	✗	S – 30% C – 30% F – 5% L – 35%	✗	S – 40% C – 20% D – 30% F – 10%	✗	95%	✗	S – 70-90% F – 30-10%
Aid component	✗	✓	✗	✓	✗	✗	✗	✗	✗
No. of beneficiaries	NA	23+40+5	NA	6+3	NA	5830	NA	3000	NA
Grid-connected	✓	✗	✓	✓	✗	✓	✗	✓	✗
Overall energy access	✗	✗	✓	✓	✗	✓	✗	✗	✗
Irrigation energy access	✓	✓	✓	✓	✓	✓	✓	✓	✓
DISCOM benefit	✓	✓	✓	✓	✓	✓	✓	✓	✓
Farmer / village contribution to project	✓	✗	✓	✓	✓	✓	✓	✗	✓
Farmer / village ownership over pump/project	✓	✗	✓	✓	✓	✓	✓	✗	✓
Farmer /village economic benefit	✓	✓	✓	✓	✓	✓	✓	✓	✓
Farmer income from sale of electricity	✗	✗	Rs. 7 per unit	Rs. 4.63 & Rs. 3.35 per unit	✗	✗	✗	✗	✗
Increased Community involvement	✗	✓	✗	✓	✗	✓	✗	✗	✗