Designing Financing Interventions to Catalyze Solar Pumps market in India

cKinetics
Accelerating Sustainability

CLIMATE POLICY INITIATIVE

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1 Introduction

Solar pumping segment in India has seen significant growth in recent years, primarily driven by government subsidies, ranging from 30-95%[1] (comprising of central government subsidy supplemented by the additional subsidy in some states). The initial thrust emerged from the target of 1 million pumps (by 2020-21[2]) set by the Central Government in 2014-15.

In furtherance of the same, the central and state governments have periodically come up with tenders to source and deploy solar pumps across different areas in their respective states. An overview of the cumulative installation as also state-wise installation is provided below.

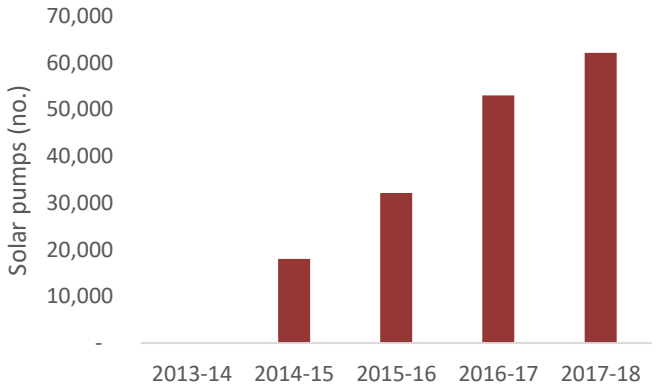


Figure 1: All-India solar pumps installations (2013-2017)

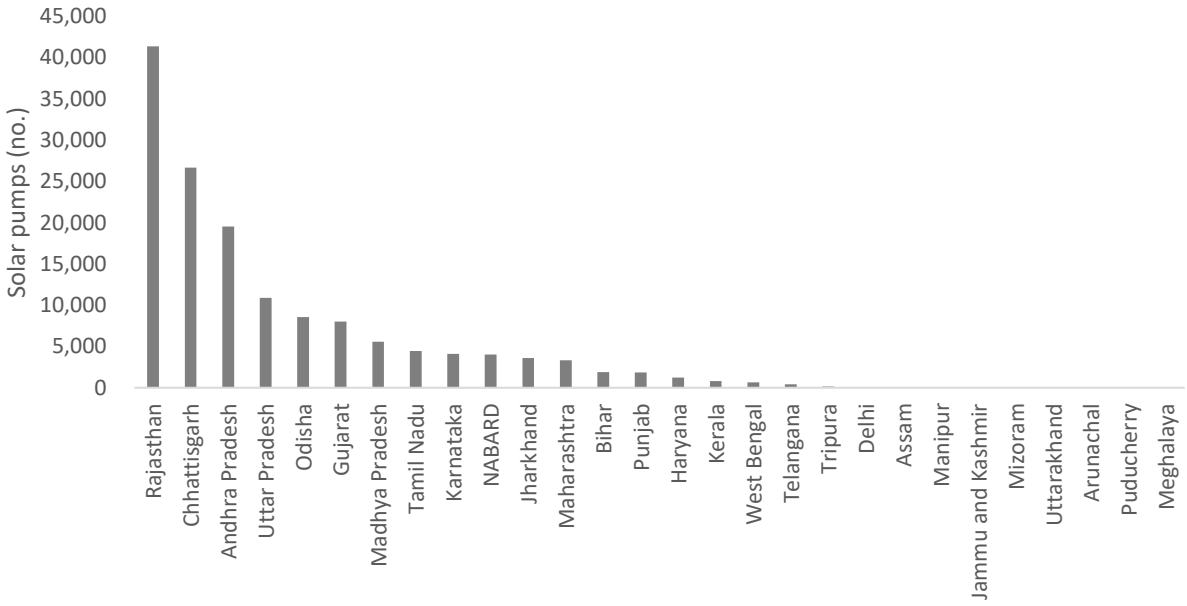


Figure 2: Cumulative solar pumps installations as of December 31, 2017

Agricultural electricity consumption has increased from 81673 GWh in 2001-02 to 191151 GWh in 2016-17.[3] The electricity for agricultural consumers is highly subsidized resulting in the long-standing problem related to the financial health of the DISCOM, and increased cross-subsidy burden on the other consumers. In addition to the loss per-se due to highly subsidized electricity tariff for irrigation purposes, the poor collection efficiency typically observed in the rural areas exacerbate the problems for the

[1] State wise subsidy allocations and disbursements are indicated in Annexure 2
[2] http://mnre.gov.in/file-manager/UserFiles/Scheme-for-Solar-Pumping-Programme-for-Irrigation-and-Drinking-Water-under-Offgrid-and-Decentralised-Solar-applications.pdf
[3] http://www.cea.nic.in/reports/others/planning/pdm/growth_2018.pdf

DISCOMs. As a potential way to mitigate these underlying challenges (losses due to pricing differential between the tariffs charged to the agri. consumers vs. the cost of supply incurred by the DISCOMs in servicing these requirements), the Government is focusing on solar pumps to evolve a sustainable mechanism to support DISCOMs in managing agriculture load commitments.

Large scale solar pumping program implemented effectively across the country is expected to be a transformational pivot for DISCOMs. To address this need, the Central Government has recently approved a massive and a highly ambitious scheme – KUSUM (Kisan Urja Suraksha Utthaan Maha Abhiyaan).

Kisan Urja Suraksha evam Utthaan Mahabhiyan (KUSUM) Scheme

Aim to add Solar capacity of 25,750 MW by 2022 with Central Financial Support of INR 344,220 million

 **Component A**	 **Component B**	 **Component C**
Setting up of 10,000 MW of Decentralized Ground/Stilt Mounted Grid Connected Solar or other Renewable Energy based Power Plants	Installation of 1.75 million Stand-alone Solar Pumps	Solarization of 1 million Grid Connected Agriculture Pumps
To be launched on pilot scale for 1000 MW capacity	***To be implemented in toto***	***To be launched on pilot scale for 100,000 pumps***
Solar or other renewable energy-based power plants (REPP) of capacity 500 kW to 2 MW to be setup on barren/ uncultivable land or in stilt fashion on agricultural land (only solar plants), within five km radius of the sub-stations by individual farmers/ group of farmers/ cooperatives/ panchayats/ Farmer Producer Organizations known as Renewable Power Generator (RPG). In case farmer, FPO, etc. can't arrange the equity, REPP can be developed through developer(s) or DISCOM, in which case the developer/ DISCOM would be considered as RPG.	Standalone solar agriculture pumps of capacity up to 7.5 HP to be installed in off-grid areas by individual farmers. Pumps of size greater than 7.5 HP allowed but CFA to be limited to that available for 7.5 HP solar pump Mandatory usage of indigenously manufactured solar panels with indigenous solar cells and modules.	Individual farmers to be provided support to solarize existing grid-connected agricultural pumps. Provision for farmer to sell excess solar power to the DISCOM. Solarization of pumps greater than 7.5 HP capacity allowed but CFA to be limited to the CFA applicable for pump of 7.5 HP. Mandatory usage of indigenously manufactured solar panels with indigenous solar cells and modules.
DISCOM to be provided Procurement Based Incentive at the rate of INR 0.40/ kWh purchased or INR 0.66 million/ MW of capacity installed per year, whichever is less, for a period of five years	CFA of 30% (50% in North Eastern States, Sikkim, Jammu & Kashmir, Himachal Pradesh, Uttarakhand, Lakshadweep and A&N Islands) of the benchmark cost or the tender cost, whichever is lower available; State subsidy of 30%; farmer to provide remaining 40% (10% as upfront contribution and 30% through loan)	CFA of 30% (50% in North Eastern States, Sikkim, Jammu & Kashmir, Himachal Pradesh, Uttarakhand, Lakshadweep and A&N Islands) of the benchmark cost or the tender cost of the solar PV component, whichever is lower available; State subsidy of 30%; farmer to provide remaining 40% (10% as upfront contribution and 30% through loan)

As stated above, KUSUM builds on the past solar pumping schemes. Key facets of these are discussed overleaf.

Government incentive outlays have determined the nature, scale and pace of uptake

Government policies and schemes – both and center and state level have been primarily focused towards financial incentives for solar pumps in the form of subsidies. The pace of state-specific policy/scheme announcements has picked up largely over the past 4 years, with much of the activity post 2016. Policies and schemes across center and state-level vary significantly. State-specific subsidies range from 40-95% of the total price of the pump.

Despite political priority, there has been lack of consistency in the schemes with frequent changes being made year on year. Variation in policies – in terms of amount of subsidy, farmer contribution, loan component, technical specifications, etc. – lead to confusion amongst farmers, system suppliers and lenders. Also, farmers have generally preferred to wait for higher subsidies under the state schemes (even for a year or so) rather than availing subsidy under the central schemes.

High state-level subsidies were a key factor that have led to a closure of the MNRE sponsored NABARD credit-linked subsidy scheme (40% subsidy, 20% farmer contribution and 40% loan) since March 2017 due to minimal usage. Even as the NABARD Credit-linked scheme enabled establishment of case and role of end-user financing in the market, the lack of uptake has made the market completely subsidy dependent.

