IMPLEMENTATION CHALLENGES OF THE PM-KUSUM SCHEME

CASE STUDIES FROM SELECTED INDIAN STATES

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Introduction

Electricity subsidies make up a large share of subsidies in the country. In FY 2023, tariff subsidies amounted to Rs 1,69,532 crore.[1] These subsidies are largely allocated to domestic and agricultural consumers with the larger share focused on powering irrigation. Several states, namely Andhra Pradesh, Karnataka, Puducherry, Punjab, Tamil Nadu and Telangana, provide free electricity for irrigation.[2] The remaining states have highly subsidized agricultural electricity, making agricultural load charges extremely nominal for farmers—Haryana charges 10 paise per unit under agricultural loads and Himachal Pradesh charges 30 paise per unit consumed.[3]

India has been subsidizing agriculture for decades. This subsidization of electricity started taking place in the 1970s and 1980s as part of the Green Revolution to help aid food production in India. The direct translation of this was distribution of highly subsidized electricity in the form of flat electricity rates for agriculture or completely free agricultural supply.[4]

While this subsidization of electricity was successful in increasing food security, the formation of the water–energy–food nexus led to adverse impacts. Many of the connections under this supply were unmetered, resulting in high consumption of highly subsidized energy to irrigate farmers' lands. Additionally, most of this free energy was produced through coal, leading to an increase in carbon emissions as more farmers opted for irrigation pump-sets to irrigate their land throughout the year.

More farmers opting for irrigation pump-sets, essentially tubewells, led to depleting groundwater levels as farmers started growing more water-intensive crops in water-scarce areas.[5] For example, according to the Central Groundwater Board (CGWB), only 13 out of 152 blocks in Punjab are under the Safe Category when it comes to groundwater tables, with the remaining being mostly over-exploited with the exception of some semi-critical blocks. At the country level, 17 per cent of India's groundwater blocks are over-exploited, with 5 per cent and 14 per cent being at critical or semi-critical stages.[6]

Another consequence of the same was financial losses for the DISCOMs despite cross subsidizing electricity. Subsidies are paid for by the Central and state governments. Funds for these subsidies are to be transferred to DISCOMs by the state governments in advance in order to be able to pay for subsidies in the following financial year. More often than not, however, these funds are transferred with a delay causing DISCOMs to suffer financially.

Since these issues have been identified, there have been several interventions to prevent water levels from depleting further, as well as to relieve the DISCOMs and state governments from their burden. Micro-irrigation technology, such as subsidies on drip irrigation systems or mini-sprinkler systems, was introduced in order to tackle groundwater depletion. The government had also launched the Ujjwal DISCOM Assurance Yojana (UDAY Scheme) in 2015 wherein states would take over 75 per cent of DISCOM debt over two years, 50 per cent of DISCOM debt in 2015–16 and 25 per cent in 2016–17.[7] Another avenue to decrease the burden of subsidies from the state government could be the introduction of solar water-pumps. The introduction of solar pumps has also been under consideration in the past but has not seen proper implementation due to high upfront costs—farmers would have to pay for solar pumps about 10 times the amount they pay for regular tubewell pumps. Solar water-pumps would help ease this subsidy burden by eradicating the need of tariff subsidy for farmers who shift from electric water-pumps to solar water-pumps.[8]

Keeping the above points in mind, introduction of solar pumps in farmers' irrigation practices and subsidization of the same can yield positive results. The Government of India launched the PM-KUSUM scheme in 2019 with a vision to solarize agriculture in India. The scheme, with its components, gives farmers access to reliable irrigation technology and provides them with an extra income source through its various components.

Introduction to PM-KUSUM

The Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan (PM-KUSUM) was introduced in 2019 with the objectives of incorporating renewable energy in farmers' irrigation practices; helping farmers gain access to solar water-pumps at subsidized rates; and giving farmers an avenue to utilize their barren land through setting up of solar power plants for energy generation.

PM-KUSUM was divided into three components, A, B and C, with corresponding targets to be met by 2022. Component A entailed developing solar power plants between capacities 500 kW to 2 MW with the objective of selling generated electricity to the DISCOMs. The target for the same was set at 10,000 MW of decentralized ground/ stilt-mounted grid-connected solar or other renewable-energy-based power plants. Component B includes installation of off-grid solar water pumps on farmers' lands. The target for Component B was set at 17.50 lakh stand-alone solar agriculture pumps. Component C first entailed solarization of grid-connected agricultural pumps through installation of grid-connected solar water-pumps on farmers' lands. The 2019 target for the same was solarization of 10 lakh grid-connected agriculture pumps.[9]

Components A and C were supposed to be implemented initially on pilot mode for 1,000 MW capacity and one lakh grid-connected agriculture pumps respectively while Component B was to be implemented in a full-fledged manner with total Central government support of Rs 19,036.5 crore. The scheme was scaled up from its pilot stage in 2021, and was in August 2022 extended till 2026.

In 2020, the Ministry of New and Renewable Energy (MNRE) introduced feeder-level solarization (FLS) as a sub-component under Component C in addition to solarization of existing electric pumps (to be referred to as individual pump solarization or IPS). It revised the targets under Components B and C in January 2024. No change in target was proposed for Component A, which remains 10,000 MW to be met by 2026. The targets for Component B were revised from 17.50 lakh to 14 lakh standalone solar agriculture pumps. The target for Component C was revised from 10 lakh to 35 lakh grid-connected agriculture pumps, including feeder level solarization.[10]

The scheme also offers subsidies for Components B and C to encourage its adoption. Under Component B, 30 per cent Central Financial Assistance (CFA) is provided on the upfront costs in addition to at least 30 per cent subsidy through the state government. In total, farmers at most have to bear 40 per cent of the costs of their solar water systems. The subsidy in the case of special states (Northeastern states, Sikkim, Jammu and Kashmir, Himachal Pradesh and Uttarakhand, Lakshadweep and Andaman and Nicobar Islands) is 50 per cent CFA for the same. Under Component C (FLS), developers receive 30 per cent CFA and no additional subsidy is provided from the state.

The three components of the scheme have been planned in such a way as to offer benefits to farmers of all categories—marginal, small, medium and large—divided on the basis of landholdings. Component A benefits farmers by giving them access to an extra source of income from their barren land. Farmers can start a solar power plant between capacities 500 kW and 2 MW and sell the electricity generated to the grid. However, with no subsidy, this component would mostly benefit large farmers who have the capability to acquire large loans from banks (see *Table 1*).

Component B targets small farmers who are currently dependent on the erratic main grid agricultural supply. The farmers can opt for standalone solar water pumps replacing their electric/diesel pumps, which would lead to savings in terms of operational costs such as amount spent on purchasing diesel or paying electricity bills.

Component C is divided into two sub-components. The first is individual pump solarization (IPS), which involves setting up grid-connected solar water-pumps on farmers' lands. Under IPS, the capacity of the solar power plant can be twice the capacity of the farmers' existing water pumps in kW so that farmers can sell the excess electricity generated back to the grid. The second sub-component, feeder-level solarization (FLS) entails farmers with land located at a 5-km distance from the nearest substation to start a microgrid and sell power to the substation and power their agricultural feeders. This would help ease the subsidy burden from the state government with regard to the subsidy provided to the feeders' agricultural users.

Table 1: Component-wise savings/income of farmers

Component	Purpose	Assumption	Savings/income
Component A	Introduced to incentivize farmers with large areas of barren land to invest in solar power generation	A farmer with 14 acre of land would set up a plant of about 2.5 MW with an upfront cost of Rs 8 crore. The units generated in a day would be about 16,900 with a tariff of Rs 3.14/unit.	Daily income: Rs 53,066 Monthly income: Rs 15,91,980 Breakeven period: 5 years
Component B	Introduced to incentivize farmers to shift from electric/ diesel pumps to solar pumps	A farmer with 6 acre of land shifts from a 12 horsepower (hp) diesel pump to a 7.5 hp solar water-pump. The farmer used the diesel motor for 150 days a year using 5 litres/day of diesel on an average. The cost of diesel is Rs 86.52/litre.	Average annual savings: Rs 64,890
Component C	Introduced to incentivize farmers to replace their electric pumps with solar pumps and for farmers with large areas of barren land to invest in solar power generation	A farmer with 14 acre of land would set up a plant of about 2.5 MW with an upfront cost of Rs 8 crore. The units generated in a day would be 16,900 units with a tariff of Rs 3.51/unit.	Daily income: Rs 59,319 Monthly income: Rs 17,79,570 Breakeven period: 3–4 years

Source: Farmer interviews

Current implementation status of PM-KUSUM

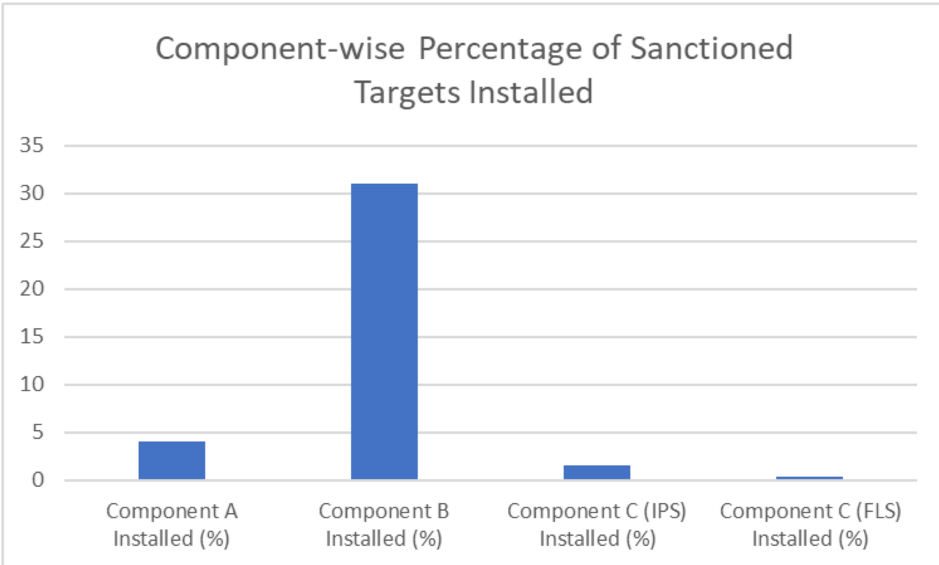
The PM-KUSUM scheme did not see as much acceptance as was envisaged. Components A and C have not yet had a proper take off. According to the Ministry of New and Renewable Energy, Component A has only achieved 4 per cent success, and Component C could only achieve 1.6 and 0.55 per cent installed capacity out of its sanctioned target under both its sub-components by April 2024. Component B achieved a success rate of 31 per cent (see *Graph 1*).

Table 2 shows the performance of different states in terms of implementation of different components of the PM-KUSUM scheme. Installation of Component A is at **4 per cent**, with 209.28 MW of 4,766 MW sanctioned capacity installed. Only six states have initiated work under Component A, led by Rajasthan and followed by Himachal Pradesh, Madhya Pradesh, Haryana, Maharashtra and Chhattisgarh. The states with the highest targets include Rajasthan, Maharashtra, Gujarat, Madhya Pradesh and Odisha, with 1,200 MW, 700 MW, 500 MW, 600 MW, and 500 MW targets set respectively. Maharashtra could achieve installation of 2 MW and no implementation has happened in Gujarat and Odisha. Himachal Pradesh has been able to achieve 23 per cent installation followed by Rajasthan with 13.5 per cent installations. The target allocated to Himachal Pradesh, however, is 100 MW, which is only about 8 per cent of the target allocated to Rajasthan, which stands at 1,200 MW.