Recently announced state schemes and subsidies

Maharashtra

After discontinuing the solar agriculture pump scheme in 2016 due to affordability issues and opting to feeder-based solar energy scheme, Maharashtra again announced its ambitious plans to install 100,000 solar pumps for off-grid regions in three years from FY 2018-19 to FY 2020-21 under Mukhyamantri Saur Krushi Pump Yojana[4]. Under the scheme, the government aims to provide 95% subsidy on pump sets to SC/ST farmers and 90% subsidy to general category.

SUBSIDY AVAILABLE

-90% to 95%

UNIQUE ELEMENT:

-Additional tax of INR 0.10 /unit has been levied on commercial and industrial consumers to provide subsidy to beneficiary

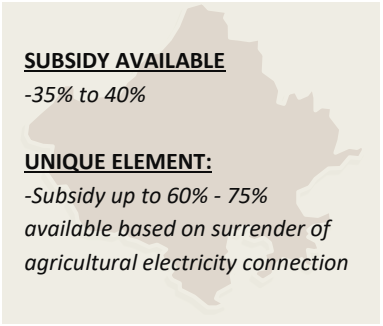
To further encourage the use of solar pumps, the Maharashtra government has decided to give two LED bulbs, a DC fan and a mobile charging socket for charging, as part of this scheme. Of the total target, Maharashtra State Electricity Distribution Company (MSEDCL), the implementing agency for the programme has released a tender for 75,000 solar pumps in 2018-19.

In order to meet the fund requirements, tax on commercial and industrial consumers has been increased by INR 0.10 per unit. However, MSEDCL's aggregate sales to commercial and industrial consumers during FY2018-19 and FY 2019-20 is estimated to be 36,545 MUs[5], which translates into INR 8.66-10.39 billion over the next two years i.e. financing of INR 86 crore monthly, which may still fall short of meeting the target of 100,000 solar pump installations.[6]

[4] https://www.mahaDISCOM.in/solar/index.html
[5] http://www.mercindia.org.in/pdf/Order%2058%2042/Order-195%20of%202017-12092018.pdf
[6] https://www.mahaDISCOM.in/solar/doc/Chief%20Minister%20Solar%20AG%20Pump%20Project%20-%2020181115%201448539410.pdf

Rajasthan

The state's horticulture department led the momentum in adoption of solar pumps in 2011-12 by offering a subsidy of 86% driven by clubbing subsidies available under various programmes such as Rashtriya Krishi Vikas Yojana (RKVY), National Horticulture Mission's (NHM) water harvesting structures scheme. However, in the state budget for 2018-19, the government has announced state subsidy of 35% and 40% for a 3 HP and 5 HP solar pump respectively, with the total subsidy ranging from 60% to 75%, depending on whether the farmers surrender their existing agricultural connection or not.

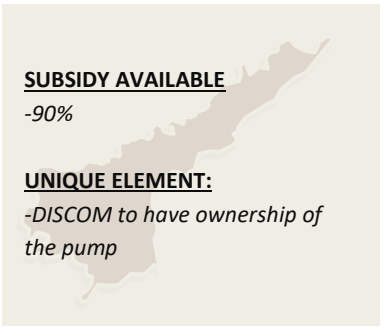


SUBSIDY AVAILABLE
-35% to 40%

UNIQUE ELEMENT:
-Subsidy up to 60% - 75% available based on surrender of agricultural electricity connection

Andhra Pradesh

The Government of Andhra Pradesh is also taking up the solar pumps programme in a big way in the State through New & Renewable Energy Development Corporation of Andhra Pradesh Limited (NREDCAP). As of December 31, 2018, the state government has installed 19,526 pumpss mainly covering the small and marginal, SC/ST & NTR Jalasiri farmers (8,275) by spending around INR 400 crore[7]. In the state budget of 2018-19, the state Government announced that it will provide 60% (previously 56%) of cost of the pumps as subsidy and the central government will arrange for 30% as central financial assistance. Thus, the farmers contribution would only be 10%. The state provides subsidy either through the DISCOMs (in which case the ownership lies of the pumps lies with DISCOM) or using funds from fisheries and agricultural department. The state has particularly focused on SC/ST farmers by providing them additional subsidy through the NTR Jalasiri scheme, under which SC farmers pay a share of only Rs 6,000 per pump.



SUBSIDY AVAILABLE
-90%

UNIQUE ELEMENT:
-DISCOM to have ownership of the pump

Even while, innovative models being tried, there are challenges that are limiting the scale-up of the segment – an illustrative representation is provided overleaf.

[7] http://www.apagrisnet.gov.in/2018/Budget%20speech%20english_Assembly_07.pdf

Key barriers expressed by stakeholders inhibiting growth of solar pumps

The figure below delineates the risks and challenges as expressed by different stakeholders (end consumers, enterprises and lending institutions) that is limiting the adoption and growth of solar pumping in rural India.

	End-consumers	Enterprises	Lending institutions
Market challenges	1. Lack of awareness on the government schemes and policies 2. Reluctance in adopting new technologies 3. Limited maintenance and training support	1. Confusion on the applicable GST rates 2. Prevalence of system installation model due to high subsid schemes resulting in uncertainty of the RESCO model 3. Mandatory use of indigenously manufactured solar panels under KUSUM Scheme	1. Inconsistency in schemes at center and state-level 2. Lack of scale of the existing enterprises 3. Risk of theft 4. Asymmetry in information available and required by lenders 5. Waivers spoiling credit discipline
Financing challenges	1. High upfront cost making affordability a challenge especially for the small and marginal farmers 2. Lack of affordable end-consumer financing products	1. Delay in disbursal of subsidy resulting in cash flow management 2. Lack of financing options especially for alternative models 3. Limited availability to term loans for short-term operational expenses 4. Lack of collaterals limiting access to debt	**End-consumers**: 1. Low bankability of end-consumers 2. Default risk on getting access to subsidized electricity **Enterprises:** 1. Lack of collateral 2. Default and delay risks
Addressing the challenges	► Creating innovative business models to enhance reach to small and marginal farmers	► Providing access to bridge finance to address risks related to delay in subsidy disbursal ► Availability of working capital term loans ► Access to collateral free loans	► **Providing guarantee structures to secure lenders against default and delay**

Going forward

Even as KUSUM is getting rolled out as a flagship national scheme, it is **critical to ensure that business case, market ecosystem and operational mechanics of the solar pump product itself are well established**. This is particularly critical given that growth has been slower than targeted (even when subsidy levels have been fairly high).

Hence, there is a need to design interventions – in terms of financing, policies, business models, etc. to deliver on the targets and opportunity catalyzed by the KUSUM scheme.

This report presents a comprehensive view of the segment and prospective models which can help craft a feasible and scalable segment.

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2 Designing business model interventions to catalyze uptake of solar pumps

As discussed earlier in the paper, most solar pumps are currently sold through government schemes. The role of private sector has primarily been more of a system installer rather than a comprehensive renewable energy service provider (RESCO). However, some developers are attempting to go beyond the government tender route and sell directly to customers through models which necessitate financing to the end customer (i.e. the farmer in this case). In certain cases, this has been effectively aggregated via the agricultural supply chains of MSMEs and corporates. An overview of these models (attempted in recent past) is synthesized in Annexure 1.

Even as the opportunity for solar pumping segment has been catalyzed by the KUSUM Scheme, there is a need to design interventions to ensure that the implementation bottlenecks encountered in the past are appropriately addressed. This report synthesizes the implementation approaches and the business case for different stakeholders in context of the recently announced KUSUM scheme as also couple of other upcoming models / constructs is discussed in the sections below.

2.1 Establishing the feasibility of solar pumps under KUSUM Scheme

Interventions needed to increase reach to farmers with smaller land holdings

Under Component B of the KUSUM scheme, capital subsidy of 60% is available for the farmers in replacement of diesel pumps in off-grid settings. Further the scheme envisages a loan for the 30% of the balance 40% as basis for farmers to procure the same.

Majority of farmers in India have low acreage (less than 1 acre) and hence the case for solar pump ownership on a stand-alone basis seems to be limited – refer table below. *In the scenario, where the farmer needs solar pump for only one irrigation cycle out of a total of three (the rest being rain-fed irrigation), it makes business sense for the farmer only with a landholding of at least 2.5 acres to procure a 3 HP pump*. Hence, additional incentives maybe needed to upscale the uptake.