Under Component B, about 4 lakh agricultural pumps have been installed as opposed to 12.94 lakh sanctioned pumps in total, making installation **31 per cent** of sanctioned pumps under this component. Haryana is leading implementation in Component B with 47 per cent of sanctioned pumps installed. Following Haryana are Rajasthan and Uttar Pradesh, at 30 per cent and 47 per cent installations respectively. Punjab has shown subpar performance, with only 12.5 per cent of the sanctioned pumps installed. It is also to be noted that while Uttar Pradesh is performing well in terms of its sanctioned target, the targets set for the state are only about 50 per cent of the targets set for Haryana and Rajasthan.

Component C stands at **1.6 per cent** (**IPS**) and **0.3 per cent** (**FLS**), with 2,644 pumps installed out of 161,204 sanctioned pumps under individual pump solarization, and 9,603 pumps installed out of 33,76,466 sanctioned pumps under feeder level solarization. Component C has seen limited participation, with only five states having started implementation in total with more active implementation under feeder-level solarization (FLS). It is also to be noted that Component C implementation was only properly started once the pilot phase ended in 2021. Currently, states are floating tenders and starting implementation on the same.

Graph 1: Percentage of installation against sanctioned targets under Components A, B and C as of April 2024



Source: MNRE KUSUM portal as accessed on June 20, 2024 https://pmkusum.mnre.gov.in/landing.html

In total, only 8.7 per cent of the total sanctioned pumps have been installed so far. This may be attributed to slow implementation of each component, with Component B having seen consistent implementation since the launch of the scheme, and Components A and C not having seen proper implementation so far.

This is despite the Central Financial Assistance (CFA) as well as state subsidy offered to farmers towards purchasing solar water-pumps. While no subsidy is offered under Component A, the Ministry of New and Renewable Energy (MNRE) offers 30 per cent subsidy under Component B along with at least 30 per cent subsidy offered by the state governments under the same component. This makes the farmer share at most 40 per cent of the total costs in case of an off-grid solar water pumpset. Some states also offer extra subsidies for reserved category candidates under Component B. Under Component C, 30 per cent of the benchmark cost of a solar power plant is also subsidized by the Central government.

Overall, Component B of the scheme has been active, especially in northwestern states. Components A and C while not active, have shown good results in the areas where they are present (see *Table 2*).

Component B implementation has taken place relatively successfully due to the involvement of farmers as the sole direct stakeholders, as compared to Components

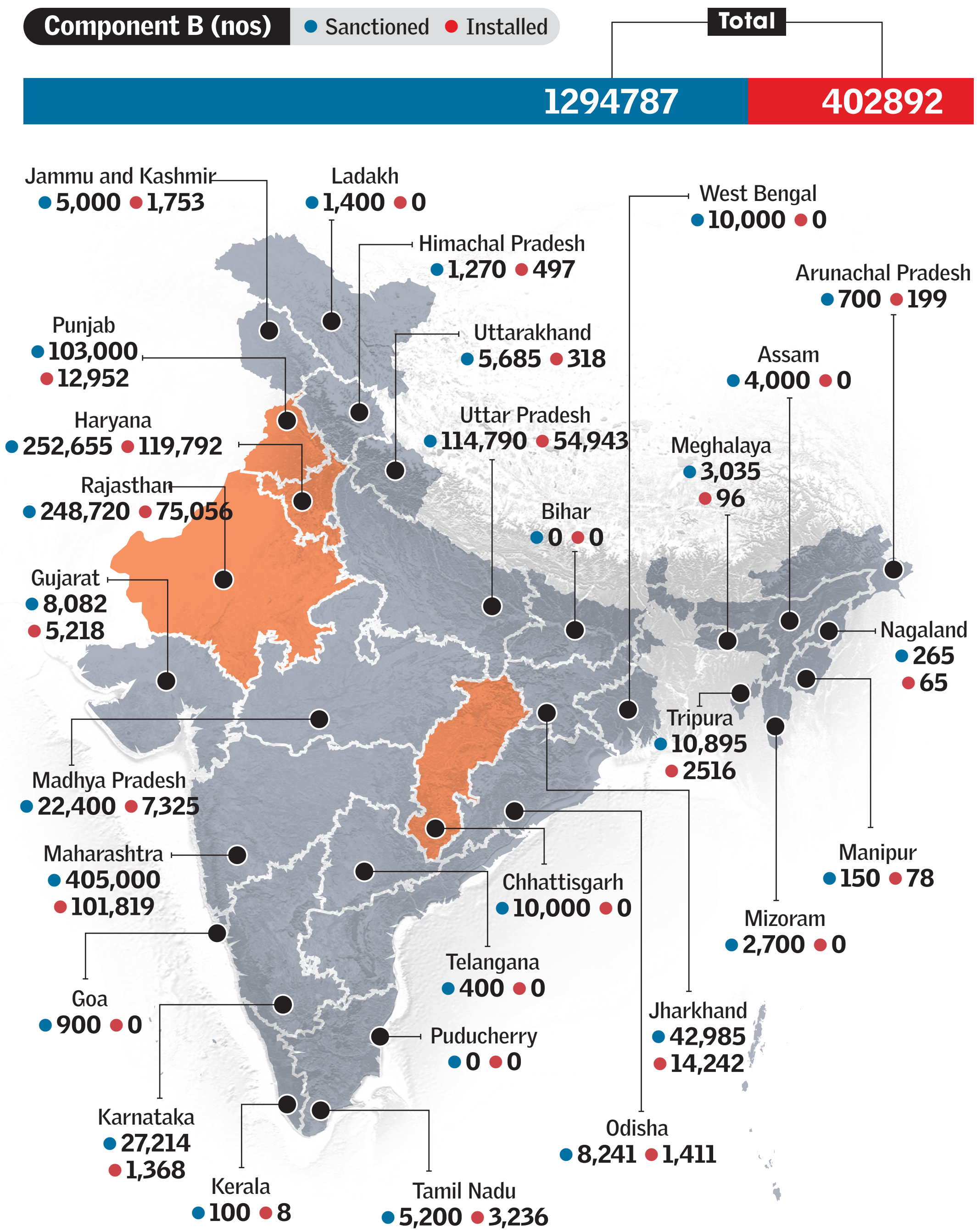
A and C where multiple stakeholders are involved, making the implementation process complicated. It is for this reason that the Centre for Science and Environment decided to understand through an on-ground survey the reason behind the success of Component B in some states and low success rates in other states.

Table 2: Status of implementation under the PM-KUSUM Scheme as of June 2024

S. no.	State	Component A (MW)		Component B (number)		Component C (number)			
		Sanctioned	Installed	Sanctioned	Installed	Sanctioned (IPS)	Installed (IPS)	Sanctioned (FLS)	Installed
1	Arunachal Pradesh	2	0	700	199	0	0	0	0
2	Assam	10	0	4,000	0	1,000	0	0	0
3	Chhattisgarh	30	4	10,000	0	0	0	157,500	0
4	Bihar	0	0	0	0	0	0	160,000	0
5	Goa	150	0	900	0	0	0	11,000	0
6	Gujarat	500	0	8,082	5,218	0	0	11,000	700
7	Haryana	85	2.25	252,655	119,792	0	0	625,500	0
8	Himachal Pradesh	100	22.9	1270	497	0	0	0	0
9	Jammu and Kashmir	20	0	5,000	1,753	4,000	0	0	0
10	Jharkhand	20	0	42,985	14,242	1,000	0	0	0
11	Karnataka	0	0	27,214	1,368	0	0	587,000	0
12	Kerala	40	0	100	8	55,100	835	25,387	4421
13	Ladakh	0	0	1,400	0	0	0	0	0
14	Madhya Pradesh	600	16.13	22,400	7325	0	0	295,000	0
15	Maharashtra	700	2	405,000	101,819	0	0	775,000	3,650
16	Manipur	0	0	150	78	0	0	0	0
17	Meghalaya	0	0	3,035	96	0	0	0	0
18	Mizoram	0	0	2,700	0	0	0	0	0
19	Nagaland	5	0	265	65	0	0	0	0
20	Odisha	500	0	8,241	1,411	65,000	0	10,000	0
21	Puducherry	0	0	0	0	0	0	0	0
22	Punjab	220	0	103,000	12,952	186	0	75,000	0
23	Rajasthan	1,200	162	248,720	75,056	6,418	1,739	200,000	832
24	Tamil Nadu	424	0	5200	3236	0	0	0	0
25	Telangana	0	0	400	0	0	0	20,000	0
26	Tripura	5	0	10,895	2,516	2,600	50	0	0
27	Uttar Pradesh	155	0	114,790	54,943	2,000	0	370,000	0
28	Uttarakhand	0	0	5,685	318	200	0	0	0
29	West Bengal	0	0	10,000	0	23,700	20	0	0
	Total	4766	209.28	1,294,787	402,892	161,204	2,644	3,376,466	9,603

Source: MNRE PM KUSUM portal accessed on June 20, 2024 https://pmkusum.mnre.gov.in/landing.html

Status of implementation under the PM-KUSUM scheme (Component B)



Source: MNRE PM-KUSUM portal accessed on June 20, 2024

Objectives

2024 marks the completion of five years of PM-KUSUM. There is a large disparity in states with regard to the number of pumps sanctioned vis-a-vis installed. With state governments disseminating proper information and intricately and strategically placed solar motor vendors, it is difficult to identify reasons for the large gap between policy and implementation.

Through this report, CSE aims to understand how state-level interventions have helped in attracting farmers towards adoption of solar water pumps under the PM-KUSUM scheme, and the factors that have prevented some states from achieving the same.

Identification of best practices and challenges at the ground level will help pave a way forward for implementation of this scheme. With the scheme benefiting farmers of all categories while contributing towards India's Nationally Determined Contributions (NDCs),[11] the scheme holds immense potential in terms of changing the way farmers practise irrigation in the country. Additionally, challenges, with the most prominent being that of groundwater depletion, need to be addressed in order to ensure that farming in India is truly sustainable.

Methodology

Data for this report was collected through primary research in the form of surveys. These surveys included interviews of stakeholders at the administrative as well as ground level.

Stakeholders from Haryana, Rajasthan, Chhattisgarh and Punjab were interviewed for an understanding of the change in irrigation practices that they experience through a shift to solar energy from diesel-powered or electric solar pumps. Interviews with state nodal agencies and developers have helped gain understanding of the process behind implementation and challenges faced at the state level when it comes to Component B of the scheme.

Rationale behind selection of states

Haryana is currently the top-performing state, with 47 per cent of its sanctioned target achieved. While farmers in Haryana are receiving 75 per cent subsidy as against the minimum subsidy requirement of 60 per cent on PM-KUSUM pumps, it is also to be noted that agricultural supply in the state is highly subsidized. Having had a relatively good success rate when it comes to installation, Haryana's example could help identify best practices under implementation under PM-KUSUM.

Rajasthan has consistently been performing well in implementation of Components A, B and C. The state is offering a 60 per cent subsidy under Component B. Rajasthan also has low water levels, but has seen high dissemination of water pumps under Component B. Further, Rajasthan has been one of the pioneers in implementation of Component C, with India's first Component-C plant having been commissioned in Alwar. Insights from Rajasthan would help understand challenges and best practices under Component B as well as Components A and C.

Chhattisgarh, while inactive with regard to implementation of the scheme, has actively worked towards inculcating solar energy in the state's farmers' irrigation practices through the Saur Sujala Yojana (SSY) since 2016. Survey and analysis of the implementation of the SSY scheme may help one identify its salient features which have helped in adoption of solar water-pumps by farmers.

Punjab, despite being an agrarian state, has seen slow offtake of the PM-KUSUM scheme, including Component B. The state has only been able to achieve about 12 per cent installations under the component and has seen no implementation under Components A and C so far. According to data, the dissemination of water pumps in Punjab is also extremely concentrated. Surveys in the state were conducted to understand what was ailing in the state policy leading to poor implementation.

The survey was conducted keeping stakeholders under the Components under consideration. This was done through interviews of the following:

1. Farmers: Farmer interviews were conducted to understand farmers' motivation behind availment or non-availment of the PM-KUSUM scheme and to understand the overall impact of the scheme on its beneficiaries. These interviews would also help calculate savings and emissions reductions that have taken place through the scheme.

2. State Implementing Officers under Components A, B and C respectively: Interactions with state implementing agencies were conducted to gain understanding on the targets set for each state and each district within the state, and to assess patterns of implementation over the years. These interviews also helped understand the process behind processing of applications, and challenges faced at the administrative level.

3. DISCOMs: State DISCOMs are responsible for the implementation of Components A and C. They are able to give insights on the slow offtake of these

Components and the process behind applications and installations. These interviews would also help understand the way-forward as states become more actively involved in Component C implementation.

4. Developers (empanelled agencies): Service providers of solar water-pumps would help gain insight on challenges faced at the ground level in terms of technical difficulties faced by farmers. Additionally, developers would be the ones to share key information about water levels, concentration of pumps on the basis of geographical area, and farmer attitudes owing to their being in constant touch with farmers.

Case studies

Rajasthan

Rajasthan is the most successful state in terms of performance under all three components, and has installed 30 per cent of its sanctioned target under Component B. The implementation system in Rajasthan is decentralized in that Component A is managed by the State Nodal Agency—Rajasthan Renewable Energy Corporation Limited (RRECL)—Component B is managed by the Horticulture Department, and Component C is managed by the state DISCOMs. In order to gain insights on the implementation of the PM-KUSUM scheme, all stakeholders were interviewed on the ground including State Nodal Agency Officers, Solar System Developers, Horticulture Department, State DISCOM, as well as farmers.

A total of 17 farmers were interviewed in selected villages in Jaipur, Dausa and Alwar districts of Rajasthan. The farmers were chosen from among those who have availed solar pumps under the PM-KUSUM scheme and ones who had not. The questionnaires for the farmers included questions that would help gain insight on the application process for the scheme, their irrigation habits before and after the addition of solar pumps, and to understand factors preventing farmers from availing themselves of the scheme.

Out of the 17 interviewed farmers, eight availed of benefits under the PM-KUSUM scheme while the remaining farmers had not availed of the scheme. These farmers had an average landholding of 4.7 acre. The eight farmers cumulatively owned nine electric water-pumps and one diesel water pump. The capacity of electric water-pumps was 5–10 hp. This means that all eight farmers using solar water-pumps have a backup in the form of electric or diesel water-pumps, with the exception of one farmer who is exclusively using solar water-pumps. Most farmers have solar water-pumps of 7.5 hp except for one farmer who has two 5 hp solar water-pumps.

Under each PM-KUSUM phase, targets are set for districts across Rajasthan on the basis of demand and the water table. The targets for Rajasthan as a whole were as follows: 2019–20: 23,814 pumps; 2020–21: 36,000 pumps; and 2023–24: 189,000 pumps. These targets are then divided among the districts in Rajasthan. The initial target for the district of Jaipur was only 3,000 as opposed to the 50,000 target currently. The number of applications in the first cycle in the year 2020 far exceeded the 3,000 target, resulting in a backlog in terms of installation of systems. For this reason, applicants have had to wait a year to a year and a half to get their systems installed.

Table 3: District-wise target and corresponding number of installed water pumps

District	Total number of pumps installed	3 hp	5 hp	7.5 hp	10 hp
Jaipur	7,927	65	1,593	6,226	43
Dausa	508	20	266	222	0
Alwar	862	7	42	771	0

Source: PM-KUSUM portal, Rajasthan https://rjliveui.hkapl.in/RJ/landing.html

Governance

Rajasthan has adopted a decentralized model to look into the implementation of various components of the Kusum Scheme. The Rajasthan Renewable Energy Corporation Limited (RRECL) is handling Component A, the Horticulture Department handling Component B, and state DISCOMs handling Component C.

One of the reasons for successful implementation of component B in Rajasthan is the involvement of their Horticulture Department. The Horticulture Department, which is handling Component B, has a strong network of block and field staff spreading awareness and disseminating knowledge on the agricultural subsidies offered by the state. The subsidy provided for availing the PM-KUSUM Scheme in Rajasthan is 60 per cent (30 per cent CFA and 30 per cent state subsidy). Additionally, SC/ST applicants get a subsidy of Rs 45,000 over and above the amount to be paid as upfront cost by the farmers.

On interviewing farmers on installation of solar water pumps under Component B, it was noted that most farmers are aware of the scheme and even the details of the subsidy, owing to the information dissemination that has taken place through television or newspaper advertisements. The horticulture department staff also regularly hosts workshops in different blocks or in the agriculture researchinstitute Shri Karan Narendra Agriculture University in Jobner. These workshops are conducted during both rabi and kharif seasons for farmers in groups of 20–50. According to field staff, these meetings are regularly conducted in all villages through block officers. The farmers regularly get to interact with the staff and hence get access to information about various schemes. They also get the opportunity to address queries with regards to incentives and guidelines. There is also a wide network of solar water pump developers on field assisting farmers with their technical issues.

There are 44 service providers providing PM-KUSUM water pumps to the farmers. These service providers are also responsible for providing technical assistance to farmers should they require it. The farmers get the option to choose their preferred service provider, which they usually choose on the basis of peer reviews and feedback. They make this decision primarily based on the promptness with which they receive technical assistance from the vendors. Farmers also have the option of seeking assistance with regards to maintenance of the system, as five years of free of cost operations and maintenance by the developers are guaranteed under the PM-KUSUM scheme.

So far, implementation of Component B has taken place in about three cycles—2019–20, 2021–22 and 2023–24. While the first cycle had a smaller target of about 23,000 to be achieved, the number of empanelled agencies was high, reaching about 40, owing to the prices released by the Ministry of New and Renewable Energy (MNRE) matching with vendor quotations. In the second cycle of the scheme, the number of empanelled agencies providing solar systems was very low, dropping from about 40 to 19, as the prices of solar systems increased. This resulted in higher prices and slower implementation as a larger number of applications had to be catered to by a lower number of empanelled agencies.

Currently, farmers receive free agricultural electricity. However, the farmers are aware that this change was a result of last year's elections and that in the future they will be charged for their agricultural loads as well, and have kept that in mind while making the decision to opt for solar panels. This was the second most popular reason why farmers in Rajasthan opted for PM-KUSUM systems.

The most popular reason for farmers opting for this scheme was the motor working during the day. While household loads are now more stable and reliable, agricultural loads still encounter substantial interruptions and outages—agricultural electricity is supplied according to timetables in six hours shifts to farmers. However, this agricultural supply is mostly available at night between 10 p.m. and 4 a.m., making irrigating their fields inconvenient for farmers. Additionally, according to farmers, this electricity is not without interruptions and farmers only get access to proper electricity for four out of six hours. Farmers have expressed inclination towards irrigating their fields during the day so they can follow their routine and sleep at night. Farmers also expressed the inconvenience they face with regard to the presence of pests in the fields at night, making them more hesitant to irrigate their fields during nighttime.

Incentives

Motivating factors for farmers to opt for PM-KUSUM

Farmers in Rajasthan are getting 60 per cent subsidy (30 per cent CFA plus 30 per cent state subsidy) on their PM-KUSUM solar water-pumpsets. SC/ST candidates receive an additional Rs 45,000 subsidy on the upfront costs of the same. The state also offers subsidy on micro-irrigation technologies such as drip irrigation, mini sprinklers, farm ponds, mulching, etc., making it easier for farmers to move towards sustainable agricultural practices.

Water levels in Rajasthan are low. This means that farmers have to invest in larger pumps to lift the water from the ground and also invest in borewells for the same. The scheme currently only covers the solar system including junction box, panels, panel structure and motor, and does not cover borewells. Farmers in Rajasthan have to get deep borewells dug, the average cost for which comes up to Rs 95,000 per farmer.

About 60 per cent of Rajasthan's population is dependent on agriculture, but the state suffers from low water levels. Out of the districts surveyed (Jaipur, Alwar and Dausa), no district had water above the level of 100 feet, and the water levels went down to even 700 feet in the district of Dausa. Due to lower water levels, Alwar, in addition to Dausa, could not see proper implementation of Component B of the PM-KUSUM Scheme. Under the National Horticulture Mission, the Rajasthan Government, through the Horticulture Department, offers subsidies on drip irrigation, mini sprinklers, farm ponds, etc., which were found to be present in almost all the farmers' lands. Farmers in Rajasthan have availed of these schemes on drip irrigation and farm ponds, spending about an average of Rs 1,00,000 or more on each. Despite investment in borewells and new irrigation technologies being expensive, farmers are active in availing of these subsidies due to the returns they offer as well as their awareness of depleting water levels.

This practice has helped farmers use water more efficiently and hence, avoid contributing to the depleting groundwater levels. Farmers from different categories (SC/ST, OBC and general) are all adequately informed about subsidies and the benefits farmers are entitled to. Through convergence of schemes, farmers have been able to cultivate their land despite low water levels and extreme heat. Nemichand, a Scheduled Caste small farmer from district Dudu, has cultivated his produce through drip irrigation, PM-KUSUM solar pumps, polyhouses, mulching, and farm ponds. He was able to gather information on all schemes and subsidies through meetings held in the agriculture research institute Shri Karan Narendra Agriculture University, with a constituent teaching and research campus, Rajasthan Agricultural Research Institute, in Jobner district, near Dudu.

In addition to farmers having access to subsidies, most areas in Rajasthan already have an electricity connection and hence most farmers have electric water pumps installed on their lands. This indicates that savings with regard to upfront costs were not the main motivating factor for farmers to invest in solar water-pumps. The main motivating factor for farmers opting for solar water-pumps was that they could operate these pumps during the day instead of at night, and have access to a more reliable source of irrigation. Agricultural electricity provided to farmers otherwise would only be available for six hours in a day, divided into weekly phases on the basis of a timetable. Additionally, out of the six hours of supply, farmers would only receive about four hours of agricultural electricity, with voltage fluctuations.

Economics

Farmers in Rajasthan get 60 per cent subsidy on the upfront costs of a solar water system, which includes a solar water-pump, solar panels, junction box, a lightning arrestor, along with five years of guaranteed technical assistance and insurance against theft or damage.