Table 1: Business case for farmers under KUSUM scheme against upfront contribution of 10%

		Size of land possessed (in acres)						
			0.02	**1**	**2.5**	**5**	**7**	**10**
1 Irrigation cycle	**Pump size (HP)**	**3**	0	7.9	3.1	1.5	1	0.7
		5	0	8.9	4.2	2.1	1.5	1
		7.5	0	12.1	5.9	3.2	2.3	1.6
		10	0	17.2	8.7	4.9	3.6	2.5
2 Irrigation cycle	**Pump size (HP)**	**3**	0	3.9	1.5	0.7	0.5	0.3
		5	0	5.1	2.1	1	0.7	0.5
		7.5	0	7.1	3.2	1.6	1.1	0.8
		10	0	10.4	4.9	2.5	1.8	1.2
Land holding size (in acres)		*< 0.02*	*0.02 - 1.0*	*1.0 - 2.5*	*2.5 – 5.0*	*More than equal to 5*		
Distribution of Agricultural Households by land holding size[8]		◀6%▶	◀31%▶	◀30%▶	◀20%▶	◀13% ▶		

(values in the cells represent the payback in years for farmers providing the entire 10% contribution upfront and taking loan equivalent to 30% of the cost); **Source**: cKinetics research

[8] NABARD All India Rural Financial Inclusion Survey 2016-17

For a farmer using a diesel pump, the avoided cost pertaining to fuel cost, pump maintenance and in time, pump replacement, helps create a case for solar pumps. While, business case exists largely for farmers with land of sizes greater than 2.5 acres, **67% of Indian farmers possess land of sizes smaller than 2.5 acres.** *Therefore, models facilitating /catalyzing the reach to farmers with smaller landholding are needed to truly leverage the KUSUM opportunity.*

Financial incentives needed for farmers to solarize grid-connected agricultural pumps

Financial incentives in the form of Feed-in-Tariff (FiT) or higher subsidy rate would be required as an incentive for farmers, currently used to electricity as source for greater than 80% of their irrigation needs (in terms of pump-hours), to solarize their existing electric pumps. This is largely due to the low agricultural tariff existing in India. Illustrative analysis on this is provided in the tables below.

*The effective cost of electricity for a solar pump of 5 HP capacity (used for two seasons) even at an 80% subsidy is more than average electrical tariff of INR 1.65/ kWh, as can be seen in Table 4 overleaf***.**

Table 2: Payback for a farmer using a combination of electric and diesel pump (of size equivalent to 5 HP solar pump)

			Size of land possessed (in acres)					
			0.02	**1**	**2.5**	**5**	**7**	**10**
1 Irrigation cycle	**Diesel usage**	**80%**	17.3	6.6	3.3	1.7	1.2	0.9
		60%	0.0	8.6	4.4	2.3	1.7	1.2
		40%	0.0	12.4	6.3	3.5	2.5	1.7
		20%	0.0	19.9	11.5	6.4	4.7	3.4
		0%	0.0	0.0	0.0	0.0	0.0	0.0
2 Irrigation cycle	**Diesel usage**	**80%**	16.8	4.0	1.7	0.9	0.6	0.4
		60%	0.0	5.2	2.3	1.2	0.8	0.6
		40%	0.0	7.6	3.5	1.7	1.2	0.9
		20%	0.0	13.8	6.4	3.4	2.4	1.6
		0%	0.0	0.0	0.0	0.0	0.0	0.0

Source: cKinetics research

Table 3: Payback for farmer with 5-acre landholding and using solarized electric pump (of size equivalent to 5HP solar pump)

			FiT									
			0	2	2.5	3	3.5	4	4.5	5	5.5	6
1 Irrigation cycle	**Diesel usage**	**80%**	1.7	1.4	1.3	1.3	1.2	1.2	1.1	1.1	1.1	1.0
		60%	2.3	1.8	1.7	1.6	1.5	1.4	1.4	1.3	1.3	1.2
		40%	3.5	2.4	2.2	2.1	2.0	1.8	1.7	1.7	1.6	1.5
		20%	6.4	3.7	3.3	3.0	2.8	2.5	2.4	2.2	2.0	1.9
2 Irrigation cycle	**Diesel usage**	**80%**	0.9	0.8	0.8	0.8	0.8	0.8	0.7	0.7	0.7	0.7
		60%	1.2	1.1	1.0	1.0	1.0	1.0	0.9	0.9	0.9	0.9
		40%	1.7	1.5	1.5	1.4	1.4	1.3	1.3	1.2	1.2	1.2
		20%	3.4	2.6	2.5	2.3	2.2	2.1	2.0	1.9	1.8	1.8

Source: cKinetics analysis

Table 4: Effective tariff of 5HP solar pump (in INR/ kWh) employed at a 5acre farm

		Subsidy				
		60%	70%	80%	90%	100%
FiT	0	2.50	2.43	2.35	1.46	1.40
	1.5	1.77	1.69	1.62	0.72	0.66
	2	1.52	1.44	1.37	0.48	0.41

Source: cKinetics analysis

For an electric pump, considering a 2-irrigation cycle and 60% subsidy under Component C of KUSUM scheme, it can be seen that the effective cost of a 5HP AC solar pump is higher than the average agricultural tariff (Rs. 1.65/kWh). Thus, a FiT of between INR 1.5 ~ 2/kWh is needed to frame an inflexion case and uptake within grid connected framers.

Further, business model innovations are required to:

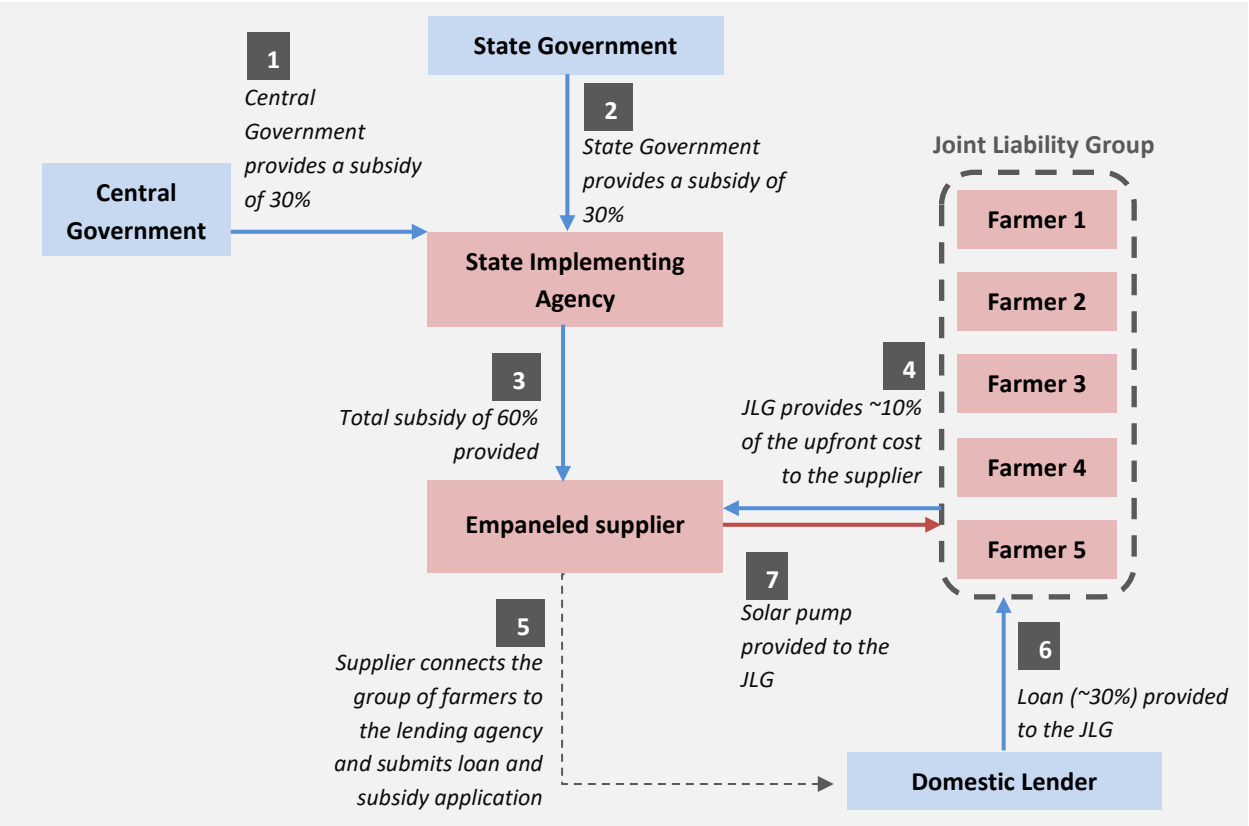
1. Increase reach to farmers with smaller landholdings
2. Maximize capacity utilization of solar pumps to create an effective business case for farmers
3. Reduce the effective cost of solar pumps for farmers

2.2 Evolving models to catalyze adoption of solar pumps

Model 1: Joint Liability Groups model

- **Description**

Small and marginal farmers often face challenges in purchasing solar pumps due to the high upfront cost and lower capacity utilization (considering that their land acreage is limited). As such, the model of Joint Liability Group, consisting of a group of farmers who come together to avail a loan equivalent to ~30% of the pump cost from a lender (like an MFI) as also collectively contribute the 10% of the total cost due as beneficiary contribution, is being explored. ***Illustration below provides the schema for the same***.



Objective

- Reduced contribution of individual farmers thus enhancing access for the small and marginal farmers
- Enhancing capacity utilization of the pumps
- Reduced default and delinquency risks

- **Key risks**

Risk	Degree of Risk	Description
Moral hazard	LOW	The risk of farmer reselling the pump is reduced as there is joint ownership of the pump
Risk of payment delay and default	MODERATE	The risk of delay and default in loan repayment is significantly reduced due to JLG based ownership (this has been a very effective mechanism for scaling up micro-finance and SHG financing)
Limited uptake with small/marginal farmers	LOW	Due to the JLG construct, the upfront contribution of 10% is reduced thus, enabling small and marginal farmers to adopt solar pumps at scale

- **Conditions for feasibility**
  - Economic feasibility in areas where farmers completely or partially rely on diesel pumps

- **Conditions for scalability**
  - Capacity building support for optimal use of solar pump by the farmer group
  - Adequate after sales service network for farmers for operating, maintenance and replacement needs
  - Farmer awareness programs in context of benefits to farmers by using solar pumps instead of a mix of electric and diesel pump or solely diesel pumps

Model 2: DISCOM-led avoided loss basis with sale of excess power

- **Description**

Currently, DISCOMs report significant losses (ranging from INR 6-9/unit onwards depending on the state) in supplying power to the agricultural consumers, owing to the subsidized cost of electricity for such consumers. A recent 'Average Cost of Supply' study of a rural feeder in Uttar Pradesh supported by Shakti Sustainable Energy Foundation revealed the same as being in the range of INR 8.1/unit onwards (with one particular area being at INR 19.34/kWh). Thus, there is a vested interest for DISCOMs to explore solar pump interventions to cap these losses and possibly define a comprehensive transition path. In some of the states, DISCOMs are implementing /piloting solar pump installations wherein DISCOM is procuring the pumps paid primarily through its own resources (e.g. in case of recent Maharashtra tenders, this is enabled through a cess of INR 0.10/unit on C&I customers of the DISCOM) with the beneficiary contribution limited to 10% of the pump cost.

This approach is also deemed quite pertinent since many of the states are uncertain of the extent of subsidy commitments they can make (as their share to the KUSUM allocations from Centre) on regular basis for supporting the targets under the KUSUM scheme.

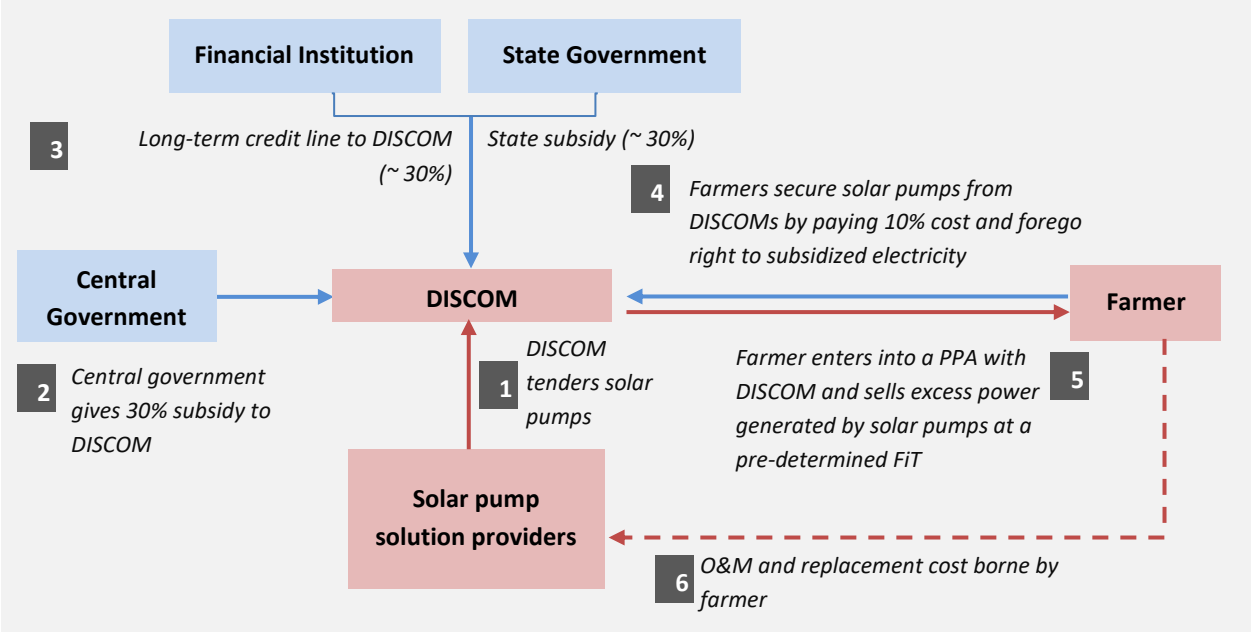
This model is best analyzed on an avoided-loss basis for the DISCOMs. To scale the intervention, DISCOMs can raise the necessary financing through a long-term credit line which can be serviced from the avoided costs/losses and/or through cess levied on other DISCOM consumers. This will enable DISCOMs to provide solar pumps to the farmers for their irrigation needs in lieu of grid connected electric pumps.

- **Objective**

Enable a market-based model of solar pumps by:

- Reducing DISCOM's operating losses associated with supplying electricity to the agriculture sector
- Increasing farmer savings (income) and promoting judicious use of water by enabling sale of excess energy to the grid

- **Schema**



- **Key risks**

Risk	Degree of Risk	Description
Delay risk of DISCOM	MODERATE to HIGH	Given the poor financial health of most DISCOMs in India, there is a high risk of payment delays for the financial institution providing long-term credit to DISCOMs
Moral hazard	HIGH	Due to limited farmer contribution, a moral hazard may arise with the risk of farmer
Limited uptake with small/marginal farmers	LOW	Since most farmers in India are in the small/marginal category[9], giving even 10% cost of solar pumps at one go may be a challenge for them.
Risk of payment delay to farmers for the power exported to the grid	HIGH	Given the poor financial health of DISCOM, there is a risk of payment delay from DISCOM to the farmer for the units sold by the latter to the former under the PPA

[9] Over 87% farmers operate in the Marginal (below 10 ha.) and Small (10 - 20 ha.) category, NABARD All India Rural Financial Inclusion Survey 2016-17

- **Conditions for feasibility**
  - Economic feasibility in areas where farmers rely partially (or fully) on diesel usage– over and above electric pumps due to erratic supply
  - Optimal feed-in-tariff – it should be less than variable component of the average power purchase cost of DISCOM and transmission losses, but at a level which incentivizes farmers to solarize the existing pumps and ensure judicious use of water

- **Conditions for scalability**
  - Catalytic instrument to mitigate risk of payment delay by DISCOM to:
    - the farmer (with respect to the feed-in-tariff)potentially the payment concerns of financial institution lending to DISCOM (with respect to the long-term loan); can only be addressed as part of larger DISCOM bankability reforms
  - Adequate after sales service network for farmers for operating, maintenance and replacement needs
  - Farmer awareness programs in context of benefits to farmers by using solar pumps instead of a mix of electric and diesel pump or solely diesel pumps
  - Awareness programs for the DISCOMs in terms of benefits to them under this model so as to encourage them to participate and increase their willingness to prioritize this scheme

- **Financial feasibility: Scenario analysis**

Considering DISCOMs incur high losses (considering average cost of supply being ~INR 6.4/unit++), an analysis has been undertaken to gauge the case for DISCOMs to fund the procurement of pumps (up to 30% of costs) beyond the state subsidy and CFA under the KUSUM Scheme; thus creating a model predicated on avoided loss from supplying to agricultural users. The analysis indicates that the levelized cost of electricity for a solar pump is in the range of INR 6.4 to 7.5/ unit, thus making a case for DISCOM to explore the option.

As was illustrated in table 4 earlier in this document, for a farmer contributing only 10% of the total pump cost, the effective cost of solar pump is lower than the average agricultural tariff even without selling excess units to the grid. However, to incentivize farmers to make judicious use of water, a tariff of ~INR 1.5/ unit can be explored. For the purpose of this analysis, it was assumed that the DISCOM will fund the program through a 10-year loan at 9%.

Table 5: Payback (in years) for DISCOM based on avoided loss model for 5 HP pump irrigating 5- acre land for two seasons

		Feed-in-Tariff (FiT)		
		0	1.5	2
DISCOM Contribution	0%	1	1	1
	10%	3	6	8
	20%	4	7	9
	30%	7	11	12

Source: cKinetics analysis

Replicating the Maharashtra model

As discussed in an earlier section, Maharashtra state, under the Mukhyamantri Saur Krushi Pump Yojana is providing solar pumps to farmers (general category) at a subsidy of 90%. An analysis of the recent procurement in Maharashtra indicated that DISCOM could fund up to 80% of the pump capex (supported by a cess levied on the C&I consumers) resulting in avoided loss. The payback for the discom considering a mix of 3 HP and 5 HP pumps (in the ratio of almost 30: 70 in line with the procurement undertaken) is indicated below. The 3 HP pump is expected to be deployed for irrigation of 2.5 acre fields whereas the 5 HP pump is assumed to be do so for a 5 acre field.