Farmers in Rajasthan are mostly opting for 7.5–10 hp pumps, the current listed cost for which is Rs 4,53,322 and Rs 5,81,239 respectively. Farmers who had opted for the scheme in the initial cycles had to pay the upfront costs of Rs 1,34,000 after deducting subsidy amount for a 7.5 hp water pump, and farmers who are now getting access to pumps from the second cycle have had to pay Rs 2,14,638 for a 7.5 hp water pump. This is in spite of the fact that farmer share is only 40 per cent of the cost of the solar water-pump. This discrepancy in the upfront cost is due to the price of solar water-pumps increasing in the second implementation cycle. Each year, developers are chosen to disseminate water pumps through a tendering process. The prices of these developers have to match the ones released by MNRE. In case of a mismatch under any category, some categories may not get approved for dissemination. For example, in the second cycle, only DC pumps were available to be disseminated, which are more expensive than AC pumps. This also contributed to the farmer share increasing.

As farmers use electric pumps more frequently, the chances of the motor malfunctioning would also increase. 100 percent of the farmers expressed that they would need to get their water pumps repaired at least once a year. The average amount spent by each farmer on maintenance of their electric water pumps was about Rs 11,000. Since solar water-pumps don’t require maintenance and rarely malfunction, farmers have experienced savings in this regard. The farmers who had availed of the scheme had received their water pumps between 2019 and 2024, and 100 per cent of the farmers reported not having spent any amount on maintenance of their solar water pumps. Whenever farmers experience technical difficulties with regard to their solar water pumps, they may reach out to their respective developers for technical assistance—according to PM-KUSUM guidelines, five years of technical assistance and panel insurance is guaranteed to farmers availing themselves of the scheme. There is, however, also the challenge of the panels getting stolen. The insurance covers theft and damage for five years, but in case of the panels being stolen, it takes about six months for farmers to get new panels after going through the entire process of getting in touch with the empanelled agency, filing an FIR, etc. This inconveniences farmers who are now fully dependent on their solar motors to fulfill their irrigation needs.

Additionally, although agricultural electricity is currently free in the state, the farmers were paying separate bills for agricultural loads till 2023. On an average, these farmers paid Rs 1,200 per month on their agricultural load, which in the case of availment of the scheme translates to an average annual savings of Rs 14,400 per annum for farmers. The farmers are also aware that this change only occurred during election time and are expecting for agricultural load to be charged again. 100 per cent of the farmers expressed that solar increases savings in this regard as well.

In total, farmers are able to save an average amount of Rs 25,400 per farmer per year through a shift from electric water pumps to solar water pumps.

Reasons for non-availment

The main reasons for non-availment of the scheme in Jaipur were high upfront costs and free agricultural electricity. Out of the nine farmers who had not availed of the scheme, only two farmers conveyed that they wouldn't be interested in applying for the scheme due to low water availability and lack of desire to get a solar water pump respectively. Five farmers conveyed that they would be inclined to apply if they had the option of paying in installments and if the subsidy amount were to increase. While the amount is subsidized and even more so for SC/ST candidates, the amount to be paid is still too high for small and marginal farmers to pay in one installment.

The remaining two farmers were from district Dausa. Due to low water levels, the district of Dausa saw relatively lower knowledge with regard to the PM-KUSUM scheme. While the farmers were aware of its existence, there was a lack of knowledge and misconceptions surrounding the scheme. While one farmer did not have any information, another farmer was under the misconception that the scheme was only applicable for SC/ST candidates. The Horticulture Department in the district also conveyed that Dausa has a smaller target and hence knowledge dissemination has also only taken place in areas with feasibility to introduce new irrigation technology.

Status of Components A and C

Overall, the scheme has been a success in Rajasthan mainly due to proper information dissemination and decentralization in terms of implementation. When it comes to Components A and C, Rajasthan has been the first state to have a plant installed and commissioned. While Component A was not a success due to difficulties regarding bank loans, Component C is proving to be successful so far. Implementation for the same only began in 2022 and two plants are running already with at least three more in the pipeline. Through Component C, agricultural feeders have been solarized, easing the farmers' irrigation schedules by giving them the option of irrigating their land during the day as opposed to when they powered agriculture through agricultural load, which would provide electricity according to a timetable and mostly supply electricity at night.

Haryana

The total subsidy for agricultural electricity for Haryana in 2023 was about Rs 5,000 crore. Haryana has subsidized agricultural electricity highly for decades. This subsidization had been causing the DISCOMs in Haryana to lose money as the tariffs went as low as 10 paise per unit and due to the presence of a large number of unmetered connections making it difficult to gauge the exact subsidy being provided to farmers. It was only with the introduction of the Ujwal DISCOM Assurance Yojana (UDAY) scheme launched in 2015 that the DISCOMs were able to recover those losses and gain profits of 1 per cent in 2019. However, the revenue generation of DISCOMs from agricultural consumers remains at about 2 per cent, when agricultural consumers amount to about 22 per cent of all consumers in the state.

Solar pumps are a good avenue towards reducing the subsidy burden on the state and DISCOMs and are also helpful in making agriculture sustainable. Solar pumps were first introduced in Haryana in the early 2010s for demonstration. However, these pumps were scattered around the state and were small in number—there were only 3,500 water pumps in Haryana before the introduction of the PM-KUSUM scheme. The number has now crossed 100,000.

Out of the 100,000 pumps disseminated across 22 districts, ~28,000 and ~24,000 water pumps are installed in Hissar and Sirsa districts, while the lowest number of water pumps are installed in Panchkula and Kurukshetra, which have only about 100 water pumps installed. This could be attributed to districts like Panchkula and Kurukshetra being primarily paddy-cultivating districts.[11] Being primarily paddy-cultivating districts, the farmers had applied for and received electric pumps earlier. With highly subsidized agricultural supply in the state, these farmers may not see much utility in availing themselves of solar water-pump schemes. Agricultural supply along with canal supply was conveyed to be enough for farmers to fulfill their paddy cultivation needs.

In Haryana, a total of 20 farmers were interviewed in Jhajjar and Sonipat districts, located around the National Capital Region in Haryana where about 6,000 and 4,000 solar water-pumps have been installed respectively. Farmers who had availed of the scheme as well as farmers who had not availed of the scheme were chosen for interviews.

Out of the 20 farmers interviewed, 11 had availed of the PM-KUSUM scheme. These farmers have an average landholding of 4.7 acres. These farmers cumulatively have 20 diesel water-pumps, with an average use of about 8.5 litre/day of diesel whenever used. This consumption of diesel for irrigation would take place in addition to irrigation through canals. Farmers reported using solar water pumps for about four months during paddy season and about five times over the course of wheat season. In total, water pumps would be used for about 150 days in a year.

Governance

The implementation of the PM-KUSUM scheme in Haryana is handled by the State Nodal Agency (SNA), Haryana Renewable Energy Development Agency (HAREDA) and the state's DISCOMs (UHBVN and DHBVN). Components A and C are the responsibility of the DISCOM while Component B is handled by HAREDA. Under Component B, SNA is responsible for information dissemination, coordination with tendering agencies, coordination with vendors, communication with the Central ministry, the Ministry of New and Renewable Energy (MNRE), etc. While Components A and C tasks are handled by the DISCOMs, all Component B applications are verified and approved by SNA. In the initial stages of the scheme, all Component B applications were to be submitted directly to HAREDA. However, in the last few cycles, Customer Service Centres (CSCs) have played an important role in helping farmers apply. Each village has at least one CSC through which they can apply for any of the Government schemes. Ten out of 11 farmers who had availed of the scheme had applied for it through CSC. One applicant from 2019 was the only one who had applied directly through HAREDA.

The PM-KUSUM scheme is implemented in phases. Since its launch, Component B applications have been accepted in four rounds.

According to MNRE, the phase-wise targets for states are set on the basis of the demand of water pumps received in the preceding year. It is evident from the phase-wise targets that the PM-KUSUM scheme has seen popularity in Haryana as the targets have only increased each year with the exception of the last year (see *Table 4*).

Table 4: Phase-wise targets for implementation of Component B in Haryana

Year/phase	Target
2019–20	15,000
2021–22	22,000
2022–23	50,000
2023–24	42,850

Source: HAREDA PM KUSUM Portal https://pmkusum.hareda.gov.in/HR/landing.html

These targets are also set according to geographical areas and water tables. In the areas of Sonipat and Jhajjar, last year's target was set at only 3,000 farmers, making it difficult for all interested applicants to get access to the scheme as the portal would close after the target number of applicants was reached. In the initial year, applications would be accepted in bulk, resulting in a delay in installation owing to the large number of applications. Due to this, one farmer out of 11, who had applied in the first round, received their solar water pumpset a year after application. Applications are now accepted according to targets set for each district, making the gap between application and installation only about two to three months.

Haryana, with regard to information dissemination, has a strong network of solar water pump developers on the ground. The developers, along with the SNA, would release advertisements in newspapers and on TV to make farmers aware of the scheme. While for many farmers this was the source of information, the main source of information was word of mouth.

One of the main challenges faced by farmers was the lack of availability of water pumps of all sizes. The Ministry of New and Renewable Energy releases tenders for different categories of water pumps, and pump capacities are decided on the basis of the MNRE benchmark costs and vendor quotations matching. Currently, Haryana is offering only 3 hp surface pumps with pumps under the remaining categories (7.5 hp and 10 hp) being submersible pumps. The water levels in Haryana in some areas are shallow and don't need submersible pumps. However, the size of the land is too large to be irrigated through a 3 hp pump. For this reason, farmers require surface pumps of 5 hp or 7.5 hp, which are currently not available. This leads to the farmers having to invest an extra ~Rs 60,000 in order to get a borewell dug for a 5 hp or 7.5 hp submersible pump. Since the water is being extracted from a level that is too deep, the soil also gets lifted with the water affecting the quality of water.

SURFACE AND SUBMERSIBLE PUMPS

Farmers get the option to choose between pump capacities as well as surface and submersible pumps. This decision is based on the water levels and land size of the farmers. Submersible pumps are to be placed under water at all times while surface pumps remain above the surface. It is best to use surface water pumps when the water table is less than 10 metre. Submersible pumps work best in borewells and are used when water levels are deeper than 10–15 metre. Submersible pumps are known to be more efficient and cost slightly more than surface-water pumps.

Incentives

Lower upfront costs and higher savings

Farmers in Haryana grow mainly paddy and wheat, of which paddy has large irrigation requirements. Irrigation, especially in Sonipat, was done through diesel water-pumps due to the lack of electric connections on the farmers' lands—11 farmers who availed of the scheme had been using 20 diesel pumps for irrigation cumulatively.

The farmers who did have electric connections on their land complained of getting extremely delayed technical assistance and high costs of repair in the case of damage, One farmer out of the nine farmers who had not availed of the scheme was unable to use his electric water-pump due to a storm having damaged his cables and his not having enough funds to be able to get it repaired. For farmers who previously owned electric pumps, the shift to solar meant having the freedom to irrigate their fields during the day instead of relying on the time table released by the state nodal agencies on a weekly basis. This time table would mostly allot nighttime slots to farmers, making it inconvenient for them to irrigate their land.

Compared to Rajasthan, sustainability with regard to agricultural practices for farmers in Haryana is not as big a motivation. The reasons for this include availability of weekly supply of canal water according to time table, a safe water table, and larger subsidy on solar water-pumps. Investment in micro-irrigation technologies such as drip irrigation, mini sprinkler, etc. would entail higher costs for farmers. As farmers are not facing a water issue they don't currently find micro-irrigation technologies necessary. Upon being asked about water conservation, farmers in Haryana said that it limits their options when it comes to the kind of crops they can cultivate.

Haryana offers a 75 per cent subsidy on solar water-pumps under the PM-KUSUM Scheme. While 30 per cent of the subsidy is through the Central government, the state government—which gets its subsidy funding for the scheme from NABARD—bears the remaining 45 per cent. This makes the upfront costs of the PM-KUSUM water-pumps relatively lower for farmers in Haryana. Along with financial subsidy, the scheme guarantees five years of free-of-cost maintenance of farmers' solar water-pumps through solar water-pump developers. Replacement of panels, however, takes longer than is suitable for farmers—whenever there is a hailstorm, the panels risk getting destroyed. One farmer faced this issue and had not been able to get a replacement for the panel in more than a month. The reason for this is the numerous steps involved in getting new panels in the event of damage or theft The farmers have to place a call on a toll-free number of the vendor and wait for their turn to get a call back from the vendors. They found this process impersonal and long. The lack of availability of a replacement for the damaged panel results in the water pump's performance going down, which in turn results in improper irrigation of farmers' land. Proper channels of communication for technical assistance need to be established in this regard.

Economics

The costs of installing a grid-connected electric water-pump in the state of Haryana are incredibly high. Farmers have to pay for the poles to be set up between their land and the nearest substation, in addition to paying for the cables, water pump, accessories, borewell, etc. Due to this, electric pumps become expensive costing about Rs 2,50,000 per water pump. The process of getting an electric pump also takes about four to five years from the date of application to installation. Additionally, even though agricultural electricity in Haryana is highly subsidized, farmers pay about Rs 200–300 per month for agricultural electricity. Solar water-pumps are extremely cost-effective in comparison to electric pumps both in terms of upfront costs and operational costs.

The cost of a diesel pump currently is about Rs 45,000 while the upfront costs of solar pumps are in range of Rs 50,000–1,50,000 (see *Table 5*).

Additionally, in case of submersible pumps, farmers have to spend about Rs 60,000 extra on digging of borewells and other accessories. Haryana has areas with deep as well as shallow water levels. The farmers cultivating land in areas with deep water levels have to opt for submersible water pumps which require digging of borewells, while farmers cultivating land in areas with shallow water levels can opt for surface-water pumps which don't require digging of borewells. The upfront costs of solar water-pumps are higher than those of diesel water pumps. They, however, offer savings.

On an average, farmers in Sonipat spend about Rs 43,500 on diesel per paddy season, and about Rs 4,000 on diesel per wheat season, making their total diesel

Table 5: Capacity-wise upfront costs of solar water pumps

Solar water-pump capacity	Upfront cost (Rs)
3 hp	54,000
5 hp	58,000
7.5 hp	86,000
10 hp	1,40,000

Source: PM KUSUM Portal, HAREDA https://pmkusum.hareda.gov.in/HR/landing.html

expenses per year ~Rs 50,000. Eleven out of 11 farmers who availed of the scheme reported savings to be the primary advantage of shifting to a solar water pump from a diesel water pump. With the solar water pump, farmers don't have to spend any money on operations of the pump and hence, have savings of about Rs 50,000 when it comes to operational expenses.

Diesel water pumps and electric water pumps require maintenance as the motor malfunctions more often in comparison to that of solar pumps For this reason, farmers have to spend an extra Rs 2,500–5,000 on maintenance of these pumps. Solar pumps, on the other hand, don't require maintenance as these motors rarely malfunction.

Farmers who have owned or still operate their electric pumps would pay about Rs 500 per month per farmer for agricultural electricity. It is to be noted that agricultural electricity in Haryana is highly subsidized, with the current tariff being 10 paise per unit. These farmers would hence spend Rs 6,000 per year per farmer.

In total, the average savings of a farmer can be calculated to be about Rs 55,500 per year in the case of farmers who only own diesel pumps, about Rs 62,000 for farmers who own both diesel pumps and electric pumps, and Rs 9,000 for farmers who only own electric pumps.

Reasons for non-availment

Three out of nine farmers who had not availed of the scheme had not been able to do so because of the lack of availability of non-saline water for irrigation of their land. The farmers would get canal supply once or twice a week, leading to them being able to irrigate their land accordingly. If they needed to lift water for irrigation, they found diesel pumps to be reliable and adequate for that. The farmers expressed that the investment towards solar water-pumps would be too much keeping in mind the frequency with which they would use it. The farmers, however, were aware of the benefits offered and would be eager to avail of the scheme should they get access to non-saline water.

Another reason expressed by farmers for non-availment of the scheme was the lack of reliability. The farmers showed concern over the pump not working during monsoon or foggy winters. In this case, farmers found diesel pumps to be most reliable. While diesel proves to be expensive, it was realized through these surveys that when it comes to reliability in terms of power, farmers are more trusting of diesel water-pumps.

Haryana has water levels of 15–150+ feet. This results in the farmers of Haryana needing both surface and submersible water pumps in the state. Currently, only 3 hp-capacity water pumps are available in the surface option and hence farmers with larger landholdings are hesitant to avail of the scheme due to the unavailability of larger surface water-pumps. One out of the nine farmers who had not availed of the scheme expressed the need for a 5-hp surface water-pump and conveyed that they would apply for the scheme tomorrow if they had this pump capacity option. Conversely, farmers with smaller landholdings were not interested in availing of the scheme because it seemed too expensive for a small land area—three out of nine farmers who had not availed of the scheme expressed that if they had more land, they would invest in a solar water pump.

Farmers also expressed concerns over high upfront costs of solar water pumps. As in Rajasthan, farmers in Haryana would also be more likely to opt for solar water-pumps should they get the option to pay in installments.

The State Nodal Agency personnel also expressed that the PM-KUSUM scheme would mostly be successful in the form of a shift from diesel water-pumps to solar water-pumps. Farmers who already have electric water-pumps will be less incentivized to avail of the scheme. This is evident from primarily paddy-cultivating districts not having participated in the PM-KUSUM scheme actively.

Status of Components A and C

Implementation of Component A is done through Haryana's DISCOMs, Dakshin Haryana Bijli Vitran Nigam (DHBVN) and Uttar Haryana Bijli Vitran Nigam (UHBVN). While DHBVN has been successful in implementation, UHBVN has faced challenges, leading to delay in implementation. DHBVN has awarded Letters of Award (LoAs) for all 45 MW that had been allotted to them while UHBVN has been able to award LoAs only for 4.96 MW out of the allotted 40 MW. The barren land available under DHBVN jurisdiction is located on the border of Rajasthan as opposed to the UHBVN border located close to Delhi, making the land in Dakshin Haryana cheaper than the land in Uttar Haryana. Due to this, implementation of Component A has seen more success in the former. The tariff set for Component A plants is Rs 3.11/unit making it too low for farmers starting power plants in areas with expensive land. Additionally, the cost of setting up a solar power plant under Component A is about Rs 4 crore/MW, leading to the developers breaking even only after about 10 years of having set up the plant.

Farmers in southern parts of Uttar Haryana are paddy farmers and are able to earn a good livelihood from selling their produce. These farmers find cultivating paddy to be more profitable than starting a solar power plant.

Component C has not seen successful implementation in the state yet primarily because of the tariff having been set at Rs 2.33/unit for solar power plants to be set up under Component C (feeder level solarization or FLS). With the benchmark costs having been set at Rs 4 Crore/MW, this would make the payback period about 10 years. Despite the 30 per cent subsidy, the costs of setting up a solar power plant are expensive compared to the returns. Farmers with land located around the National Capital have expensive land and would rather invest in businesses such as starting a warehouse, which appear to be more lucrative and have a shorter break-even period. Component C (Individual Pump Solarization or IPS) was first piloted in Karnal and Yamunanagar. However, this model was unsuccessful as setting up a solar-powered water-pump under Component C (IPS) would entail the farmers having to remove their electric water-pumps and replacing them with solar water-pumps, which they were unwilling to do. Additionally, net metering, which was incorporated to incentivize farmers to use water pumps judicially, has proven to be unsuccessful as the panels generate less electricity than they consume and hence farmers do not get to earn from these systems. When these systems do not generate surplus electricity, nothing is left to be sold to the DISCOM and hence farmers are unable to get additional income. These systems are also more expensive and despite a 60 per cent subsidy, farmers have to pay around Rs 2,00,000 for a 10-kW water pump. These high upfront costs and the availability of electric water-pumps on the farmer lands already lead to the farmers not feeling motivated to shift to grid-connected solar water-pumps.

According to DISCOM officials, Haryana has received land parcels from National Highway Logistics Management Ltd. along the Ambala–Kotputli Highway. Through these parcels, 18-MW capacity will be tendered in CAPEX mode in June 2024 in Haryana.

Punjab

Punjab is one of the more underperforming states in the country, with only 12.5 per cent of its targets achieved. Punjab is actively engaged in agriculture and primarily cultivates paddy and wheat despite having low water levels. These low water levels need bigger water pumps in order to lift water from large depths, and to cover the large landholdings of most farmers.

Out of 23 districts, solar water-pump dissemination in Punjab is concentrated in three districts, Bathinda, Fazilka and Sri Muktsar Sahib. Owing to this, surveys were conducted in Fazilka and Bathinda to understand the factors affecting large-scale dissemination of water pumps in these districts.

A total of 16 farmers were interviewed across Bathinda and Fazilka districts of Punjab. Farmers who had availed of the scheme as well as farmers who had not availed of the PM-KUSUM scheme were chosen for interviews.

Out of the 16 interviewed farmers, 11 had availed of benefits under the PM-KUSUM scheme while the remaining farmers had not availed of the scheme. These farmers had an average landholding of about 7.5 acre. These 11 farmers cumulatively owned three electric water-pumps and seven diesel water pumps. The capacity of electric water pumps was 5–10 hp. This indicates that all 11 farmers using solar water-pumps had a backup in the form of electric or diesel water-pumps, with the exception of one farmer who is exclusively using a solar water-pump. Most farmers have solar water-pumps of 7.5 hp and 5 hp except for two farmers who have 3-hp solar water-pumps.

Governance

The Government began implementation of the PM-KUSUM scheme in 2019. The target set for Punjab with regard to dissemination of water pumps under Component B is 103,000. Only about 12 per cent of this target has been achieved because of proper implementation in three out of 23 districts.

The key difference between Punjab and the remaining surveyed states is the lack of decentralization at the implementation level—all Components under the PM-KUSUM scheme are handled by the State Nodal Agency, Punjab Energy Development Agency (PEDA). The dissemination of water pumps under Component B is concentrated in three districts in the state. According to Punjab's PM-KUSUM portal, about 12,800 water pumps have been installed in the state in total. Out of these pumps, 4,694 have been installed in Bathinda, 4,334 have been installed in Fazilka, and 2,829 have been installed in Sri Muktsar Sahib. The remaining ~1,500 pumps are spread across the remaining districts of Punjab.
The SNA and developers have cited several reasons for concentration of pumps in these areas, including:

- The surveyed blocks come under the Safe Zone list released by PEDA for PM-KUSUM implementation, which only includes 22 blocks out of a total of 152 blocks.