Table 6: Payback for DISCOM on avoided loss model at 80% contribution and cess collection from C&I consumers

	Payback
1 Irrigation cycle	5.2 years
2 Irrigation cycle	4.9 years

Source: cKinetics analysis

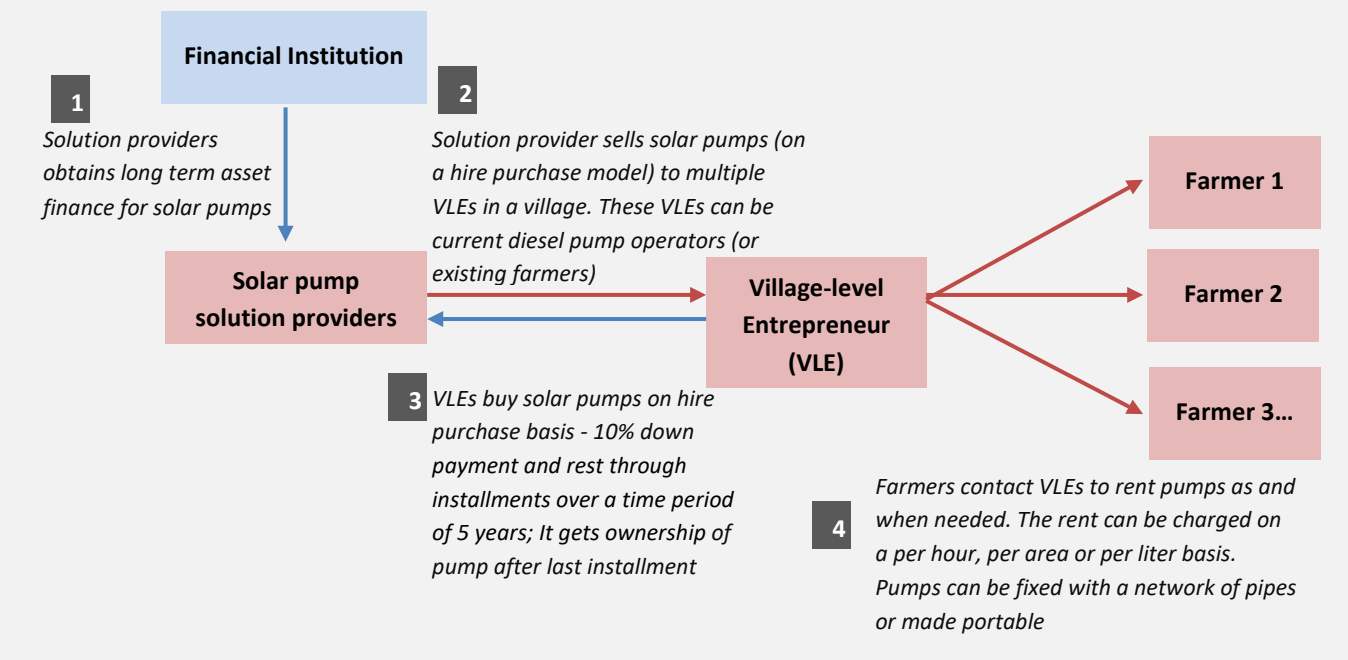
Model 3: Irrigation-as-a-Service

- **Description**

  The model is focused on providing water for irrigation through solar pumps instead of directly selling solar pumps. In this model, a solution provider sells solar pumps (perhaps without government subsidy) to village-level-entrepreneurs (VLEs), possibly current diesel pump operators, on a hire purchase basis. The service provider, i.e. the VLE, then sells irrigation as a service to farmers by allowing them to rent the pump (pricing of which could be based on different models – either on time or water consumed; latter is the case when the VLE uses his/her own tube well as source of water). The pump can be fixed at a location with a network of extended pipes or it can be made portable.

- **Objective**
  - Market expansion to include small and marginal farmers who do not own pumps currently and fulfill irrigation needs by renting diesel pumps; in most cases, these farmers cannot afford the upfront investment needed for a solar pump (even at 5-10% of the cost), diesel pump or getting the electricity connection
  - Promote judicious use of water with the pricing being done on consumption basis
  - Create a market-based model for expansion of the solar pumps segment and reduce government subsidy on solar pumps

- **Schema**



- **Key risks**

Risk	Degree of Risk	Description
Payment delay/default risk of VLE	HIGH	The business model is dependent on the business acumen of the VLE and hence there is high probability of default and delay risks for the solution provider offering the pumps on hire purchase.
Credit risk of solution provider	MODERATE	Cash flows of the solution providers are linked to those of VLEs. These factors increase credit risk of the borrower for the financial institution providing asset finance to the solution provider

- **Conditions for feasibility**
  - Requirement of long-term debt for solution providers at concessional terms
  - Applicable in areas where there are mostly small and marginal farmers who rent a diesel pump to meet their irrigation
  - There is availability of surface water (especially in case solar pumps are mobile) which can be used for irrigation

- **Conditions for scalability**
  - Catalytic instruments to incentivize lenders to provide long term asset finance to solar pump solution providers so as to reduce credit risk
  - Adequate after sales service network for VLEs/farmers for operation, maintenance and replacement needs
  - Enabling access to finance for VLEs to make the down payment (if necessary)

- **Financial feasibility analysis**

  It is foreseen that a VLE may seek a threshold income of around INR 150,000 p.a. Further, the typical rental charges for diesel pumps range INR 100-120 per hour hence the solar pump VLE is assumed to offer the same service at a rental of INR 90/hour.

  The table below highlights that such models need high utilization (in excess of 60~65%) to frame requisite interest from the VLE.

Table 7: Annual income of the VLE in the first year of operation at different utilization and rental

Rental per hour	% Utilization of solar pump					
	50%	60%	70%	80%	90%	100%
50	19,413	40,675	61,938	83,200	104,463	125,725
60	40,675	66,190	91,705	117,220	142,735	168,250
70	61,938	91,705	121,473	151,240	181,008	210,775
80	83,200	117,220	151,240	185,260	219,280	253,300
90	104,463	142,735	181,008	219,280	257,553	295,825
100	125,725	168,250	210,775	253,300	295,825	338,350
110	146,988	193,765	240,543	287,320	334,098	380,875
120	168,250	219,280	270,310	321,340	372,370	423,400

Source: cKinetics research

Assessing attractiveness of the models: Barrier-solution matrix for solar pumping segment

Challenges	Small/marginal farmers reluctant to purchase solar pumps due to limited usage or inability to give upfront equity (even 5-10% of cost of pump)	Uncertainty around phase/out continuation of subsidies leading to concerns on sustained demand	Lack of mobility of solar pumps impacting adoption on fragmented land holdings	Lack of adequate collateral with solution providers inhibiting access to debt	Delay in disbursement of subsidy leading to challenges in cash flow management	Lack of scale in private sector models	Low bankability of end-consumers	Unsustainable use of groundwater	Low farmer income
Solutions	> Reducing individual contribution by purchasing in a JLG > Irrigation-as-a-service to enable small/marginal farmers to rent solar pumps on need basis without capex > Incentivize small farmers to adopt solar pump by enabling sale of excess power to grid	> Limiting reliance on government subsidy via alternative financing mechanisms	> Irrigation-as-a-service so as to schedule irrigation where required	> Instruments to mitigate credit risk of lenders	> Limiting reliance on government subsidy via alternative financing mechanisms	> Market expansion to include small/marginal farmers; currently, subsidy accessed largely by mid/large farmers	> Hire purchase of solar pumps by farmers from solution providers	> Incentivize sustainable irrigation practices by creating alternate usage	> Creating an additional income source through sale to the grid
Model 1: JLG	✓					✓		✓	
Risk mitigation instruments required	> Bridge financing and working capital loan linked to specific orders								
Model 2: DISCOM led avoided cost with sale of excess energy	✓	✓			✓	✓		✓	✓
Risk mitigation instruments required	> Bridge financing and working capital loan linked to specific orders > Payment security mechanism to mitigate risk of payment delay from DISCOM to farmers								
Model 3: Irrigation-as-a-Service with Hire Purchase for VLE	✓	✓	✓		✓	✓	✓	✓	
Risk mitigation instruments required	> Credit guarantee mechanism for financial institution providing asset financing to RESCOs								

3 Capital landscape: Demand and Catalytic instruments to plug the gap

3.1 Demand Outlook: Estimated Capital demand by 2022

Substantial capital demand is foreseen for the solar pumps segment emanating from the increased government push due to schemes such as KUSUM. While it is uncertain if states can add subsidy beyond the 60%, as has been designed in the current KUSUM scheme, it is clear that with the roll-out of the scheme, there would be high demand for working capital and bridge financing (linked to specific orders).

In addition, with newer business models such as Irrigation-As-A-Service being tested, there also is likely to be a need of ~USD 75-100 million for asset financing by 2022 (as indicated in the figure below).

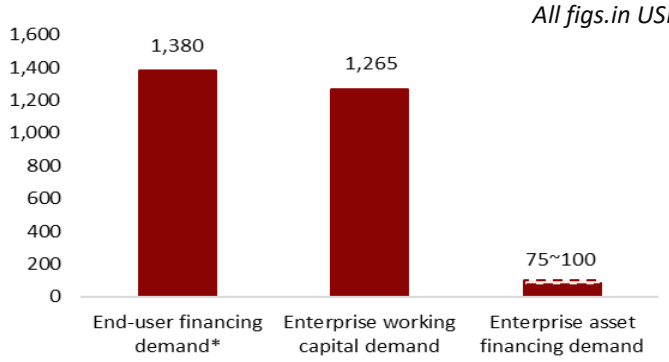


Figure 3: Annual capital needs by 2022 for solar pumps segment

Source: cKinetics' research

***Includes bridge financing for subsidy**

In addition to the increasing working capital needs of the sector, bridge financing needs of the sector are expected to increase as well due to increased public procurement market and related challenges of delay in subsidy disbursal. Therefore, catalytic instruments such as the bridge financing loan will enable enterprises to manage delay in subsidy disbursal and also enable them to increase their catchment. Further still, a Payment Security Mechanism will help secure lenders and provide the required guarantee to cover the delay in subsidy disbursal.

The following section outlines the instrument design to catalyze solar pumps segment.

3.2 Design of catalytic instruments

Solar pumping sector has received an impetus due to the KUSUM scheme. Driven by various state schemes in addition to the KUSUM scheme,

Bridge Financing Loan

Challenge being addressed: Several of the DRE products entail a government subsidy to allow for attractive economics. The process for processing and release of subsidy is time consuming even after the project has been approved.

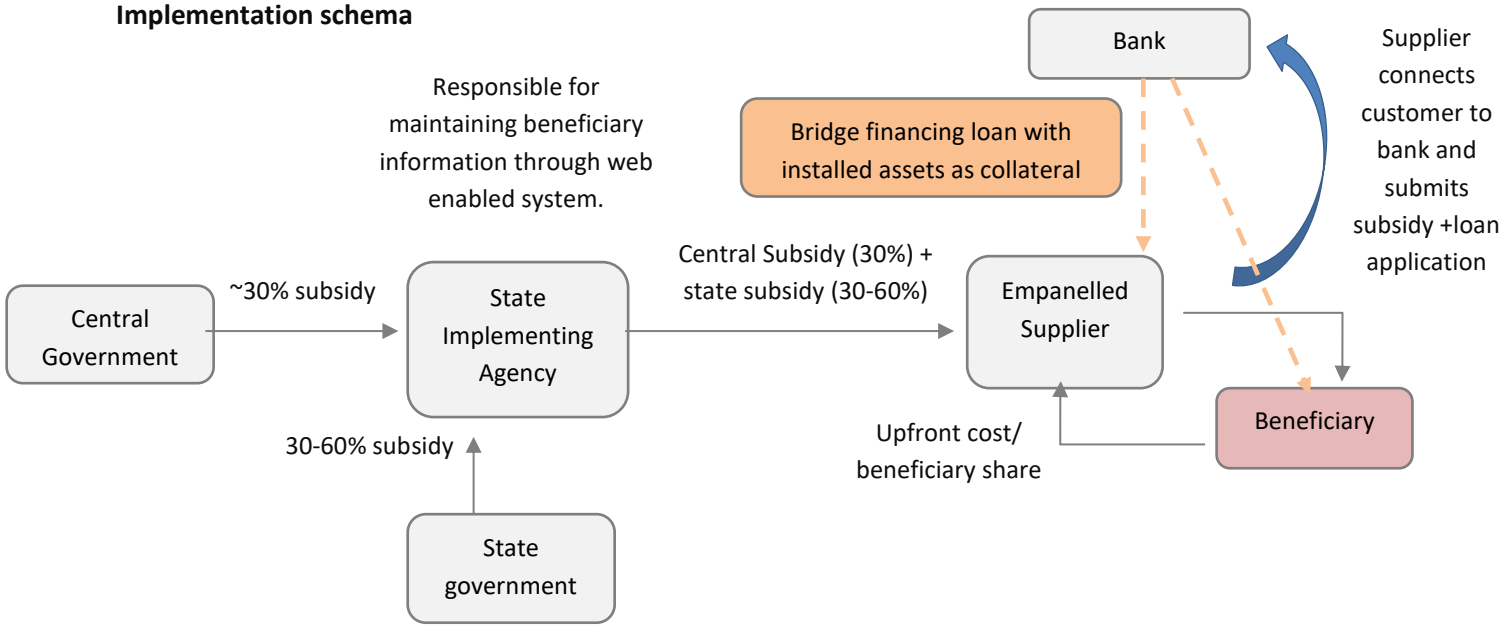
- Even as KUSUM envisages 60% subsidy, delay in disbursal of subsidy will be a major deterrent if the beneficiary is expected to organize for the bridge financing.
- On-ground experience indicates that it typically takes about 18 months for the entire subsidy amount to be disbursed after the installation has been completed.

Product: Corporate level loan with tenure of up to 18months and interest: 11~12% p.a.; bullet repayment structure

Piloting the instrument

- Leverage the current (though limited) NBFC portfolio to get banks to closely engage and understand the borrower performance and preparedness towards subsidy-oriented bridge financing product at scale
- May require guarantee /payment security to enhance scale of funding and lines to larger number of DRE enterprises

Implementation schema



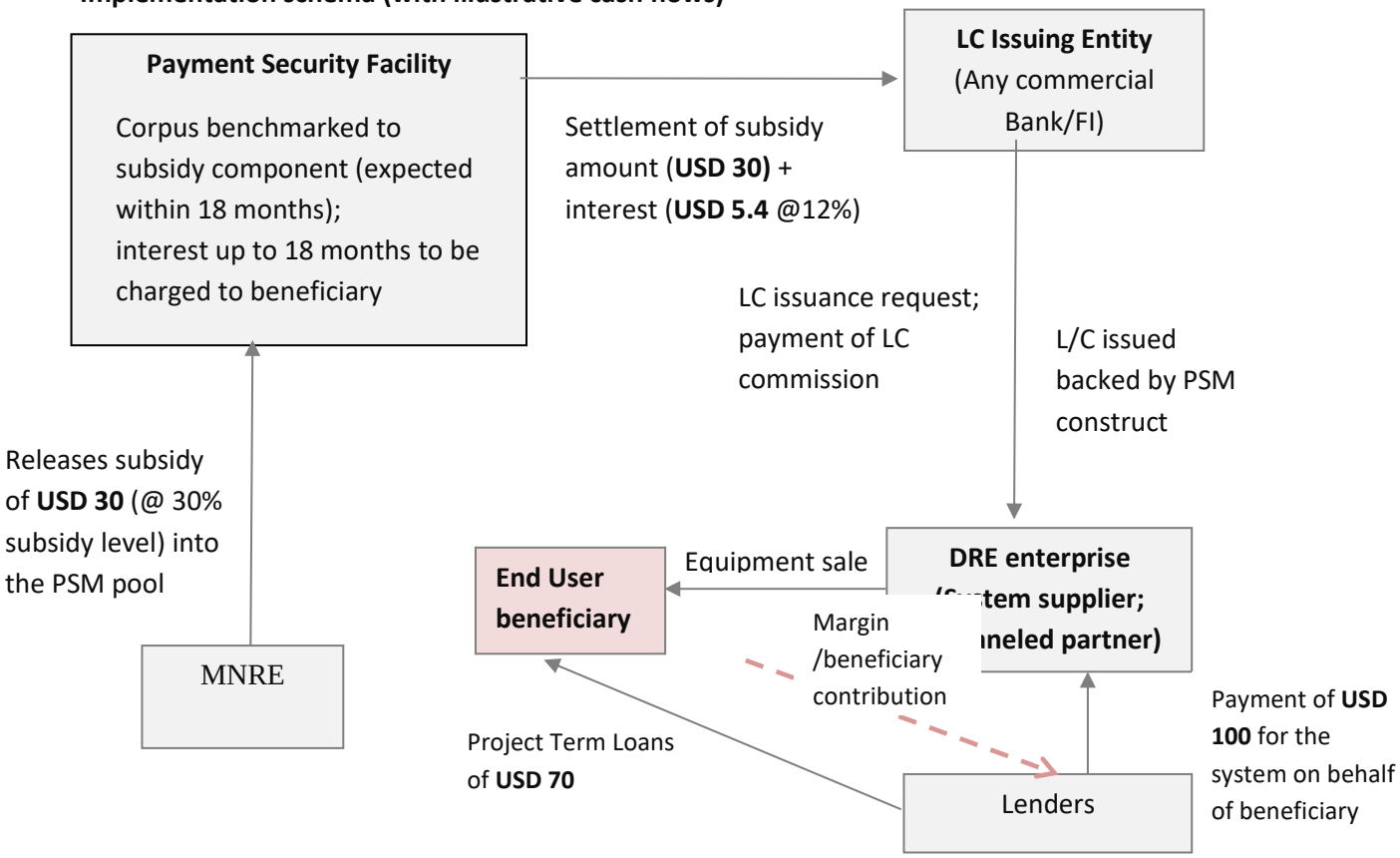
Payment Security Facility for catalyzing bridge financing for subsidy capital

Challenged being addressed: To catalyze large scale bridge financing to subsidy linked projects

Product: Payment security facility (PSF) established to protect lenders offering bridge financing for subsidy component

- Non-fund-based facility operated via a Letter of Credit (LC) mechanism as payment security for projects where in-principle sanction for the subsidy has been received and bridge financing loan is being sought
- PSF to cover up to 18-month bridge financing loan

Implementation schema (with illustrative cash flows)



The diagram above shows an illustration on the Payment Security Facility for a product priced at USD 100 and eligible for 30% subsidy by the Government.