- While Fazilka and Bathinda don't have water table depth as shallow as other areas in Punjab, the water quality below 10–15 feet is low. Because of this, farmers had not applied for any extra source of irrigation apart from the canal supply. Now that the supply is getting erratic, farmers are moving to other irrigation technologies, the most cost effective of which is solar water-pumps.

- The farmers in the surveyed districts do not primarily cultivate paddy, and hence did not opt for electric pumps earlier, and depended entirely on canal supply for irrigation. If these farmers wish to shift to electric pumps now, they wouldn't be allowed to apply for the same as the Punjab government is not accepting applications for electric water pumps under the capacity of 10 hp. Hence, farmers hoping to add new irrigation technology in addition to canal supply are now opting for solar pumps, which are the most cost-effective of all options.

- Farmers in the rest of Punjab are large farmers who have been aware of irrigation technology for years and hence had applied and procured electric pumps earlier. Due to this, they don't need to opt for solar water pumps as they get eight hours of free and reliable agricultural electricity for their electric water-pumps.

Punjab, so far, has implemented the PM-KUSUM scheme in two phases—2020–21 and 2022–23—and will now start a new cycle for 2024–25. The targets set for the first two years were about 6,000 and 7,000 respectively, which according to PEDA officers were both achieved. According to the national PM-KUSUM portal, however, the number of sanctioned pumps for the state of Punjab is about 100,000.

The PM-KUSUM scheme also offers five years of maintenance through solar water-pump developers. Farmers in Punjab, however, were less than satisfied with their technical assistance—four out of 11 farmers who had availed of the scheme expressed that technical assistance is not easily available, and that in the case of damage or theft, replacement of panels takes too long. One farmer had been waiting for a replacement for his damaged panels for one month.

Two farmers, who had applied in 2018 and 2021 respectively, expressed that the option to purchase a 7.5 hp pump was not available when they had applied for the scheme. It is to be noted that 2018 was the pilot year, owing to which the number of pump capacities available could have been limited. By 2021, the prices of panels had increased due to an increase in panel efficiency, leading to some pump capacities not being available in certain states due to price mismatch between the vendors' quoted prices and MNRE's benchmark costs. Another two farmers expressed that if the option to pay in installments had been available to them, they would have opted for bigger water pumps. These farmers had the option to opt for a bigger pump but did not have enough funds to do so.

The state DISCOM has not been proactive in addressing these gaps, resulting in slow offtake of the scheme in the state. For Components A and C, the state has not been able to begin implementation due to lack of interest from investors.

For knowledge dissemination, the Punjab government uses newspaper advertisements, and PEDA organizes mass awareness workshops. A large chunk of knowledge dissemination also happens through vendors who have a network of personnel on ground.

Economics

Punjab offers 60 per cent subsidy on solar water-pumps (30 per cent CFA plus 30 per cent state subsidy). The upfront costs of solar water pumps are in the range of Rs 70,000–Rs 2,00,000. The upfront costs are high in Punjab and subsidy is low. Earlier, Punjab was getting an additional 20 per cent subsidy through NABARD which has now been discontinued. Even 60 per cent subsidy in total makes the upfront costs of solar water systems too high for farmers to pay in a single transaction.

Of the 16 interviewed farmers, 11 had availed of the PM-KUSUM scheme in Bathinda and Fazilka districts of the state. Seven of these farmers previously owned diesel pumps, three owned electric pumps, while the remaining farmer had only a solar pump.

Agricultural electricity supply in Punjab has been free resulting in farmers not having spent any amount on the operations of electrical pumps. However, getting new electric agricultural connections requires farmers to pay for the cables, new poles set up, water motor, and other related accessories. This makes the upfront costs of acquiring a new water pump in the range of Rs 1,50,000–2,00,000 in the case of electric pumps.

The upfront costs vary greatly even between diesel water pumps and solar water pumps—farmers spend about Rs 50,000 on procuring a diesel pump of 10 hp while the upfront costs of even a 3 hp solar water-pump come up to Rs 72,000. Solar water-pumps, in this regard, are more expensive than diesel water-pumps (see *Table 6*).

Table 6: Capacity-wise solar water pumps upfront costs

Solar water-pump capacity	Upfront cost (Rs)
3 hp	72,000
5 hp	1,03,000
7.5 hp	1,45,000
10 hp	1,84,000

Source: PM- KUSUM portal, PEDA https://pmkusum.peda.gov.in/PB/landing.html

However, spending on operations and maintenance of solar pumps for all farmers was nil due to the five years maintenance guarantee provided under the PM-KUSUM scheme, making solar water-pumps the overall more cost-effective option. On maintenance, farmers spent an average amount of Rs 11,000 per year for diesel and/or electric pumps. Farmers also spent an average of Rs 34,000 on diesel per year. In total, the annual spending of a farmer on operations and maintenance of electric pumps is about Rs 11,000. The annual spending of a farmer on O&M of diesel pumps is Rs 45,000, while for solar pump owners it is nil.

Therefore, in the case of farmers who own solely diesel pumps, the savings amount to about Rs 45,000, and in case of farmers owning both diesel and electric pumps, shifting to solar water-pumps would lead to savings of Rs 56,000. Savings for farmers shifting from electric water-pumps to solar water-pumps would be nominal owing to the availability of free agricultural electricity in the state—the savings for farmers shifting from electric pumps to solar pumps would amount to Rs 11,000.

Incentives

Solar water-pumps preferred over diesel water-pumps, but not as effective as electric water-pumps

Out of 16 interviewed farmers, 11 farmers in Punjab had availed of the PM-KUSUM scheme. These 16 farmers were from Bathinda and Fazilka districts, which are among the three top-performing districts under Component B of PM-KUSUM in Punjab. The main motivation for farmers to avail the scheme was the 60 per cent subsidy. With large scale dissemination of privately sourced solar water-pumps, farmers saw value in availing the scheme as they would get 60 per cent subsidy. It is to be noted that this incentive was mostly acknowledged by farmers who were interested in making this investment.

Farmers also found solar water-pumps easier to use in comparison to diesel water-pumps, which require some labour and strength to turn on rather than just a switch. Farmers who previously owned electric water-pumps, however, still saw more utility in electric water pumps owing to the availability of reliable agricultural electricity, and electric water pumps being more powerful as compared to solar water-pumps.

Reasons for non-availment

Twenty out of 23 districts in Punjab have not seen proper uptake of solar water-pumps. One of the main reasons for this is the fact that farmers in the areas that have seen non-availment of the scheme are paddy farmers and hence have had more need for water for longer as compared to farmers cultivating fewer water-intensive crops. This has resulted in these paddy-cultivating farmers opting for electric water-pumps rather than diesel water-pumps.

Farmers who have decided not to avail of the scheme in Bathinda and Fazilka have a different set of reasons. Most farmers in these areas have solar water-pumps. Most of the installed water pumps, however, have been installed privately directly through companies rather than through the scheme. This is due to the low targets set under the PM-KUSUM scheme in Punjab. This results in the portal only being active for about a day to a day and a half, thus not giving interested farmers enough time to apply. Two out of the five interviewed farmers were hoping to apply for the scheme but were unable to apply due to the online portal shutting down as the target has been achieved. Other farmers decided not to apply for the scheme because of the notion that solar water-pumps sourced privately work better and more efficiently than PM-KUSUM solar water-pumps. According to the remaining three farmers and the village mechanic, this is because private companies measure the capacity of a solar water-pump in kW, and its capacity under PM-KUSUM is calculated in horsepower (hp). 1 hp has about 756 W while 1 kW has 1,000 W, making the private system more efficient. Due to this, farmers are willing to spend more to get better-quality water supply from privately sourced solar water-pumps.

Agricultural electricity in Punjab is completely free and farmers get supply in cycles of eight hours. In addition, farmers also get supply of canal water on a weekly basis. Due to this availability of power and water, farmers are not inclined to move towards solar water-pumps.

Status of Components A and C

Components A and C have not yet been implemented in Punjab. The target for Component A was set at 220 MW in 2021. However, this Component did not see a lot of interest from farmers because of the low tariff offered. The tariff was decided at Rs 2.74/unit, which is low according to the land rate. A target of 100,000 water pumps was set for Component C (FLS). Tenders for the same were floated twice—once in May 2022 and then in August of the same year. No bids were, however, received on the same because of the low tariff of Rs 2.74/unit. Now, the state is planning to decide on the tariff through competitive bidding and new tenders will be floated in 2024. Component C (IPS) is still in the design stage.

Chhattisgarh

The state of Chhattisgarh, while inactive with regard to the scheme PM-KUSUM, has been active with regard to installation of solar water-pumps for irrigation through the Saur Sujala Yojana (SSY scheme). The scheme was introduced in 2016 with the aim of providing access to irrigation technology to farmers without electricity access, and has consistently performed well in the state of Chhattisgarh, with 158,000 pumps installed since its inception. Each year, a target of 20,000 installations is set by the state government and so far, has been fulfilled each year. The scheme offers 3-hp and 5-hp pumps, and the subsidy is divided on the basis of the following categories: SC/ST, OBC, General.

It is to be noted that the farmer share has remained consistent since the introduction of the scheme and is communicated in terms of amount to be paid rather than percentage.

Under PM-KUSUM, Chhattisgarh has not yet implemented Component B, has implemented Component A, and Component C is under implementation. While the state nodal agency, Chhattisgarh Renewable Energy Development Agency (CREDA) is responsible for implementation of Component B, Components A and C come under the jurisdiction of the state DISCOM. With this in mind, as well as to draw comparisons between the SSY scheme and the PM-KUSUM scheme, the interviewees in Chhattisgarh included State Nodal Agencies, farmers, developers, government field staff, and Chhattisgarh DISCOM, CSPDCL.

Component A

Under Component A, Chhattisgarh was allotted a target of 30 MW installed capacity to be installed in 2021–24. Out of this target, the state has been able to install three solar power plants, with capacity 2 MW so far and 13 MW in the pipeline. The state had initially awarded letters of award (LoAs) to developers with a cumulative capacity of 24 MW divided between 26 plants. However, ten developers dropped out due to issues with financing of solar power plants. Currently, out of the 16 remaining, three have been installed and 13 are expected to be installed by September 2024, which is the deadline for installation set by MNRE.

The potential reasons for this dropout rate are zero subsidy offered on solar power plants under Component A and lack of financing options for power plants. The developers participating in the bidding process often lack the kind of assets required to provide adequate collateral to banks. The benchmark cost for installation of a solar power plant has been set at Rs 3.5 crore/MW. So far, the three plants that have been installed have been financed through an escrow agreement between the bank and the state. The formation of an escrow account depends on the bank's requirements from the loan applicant. The bank asks for the formation of an escrow account should a developer not be financially sound to be able to repay the loan. In this case, the state is also held accountable for the repayment of the loan.

Tenders have been floated twice under Component A, with a deadline of about 21 days. Now, since the last date of installation is September 2024, more tenders will not be floated for implementation under this Component of PM-KUSUM.

Component B

Implementation of Component B has not yet begun in the state. However, standalone solar water-pumps have been disseminated under the Saur Sujala Yojana as mentioned earlier.

Saur Sujala Yojana (SSY)

State Nodal Agencies, government field staff, solar water-pump developers and farmers were interviewed to gain insights on this scheme. This would help us identify common factors between SSY and PM-KUSUM, and derive best practices from the scheme. The scheme has been active for eight years and is currently in its eighth phase. With a target of 20,000 being met each year, the scheme has been a consistent success so far.

Farmer interviews were conducted in Balod, a district about 100 km from the state capital, Raipur. These interviews suggested that the scheme is also extremely well-received within the beneficiaries of the scheme. Some of the reasons for that are:

1. **Low upfront cost:** Farmers have to pay a very nominal amount in order to avail of the scheme and get their solar water pumps installed. This amount varies between categories as shown in Table 7. When compared with getting a new electricity connection, the installation of a solar water pump proves to be extremely cost effective for farmers. The amount to be paid by farmers has remained consistent since the introduction of the scheme in 2016, and results in as high as 90 per cent reduction in the total costs for farmers.

Table 7: Upfront costs for farmer categories in Chhattisgarh

Beneficiary category	3 hp water pump upfront costs	5 hp water pump upfront costs
SC/ST	Rs 10,000	Rs 15,000
OBC	Rs 15,000	Rs 20,000
General	Rs 20,000	Rs 25,000

Source: CREDA

2. **Knowledge dissemination:** Owing to the fact that the scheme has been active for about eight years, all farmers interviewed had sufficient knowledge about the scheme and the procedure for application and installation.

   The field staff who preferred to remain anonymous has been working in Balod since its inception in 2016. They shared that the scheme is beneficial for farmers in that it offers quality irrigation facilities at a very low cost, which is ideal for farmers. Additionally, the availability of 3 hp and 5 hp pumps is justified, given the topography of the state. While the water levels in Chhattisgarh are low, the pumps are able to lift enough groundwater for farmers to cultivate their land since most farmers are small or marginal.

While the scheme is being implemented well, there are a few challenges faced by the farmers and the field staff, including:

1. The beginning of the scheme (especially Phases I–III) saw quick dissemination of water pumps as the target was higher than the number of applications received. Over the years, however, the target has not changed substantially while the number of applications has increased, leading to a backlog in processing applications and the farmers having to wait over a year to get their connection. Out of the farmers interviewed, only one farmer had received their water pump in the first phase and was the only one to get their water pump within a month. Another farmer (applied in Phase V) had to wait two years to get their water pump installed.

2. The scheme was started with the intention of providing solar water-pumps to farmers who lacked access to electricity in order to power irrigation technology. This has led to the scheme mainly being implemented in South and North Chhattisgarh, with relatively less focus on the remaining state. Due to this, there are many implementation challenges on the ground as mentioned above.

3. Despite solar water-pumps being cheaper for farmers and more environmentally friendly, farmers in areas with electricity access prefer electric pumps over solar water-pumps due to the fact that agricultural electricity in the state is free and runs 24 x 7, with the exception of summer season when farmers usually face power cuts from 5 p.m. to 11 p.m. This has led to the scheme being unpopular in areas with electricity access. Most farmers opting for the scheme are the ones without an electricity connection on their land, or farmers who are environmentally conscious.

4. In the case of Balod, technical assistance is offered easily to farmers. This is due to the government field staff being active and having good rapport with farmers. The companies who are responsible for the maintenance of the pumps as per the guidelines are not adequately equipped: In case a farmer has an issue with their water pump, the company first sends it to the nearest office, then the garage, and then the main office in the capital city. Once the water pump is repaired, it is then sent back to the farmer through the same route. This makes the technical assistance process long and affects the farmers' yield. In interviews with developers, it was communicated that field staff are available in each district. However, these staff are ill-equipped to handle farmers' technical issues.

5. Similarly, it has been mandated by state nodal agency, Chhattisgarh Renewable Energy Development Agency, that 2 per cent of the total installations of a district should be available at the district office should an urgent replacement be required. Currently, however, the district of Balod doesn't have a single water pump that can help replace a damaged water pump.

It is to be noted that while Chhattisgarh has not yet participated in Component B, according to sources the state may plan to do so in the 2024–25 cycle of the scheme. Currently, Chhattisgarh is offering about 90 per cent subsidy to beneficiaries. Should the state participate in the PM-KUSUM scheme, Chhattisgarh can continue to provide the same amount of subsidy to beneficiaries while getting a 30 per cent contribution from the Centre. This will help decrease the state subsidy burden and could potentially lead to an increase in the number of beneficiaries and overall provide better-quality intervention throughout the state.

Component C

Implementation of Component C began in 2022 when the Chhattisgarh government received a target of 330,000 water pumps to be solarized through feeder-level solarization (FLS). Since this is a relatively recent development, so far only tenders have been floated and bids have been accepted. According to DISCOM officials, about a hundred bidders have participated in the tendering process. However, no LoAs have been awarded yet.

Under Component C, developers receive a subsidy of Rs 1.5 crore/MW. The tariff will be decided through a tendering process and will most likely be Rs 3–3.51/unit, as has been decided for plants under Component A as well. The current agricultural load tariff is Rs 5.05/unit paid by the state to the DISCOM, indicating that the subsidy burden on the state government will decrease should Component

REDUCTION IN EMISSIONS

A shift from electric water-pumps to solar water-pumps leads to reduction in emissions as electricity used to power grid-connected electric water-pumps is mostly generated through thermal sources. Shifting from diesel water-pumps to solar water-pumps would lead to an elimination of a substantial amount of diesel used in farmers' irrigation practices, leading to a large decrease in emissions as well. These emissions reductions, when calculated for all states that have implemented the scheme in the country, can contribute to India's Nationally Determined Contributions (NDCs).

According to the World Bank, India has a total of about 8.8 million diesel water-pumps. The reduction in emissions from replacement of even a quarter of these pumps with solar irrigation pumps would amount to 11.5 million tonne of reductions per year. This would translate to 46 million tonne of emission reduction if all diesel pumps were replaced with solar water-pumps. To put this in context, reductions from the Perform, Achieve, Trade (PAT) scheme introduced by the Bureau of Energy Efficiency, amounted to 11.92 million tonne for the cement industry, 19.25 million tonne from the steel sector and 25.17 million tonne from thermal power plants over a period of six years (in the first two cycles). Solar pumps alone on the other hand have the potential to reduce 46 million tonne of emissions just in a year. This highlights the significance of the PM-KUSUM scheme and the major contribution it could make towards achieving India's NDC goals.

C see successful implementation.

In comparison to Component A, which has a deadline set for September 2024, Component C is expected to perform better in the state of Chhattisgarh. This can be attributed to the fact that Component C has a subsidy component, and that banks are now more willing to disseminate loans as the Component has now been included in the priority-sector lending list as well as the Agriculture Infrastructure Fund.

DISCOM officials also communicated that most feeders in the state are segregated and hence implementation of Component C (FLS) should be easy. The feeders that are currently not segregated are under the process of being segregated under the Revamped Distribution Sector Scheme, also being implemented in Chhattisgarh currently.

Challenges and the way forward

India has set a renewable energy target of reaching 500 GW installed capacity of renewable energy. So far, about 140 GW of this target has been achieved. PM-KUSUM is one of the major contributing programmes and schemes towards this goal, with the potential to contribute 25 GW. Proper implementation of schemes like PM-KUSUM can add substantially to the remaining 360 GW. Additionally, such schemes also hold potential to enhance farmers' livelihoods and their incomes. The following challenges being faced with on-ground implementation, if addressed properly, can aid in successful translation of targets into installed capacity.

1. **Increase in prices of solar water pumping systems**
   Prices of solar panels consistently decreased in the last decade. However, the price of the solar panel raw material, polysilicon, increased by about six times during 2020–21.[12] This resulted in an increase in solar PV modules in that time as price increases in polysilicon are directly proportional to price increases in modules. Additionally, under the Approved List of Models and Manufacturers (ALMM), India has only included manufacturers producing solar PV modules domestically, which rely on exports of polysilicon. The vendors included in the ALMM list are the only ones allowed to supply modules for government schemes. These modules are also more expensive than the ones exported from China. All of these factors, along with the 40 per cent import duty on solar PV modules, have made solar panels more expensive since 2020. This increase in solar PV module price has led to an increase in the cost of solar water-pumps under PM-KUSUM and hence an increase in the farmers' upfront costs.

   For example, the subsidy being offered in Rajasthan is 60 per cent (30 per cent Central government's share and 30 per cent state government's share). This has led to the farmers having to bear 40 per cent of the cost of water pumps, which becomes expensive when compared with other states. Adding to this point, since water levels in Rajasthan are low, most farmers have to opt for 7.5–10 hp pumps, despite the availability of lower-capacity pumps. Cumulatively, the upfront costs for setting up a PM-KUSUM solar power system come up to approximately Rs 2 lakh for submersible AC pumps, and approximately Rs 3 lakh for submersible DC water pumps as compared to about Rs 1,00,000 for submersible AC pumps earlier. In Haryana as well, as solar panel efficiency has increased, so has the price of the PM-KUSUM water pumpsets. In the initial cycles, beneficiaries would pay an upfront cost of Rs 1,13,000 while now they would have to pay Rs 1,40,000.

2. **Centralized implementation model**
   One of the key differences between implementation in Punjab (under-performing) and Haryana and Rajasthan (top-performing) was the level of decentralization. While Components A, B and C were handled by separate implementing agencies in Haryana and Rajasthan, implementation in Punjab was done entirely by the State Nodal Agency, PEDA. This may pose a number of challenges. Components A and C have different technicalities to be addressed from Component B and hence need involvement of stakeholders with technical knowledge to be able to cater to a state. For example, Components A and C require know-how on tariff setting, tendering processes, the on-ground scenario of solar power plants, knowledge on DISCOM health, state electricity subsidies, etc. Component B requires on-ground knowledge about needs of farmers in addition to an understanding of the different kinds of subsidies offered to farmers.

3. **Access to cheap electricity for agriculture**
   The most common source of irrigation water for farmers in the country is groundwater. Most districts with the exception of a few in Punjab lie under either over-exploited or semi-critical categories when it comes to groundwater levels. However, most of these districts are also primarily paddy-cultivating districts and hence have a high usage of water for irrigation. These paddy farmers have always had a high need for water and hence had opted for electric water-pump connections years ago. These two factors have made dissemination of solar water-pumps in these areas difficult as farmers are less motivated to shift from electric pumps to solar water-pumps when they have eight hours of free agricultural electricity supply, as is the case in Punjab.

4. **Lack of affordability for one-time payment**
   Currently, the upfront costs of solar water pumpsets under the PM KUSUM scheme are in the range of Rs 50,000–Rs 3,00,000. These upfront costs increase as capacity of the solar water-pumps increases. They are also influenced by the amount of subsidy offered by the state government. These upfront costs may prove to be too expensive for farmers to pay. For example, eight out of nine farmers in Rajasthan who have not availed of the scheme expressed that they would apply if they got the option of paying for the system in installments.