Scheme structure

1. The payment security mechanism will entail setting up a 'Payment Security Fund' (PSF). Given the connect with the govt. schemes, perhaps an institution like SECI, SIDBI, IREDA or NABARD maybe best suited to house this.
2. The PSF shall be funded by grants sourced from Govt. of India (MNRE) and other sources.
3. The proposed structure is based on an expected cycle of 18 month bridge financing support. This will ensure the end beneficiary is not burdened to bring in additional margin

4. Pursuant to the approval, the DRE enterprise can access a line of credit from any commercial bank which gets backed by the PSF.
5. The proposed PSF will provide a contingent support in the form of 'First Loss Capital Support' to the LC issuing entity in case of subsidy delay from the govt. beyond the 18-month period. The LC issuing entity could be any commercial Bank/FI.
6. The subsidy flow can be channeled in a coordinated fashion with the PSF thus ensuring the commercial banks interests' are well covered.
7. The host institution would screen the applications from the different enterprises based on the approved scheme criteria and approve the ones deemed as relevant to the scheme. Host institution maybe compensated via management fees.

Piloting the instrument

- Will require the facility to be setup; engagement with MNRE[10] foreseen as a critical pre-requisite
- Private contribution /commitment to this needs to be clearly demonstrable for engagement with MNRE
- The PSF uses an expected sizing approach that calculates the Expected Loss based on portfolio mix of loans to RESCOs, weighted average Probability of Default of the loans and the Loss Given Default.
    - The covered loan product would be a 5 to 10 year product, depending on the segment (with moratorium of 6 to 12 months depending on the segment) @ ~12% p.a.
- Enterprises will have to furnish performance guarantee from technology supplier(s)

[10] Ministry of New and Renewable Energy, Govt. of India

4 Implementation Pathway

It is clear that Solar Pumping is likely to be game-changer for the Decentralized Renewable Energy landscape of the country however the sector's potential can only be effectively tapped if the emerging enterprises are appropriately supported. Given the industry structure and currently visible pathway for scale, it will be critical to enable:

i) new business models and approaches to enable scaled-up uptake at the farmer level
ii) financial product(s) that are aligned to the needs of the sector, specifically:
   - Working capital and/or inventory financing of System Installers as also Distribution enterprises
   - Enterprise level asset financing for RESCO and PAYG models etc.
   - Retail/ consumer financing for the cases where farmers want to avail of loans and procure the pump on their own
iii) risk mitigation mechanism that can motivate the lenders to engage in this fast-emerging sector

In this context, given the dependence on subsidy release and the 10x scale envisaged in the sector over next 4 years, Ministry of New and Renewable Energy (MNRE) as the Nodal agency could help pilot the **Payment Security Mechanism** on the lines discussed in the previous section. ***A preliminary analysis reveals that even with a modest corpus of USD 20 mn aimed only as a liquidity backstop can support implementation of at least 150,000 pumps over the next 3~ 4 years (considering no more than a 1:2 leverage at any given period of time).***

Even with this support in place, the system installer enterprises will bear a cost of around 3~4% on account of working capital due to typical 8~14 month delay (depending on the state) in full receipt of the receivables however this setup will help them enhance their access to working capital lines as also help them judiciously rotate their retention money etc. while scaling up their operations across multiple govt. tender awards.

If this setup works well, rather than MNRE scale this up by itself, MNRE could help evolve mechanisms which enable the projects completed by System Installers to be deemed as 'qualified' as factored receivables. This could be then covered under the Credit Guarantee Fund Scheme for Factoring implemented by National Credit Guarantee Trustee Company Ltd. for MSMEs thus creating a scalable model for system installers to get their working capital lines released and redeployed for newer projects.

In terms of financing of beneficiary (farmer) owned models, credit linked subsidy scheme channeled through NABARD and /or an entity such as Rural Electrification Corporation (REC) implemented on ground through network of RRBs, Small Finance Banks etc. represents a good structure. The challenge typically expressed in this case is the fear of credit defaults due to expectation of loan waivers. Hence to adequately cover banks /NBFCs against this, a credit guarantee mechanism is deemed a critical pre-requisite.

Similarly for piloting newer models such as Irrigation as a service and /or those entailing lease financing, a broader credit guarantee mechanism with a first loss pool in place is deemed a pre-requisite to get financiers (Banks and NBFCs) to support financing at scale. MNRE could take a lead on this and help

establish a pilot facility on lines of the Credit Guarantee Mechanism planned for rollout under the US-India Catalytic Solar Finance Partnership.

Clearly the solar pumping could emerge as the next big segment in the Renewables landscape in the country but requires that pre-requisites of success, as garnered from past implementations, are appropriately and comprehensively put in place to ensure different stakeholders are aligned and able to collectively deliver on the potential and country's defined targets.

Annexure 1: Innovative business models tried in the past

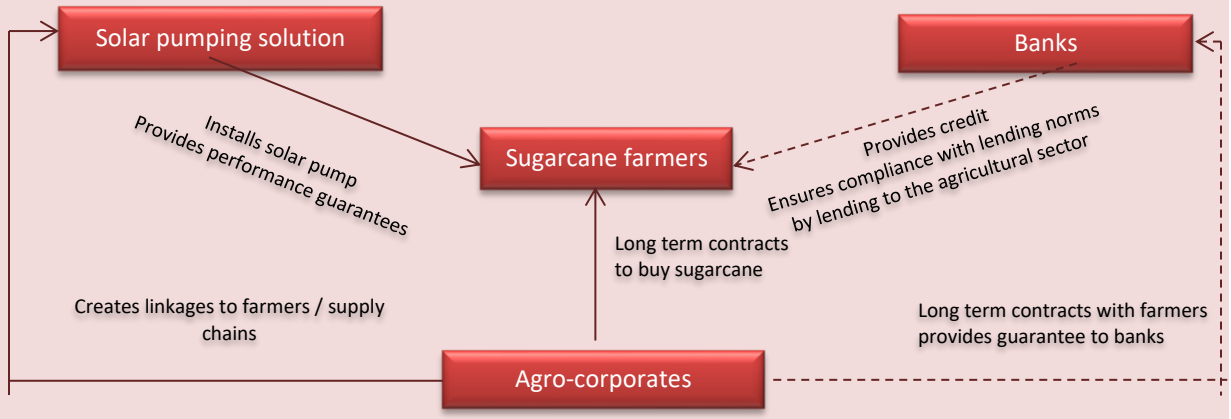
Pure Agri – capex financing model Installation of solar pumps primarily supported by government capex subsidies	
Ownership of pumps: Farmer	**Case study:** Most of the current installations in the solar pumping segment are under this model. Government subsidies are as high as 50%+ in many states, varying by region and size of the pumps. For example, 6,725 pumps were installed in FY2015 under Andhra Pradesh government's solar pump subsidy of ~85%. In Chhattisgarh, ~18,500 pumps have been installed till January 2018 under its Saur Sujala scheme with 95-98% solar pump subsidy.
Role of solution provider: System installer and maintenance for a specific period	
Financing mechanism: Partly by government subsidy and rest of the payment by farmer	

Gold Farm's ecosystem-based approach

As a different approach under the pure Agri – capex financing model, a particularly interesting use case has been in execution by a company, Gold Farm (fka Surya Power Magic), engaging corporate sugar producers to facilitate deployment of these pumps for the farmers in their supply chain.

Gold Farm is a developer of low-cost, efficient agricultural solar water pumps in India. The company is currently operating in Tamil Nadu and has 6 offices – 1 HQ + 5 Branch offices. Among the solar pumping solutions prevalent in India, they have a unique positioning as the "distribution and execution specialists" within the sugarcane farming industry, where they have adopted an ecosystem-based approach, simultaneously engaging with farmers, technology providers, banks and sugar manufacturers / other agro-based corporates (as illustrated in the figure below).