5. **Non-availability of varying pump capacities in different regions**
   Pump capacity influences the power with which water will be pulled from under the ground, as well as the distance that the water can go to, in terms of height or length. As of now, pumps till the capacity of 15 hp are permitted to be installed under the PM-KUSUM scheme, which subsidy offered up to 7.5 hp. Pumps of 7.5–15 hp capacity are eligible for the subsidy amount offered on a 7.5 hp water pump. While all pump capacities till 15 hp are mentioned in the guidelines issued by the MNRE, some of these pumps are not available in some states. Developers of solar water-pumps are decided on the basis of a tendering process. In case of a price mismatch between the MNRE and the solar water-pump developers, certain categories of water pumps do not get approved for certain states, removing that particular pump capacity option for farmers. In Haryana, surface pumps of 5 hp and 7.5 hp are not available. A farmer in Haryana had to opt for a 7.5 hp submersible water-pump as surface pumps under 7.5 hp were not available in Haryana. Due to this, the farmer had to invest an extra ~Rs 60,000 on a borewell which would not have been required had the farmer been able to get a 7.5 hp surface pump. In Punjab, while pumps of all capacities are available, proper servicing of surface pumps and DC pumps is not done in the state. These barriers prevent the farmers from applying for the water pump suitable for them and may lead to farmers opting for either a low-performing pump according to their land, or a pump of higher capacity than required leading to unnecessary expenditure on the farmer's end.

   It is also to be noted that Haryana also has a number of large farmers hoping to invest in solar water-pumps. It was expressed by the state nodal agency that the upper limit of the water pumps to be available for farmers should be 20 hp so that farmers with larger landholdings can also invest in the same.

6. **Poor implementation under Components A and C**
   Components A and C have not seen proper implementation under the scheme so far. While implementation under the two components was only properly started after the pilot phase ended in 2021, the delay in implementation may be attributed to other factors as well. Out of the surveyed states, Component A was not able to take off in any of the states properly due to financing difficulties faced by developers—the scheme offers no subsidy under the Component and banks were unwilling to disburse loans under the same, due to developers not having enough collaterals for the loans they were hoping to avail. Implementation of Component A has been given a deadline till September 2024 in Chhattisgarh, and is not accepting applications in Rajasthan and

Haryana anymore. Component C is now gaining momentum in all the states. Challenges associated with Component C include low tariffs approved by the state regulatory authorities, resulting in farmers not showing interest in participating in the component. In Haryana, the tariff associated with Component C has been set at Rs 2.4/unit, which is low for farmers in the state. Many districts in the state are located around Delhi or the National Capital Region, making the land more valuable. This makes the farmers more inclined to use the land for warehousing purposes, or to give it on rent to industries rather than start a solar power plant with a breakeven period of 10 years.

The PM-KUSUM scheme has overall shown to be a beneficial change for farmers. All 50 farmers interviewed, regardless of availment of non-availment, were of the belief that the inclusion of solar water-pumps in their irrigation practices was a welcome change. On the basis of interviews with all stakeholders involved in the PM-KUSUM ecosystem, challenges and best practices were observed in top-performing and underperforming states. In line with these challenges and best practices, the following recommendations may be noted for further implementation of the PM-KUSUM scheme till 2026:

1. **Increase farmer subsidies for solar water pumps**
   In order to keep the scheme financially viable for farmers, the Central government may accompany this increase in prices of solar PV modules with an increase in the Central Financial Assistance. Out of the ~Rs 34,000 budget set for the scheme, only about Rs 3,000 crore has been used so far. A policy change in this regard can help boost participation in the PM-KUSUM scheme while also encouraging domestic manufacturing of solar PV modules.[13]

2. **Need for decentralized implementation**
   Rajasthan has appointed the Horticulture Department as the implementing agency for Component B, resulting in the farmers getting adequate information due to a network of supervisors under the Horticulture Department already being present on the ground. While all surveyed states with the exception of Punjab have adopted a decentralized model in that SNA and the DISCOM are handling implementation of Component B and Components A and C respectively, Rajasthan showed decentralization at a deeper level due to the involvement of the Horticulture Department. The involvement of SNA and the Horticulture Department was observed in Uttar Pradesh also, and involvement of SNA and the DISCOM was also observed in Maharashtra—in both states Component B water-pumps have seen good dissemination. States like Punjab, which have adopted a more centralized model, can make this change from a

more centralized to a more decentralized model in their implementation model in order to delegate tasks to relevant officers, as well as to ease the burden for implementation on all components from one implementing agency.

3. **Push for PM-KUSUM in states using micro-irrigation technologies**
   In Rajasthan, groundwater levels are low and hence all farmers have installed micro-irrigation technology on their land. Under PM-KUSUM guidelines, special preference may be given to states with high demand as well as a robust micro-irrigation subsidy practice in places such as Rajasthan where all surveyed farmers had installed drip irrigation systems or mini-sprinkler systems subsidy owing to state mandates and the subsidy provided on these technologies. This could lead to about 50 per cent savings in terms of water use as compared to flood irrigation.[14]

4. **Provision of installments for upfront costs**
   Farmers from all surveyed villages who had not availed the scheme expressed that they would have applied if they had the provision of paying the sum in installments rather than in one transaction. The PM-KUSUM scheme may incorporate this into their guidelines by providing either low-interest financing options to farmers through banks, or by providing farmers with the option of paying in installments.

5. **Nodal agencies to ensure availability of all pump capacities**
   It should be made sure, through proper lobbying from the State Implementing Agencies, that farmers get access to all capacities of water pumps required according to the state demographics. This would require the state nodal agencies to have adequate knowledge about the farmers' needs in the state, as well as require more motivated participation from the state nodal officers' ends. For example, Rajasthan receives all capacities of pumps and all sub-categories of said pumps. According to officials, this has been made possible through lobbying of state nodal officers to match prices between the MNRE and developers. Additionally, for Component C implementation, states may float tenders through the bidding process in order to be able to decide a tariff on the basis of the developers' costs as the current tariffs are too low to be able to cover developers' upfront costs.

6. **Capacity building of state implementing officers**
   State Implementing agencies require personnel with adequate knowledge of farmer needs and good practices, especially in order to achieve proper implementation under Component B. While knowledge was easily applied in

Rajasthan through the active involvement of the Horticulture Department, the personnel in Punjab Energy Development Agency did not have adequate knowledge about farmers' needs and the different subsidies in place to aid farmers. Through capacity-building of state implementing agency personnel or through involvement of state agriculture/horticulture departments, proper implementation may be achieved in states like Punjab as well.

References

1. Power Finance Corporation. (2024). Report database 2022–23, updated up to April 2024. Retrieved from: https://www.pfcindia.com/ensite/DocumentRepository/ckfinder/files/Operations/Performance_Reports_of_State_Power_Utilities/Report%20Database%202022-23%20-%20updated%20up%20to%20April%202024EntityApr.pdf (accessed on June 11, 2024).

2. Government of India, Ministry of Power (2021). Lok Sabha unstarred question no. 3890 to be answered on 18.03.2021: Free electricity to farmers. Sansad. Retrieved from https://sansad.in/getFile/loksabhaquestions/annex/175/AU3890.pdf?source=pqals (accessed on June 11, 2024).

3. Central Electricity Authority (March 31, 2023). Electricity tariff & duty and average rates of electricity supply in India. https://cea.nic.in/wp content/uploads/fsa/2024/01/Book_2023.pdf (accessed on June 12, 2024).

4. Yashodha, Y., Sanjay, A., and Mukherjee, A. (2021). Solar irrigation in India. The International Water Management Institute (IWMI) https://solar.iwmi.org/wpcontent/uploads/sites/43/2021/09/INDIA-SITUATION-ANALYSIS-REPORT_final-version-3.pdf (accessed on May 8, 2024).

5. Sharma, S., Tripathi, S., and Moerenhout, T., with contributions from Dekens, J., Roy, D., Singhal, V., Turley, L., Uzsoki, D., and Zamudio Trigo, N. (September 2015). Rationalizing energy subsidies in agriculture: A scoping study of agricultural subsidies in Haryana, India. International Institute for Sustainable Development (IISD). https://www.iisd.org/system/files/publications/rationalizing-energy-subsidies-agriculture-in-haryana-india.pdf (accessed on May 10, 2024).

6. Shiferaw, B. (August 23, 2021). Addressing groundwater depletion: Lessons from India, the world's largest user of groundwater. World Bank Group. https://ieg.worldbankgroup.org/blog/addressing-groundwater-depletion-lessons-india-worlds-largest-user-groundwater (accessed on June 12, 2024).

7. Ministry of Power, Government of India. (September, 2015). UDAY scheme for operational and financial turnaround of power distribution companies. https://powermin.gov.in/pdf/Uday_Ujjawal_Scheme_for_Operational_and_financial_Turnaround_of_power_distribution_companies.pdf (accessed on May 9, 2024).

8. Yashodha, Y., Sanjay, A., and Mukherjee, A. (2021). Solar irrigation in India. The International Water Management Institute (IWMI) https://solar.iwmi.org/wpcontent/uploads/sites/43/2021/09/INDIA-SITUATION-ANALYSIS-REPORT_final-version-3.pdf (accessed on May 8, 2024).

9. Ministry of New and Renewable Energy (MNRE) (July 22, 2019). Guidelines for implementation of Pradhan Mantri Kisan Urja Suraksha evem Utthan Mahabhiyan (PM KUSUM) scheme. https://cdnbbsr.s3waas.gov.in/s3716e1b8c6cd17b771da77391355749f3/uploads/2022/12/2022122224-1.pdf (accessed on May 1, 2024).

10. Ministry of New and Renewable Energy (MNRE) (January 17, 2024). Guidelines for implementation of new scheme for farmers for installation of solar pumps and grid connected solar power plants. https://cdnbbsr.s3waas.gov.in/s3716e1b8c6cd17b771da77391355749f3/uploads/2024/01/20240118413909461.pdf (accessed on May 1, 2024).

11. Haryana Renewable Energy Development Agency. (n.d.). Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan (PM KUSUM) scheme. Retrieved from https://pmkusum.hareda.gov.in/HR/landing.html (accessed on June 14, 2024).

12. JMK Research. (2022, March). 38% increase in module prices in last 20 months (August 2020–March 2022). Retrieved from https://jmkresearch.com/38-increase-in-module-prices-in-last-20-months-august-2020-march-2022/ (accessed on June 18, 2024).

13. Press Information Bureau (2023, June 26). PM KUSUM scheme: 1.75 lakh solar pumps and 4.8 GW grid-connected solar power plants installed. Retrieved from https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1944762 (accessed on June 18, 2024).

14. Department of Agriculture and Farmers Welfare. (2015, August). PMKSY, micro irrigation benefits/utility. https://pmksy.gov.in/microirrigation/Archive/August2015.pdf (accessed on June 18, 2024).

The PM-KUSUM scheme, with its three components, was introduced in 2019, with the aim to solarize agriculture and encourage investment in the solar-energy sector by farmers with uncultivated barren land. Since its inception, 4 lakh diesel and electric water-pumps for irrigation have been replaced with solar water-pumps, leading to massive reductions in emissions and increased savings for farmers. However, only about 30 per cent of the target set under the scheme has been achieved so far.

This report shows that through decentralized implementation models and provisions of varying payment options for farmers, these gaps can be addressed. Component B, entailing replacement of electric and diesel electric pumps has seen the most widespread implementation in Indian states, with Haryana and Rajasthan leading in terms of installation. Taking examples from case studies from these states, as well as from under-performing ones, recommendations have been provided for Central and state governments to ensure better on-ground implementation.

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