Figure 4:Approach of Gold Farm (Surya Power Magic): Moving the entire ecosystem together



The biggest roadblock to sugar cane cultivation is insufficient power for lift irrigation, due to which there is *insufficient sugarcane farming in India. As a result of that, private sugar mills in India suffer from idle capacity of 30% - 35%. Therefore, there is an economic incentive for sugar mills to bring more land under cultivation and for farmers to increase their sugarcane yield. Given this context, Gold farm provides farmers reliable, durable and scalable access to electricity for irrigation, through solar water pumps. It empowers the farming community to take up irrigation independent of the grid, with and access to a reliable water source and engages Banks and large agro-based corporates to facilitate mass adoption of the solution.*

Irrigation-as-a-Service model

In Irrigation-as-a-Service (IaaS), aka pay-per-use irrigation services, the farmers do not make capex investments on solar pumps but pay only for use of the pumps. This is an efficient model for small-medium sized farmers who do not have willingness/ability to invest in solar pump purchase

Ownership of pumps: Irrigation service provider: RESCO (solution provider) or village entrepreneur **Role of solution provider**: Irrigation service provider (if no village entrepreneur) or project developer **Financing mechanism**: Loan from banks with long-term contracts with corporates as bank guarantee	**Case study:** **Claro Energy -** primarily a system integrator that sources and integrates solar pumps and deploys under the government tenders – had started a pilot for IaaS model utilizing a USD 500,000 grant from USAID's Powering Agriculture Initiative in September 2015. It has assembled a portable solar pump. The farmer calls a toll-free line, pre-pays and schedules irrigation. Claro currently services about 30-40 farmers per day[11]. It can be potentially move to a model where villagers can become local irrigation service providers. **International Water Management Institute (IWMI), Tata Power Solar and Agha Khan Rural Support Program (AKRSP)** had initiated a pilot in Chakhaji village in Bihar on an IaaS model. Villagers as Solar Irrigation Service Providers were supplied with large solar pumps (partly subsidized and partly as loan). These service providers thereby offer pay-per-use irrigation to farmers charging on a per hour basis (one service provider reported servicing about 100 farmers at INR 90 per hour[12]). Since the service providers work in competition with each other, the prices are also low. This has enabled high reduction in diesel pump usage in the village. Due to erratic power supply (available 4-5 hours/ day), the farmers were largely reliant on diesel pumps that proved expensive.

Excess power to grid model

Farmers are provided solar pumps by the government at a subsidized rate. They sell the excess power from the solar pump to the DISCOM under a PPA at a feed-in-tariff.

Ownership of pumps: Farmer **Role of solution provider**: System installer **Financing mechanism**: Capex partly subsidized by government subsidy; farmer may need to arrange financing for the remaining portion or there may be a loan component from the government (loan can be paid off via payments for excess power received from the DISCOM)	**Case study:** Under the **Surya Raitha Scheme** launched by the Karnataka Renewable Energy Development Agency in the state, the farmers are provided solar pumps at a subsidized cost and sell excess power generated to the DISCOM. The farmers need to pay only 10% upfront cost, with the remaining 90% as a combination of subsidy and interest-free loan from the government. Solar pumps installed are 1.5 times the capacity of existing pumps to enable excess generation. The DISCOM purchases power at INR 78/unit if subsidy is not availed and INR 63/unit if subsidy is availed. Part of the payment from DISCOMs to the farmers is adjusted towards paying off the debt. As a variant of this model, **a farmer co-operative** has been formed under a program in Gujarat. The co-operative - Solar Pump Irrigators' Cooperative Enterprise (SPICE) - constitutes of 6 farmers in Dhundi village in Gujarat. It has entered into a PPA with Madhya Gujarat Vij

[11] https://poweringag.org/innovators/low-cost-pay-use-irrigation-using-solar-trolley-systems
[12] https://www.thehindubusinessline.com/specials/india-interior/solar-powered-irrigation-in-bihars-samastipur-helping-farmers/article23005940.ece

	Company Limited – the state DISCOM for sale of excess power generated via solar pumps at a 25-year PPA. The farmers pool their surplus and have to forego their right of subsidized power from the electricity grid. The DISCOM offers a FiT of INR 4.63/kWh, with an additional INR 2.5/kWh provided by IWMI and CAFS (CGIAR programme on Climate Change, Agriculture and Food Security) as additional incentives. The 6 farmers together reported earning INR 3,64,000 from sale of excess power to the DISCOM[13]. The farmer made marginal capex investment for the pumps, with the rest being grant funded by IWMI and its partners. However, the new farmers joining SPICE seems to be willing to contribute up to 40% of total investment.

The table below compares the different business models discussed above on a variety of parameters so as to analyze the key advantage/disadvantages associated with each.

Factors	Government-subsidy driven	Agro-corporate driven	Irrigation-as-a-Service	DISCOM-driven	Catalyst/Donor-driven
Reduces farm power subsidy burden	✓✓✓✓	✓✓✓✓	✓✓✓✓	✓✓	✓✓✓
Incentivizes farmers for energy and groundwater conservation			✓✓✓	✓✓✓✓	✓✓✓✓
Increases farmer's income[14]	✓	✓	✓✓	✓✓✓✓	✓✓✓✓
Replicable and scalable	✓	✓✓	✓✓✓	✓✓✓✓	✓✓
Enables inclusion of small-mid-sized farmers	✓		✓✓✓✓	✓✓	✓✓

[13] Tushaar Shah, Neha Durga, Gyan Prakash Rai, Shilp Verma, Rahul Rathod, Promoting solar as a remunerative crop, November 2017

[14] Via direct sale of water, increased farm output and/or sale of excess electricity to DISCOMs

Annexure 2: Overview of Subsidy allocations

All-India solar pump subsidy estimation

Year	2013-14	2014-15	2015-16	2016-17	2017-18
All India	-	2083.70	6,073.58	12,655.55	15,219.27

State-wise subsidy estimation

State	2014-15	2015-16	2016-17	2017-18
Andhra Pradesh	492.80	1631.62	1002.67	25019
Karnataka	69.61	792.16	149.26	202.49
Chhattisgarh	770	00	1367.53	4802.63
UP	00	00	886.57	3.58
Rajasthan	6174	2149.38	13232	36.76
Punjab	3759	00	00	00
Maharashtra	00	3.55	192.81	176.18
Tamil Nadu	00	00	130.75	00
Bihar	00	619.44	355.39	00
Telangana	1540	00	65.30	00
Haryana	1540	00	00	95.82
Madhya Pradesh	144.15	264.73	713.26	559.46
Odisha	00	583.78	871.25	209.34
Jharkhand	00	00	1030.98	142.79
Gujarat	00	28.90	824.18	00
West Bengal	00	00	95.56	00
Arunachal	00	00	0.63	00
Kerala		0	0	19
Others (Balance)		0	0	37

Actual subsidy release data [15]

Scheme	Nodal agency	Units	Rs million	Year
Off-grid and decentralized PV application	UPNEDA	567	47.24	2014-15
	RRECL	4280	527.58	2014-15
	UPNEDA		3.84	2014-15
	DNRE		390	2015-16
	GEDA		61.236	2015-16
	UPNEDA	6,000	186.4	2015-16
	RRECL	7500	346.2	2015-16
	MEDA	2460	92.947	2015-16
	HAREDA	3050	136.323	2015-16
	NREDCAP	10,000	486	2015-16
	GEDA	2300	111.78	2015-16
Capital Subsidy Scheme	NABARD	1,569	90	2017-18
	NABARD	2049	607.1	2016-17
	NABARD	781	96.8	2015-16
	NABARD		59	2014-15
	Total		**2,039**	

[15] https://mnre.gov.in/file-manager/UserFiles/projects-sanctioned-under-offgrid-and-decentralised-solar-programme-during-2015-16-as-on-313.2016.pdf
https://mnre.gov.in/sites/default/files/uploads/Claim-recived-offgrid-decentralised-JNNSM.pdf
http://164.100.47.193/lsscommittee/Energy/16_Energy_39.pdf
https://www.nabard.org/auth/writereaddata/tender/0908181051NABARD-AR_2017-18%20English.pdf

Annexure 3: Details of policies/schemes for solar pumps in India

Government policy/ scheme	Nodal agency	Status of policy/ scheme	Year of Inception	State/ Central	Geography of focus	Objective	Target	Subsidy	Other Nuances	Achievements
Kisan Urja Suraksha Evam Utthaan Mahaabhiyan (KUSUM)	MNRE	Draft	2018	Center	Pan-India	Incentivize farmers to run solar farms and water pumps for generating solar power for extra income	28.25MW solar power over 10yrs: a) 10GW solar generation on barren farm lands b) 1.75 mn pumps c) solarization of grid-connected farm pumps 7.25GW (sell surplus solar power to DISCOM) d) solarization of tube-wells 8.25GW	60% for solar pumps (30% MNRE and 30% states)	No subsidy for solar farms but 50 paise/unit for buying power from farmers for 5 years; In solar pumps, 10% upfront by farmer and 30% debt to farmer	NA
Scheme for Solar Pumping Program for Irrigation and Drinking Water (under Off-grid and Decentralized Solar Application Scheme)	MNRE; Carried out via State Nodal Agencies[16]	Final	2012	Center	Pan-India	Subsidize solar pumps to: a) Develop models to foster scalable deployment of solar power for pumping in rural areas; b) Address and support rural development, over and above basic service of water; c) Energy access	1 million solar pumps by 2021	Below 3HP 25%; 3-5HP 20%		
CFA for Solar Pumping (part of Scheme for Solar Pumping Program for Irrigation and Drinking Water)	MNRE; carried via NABARD	Closed w.e.f March 2017	2012	Center	Pan-India	Promote solar pumps in agriculture via credit-linked-subsidy scheme	Initial target 10,000 solar pumps; later revised to 30,000 and further revised to 1,00,000 in 2015	40%	20% upfront by farmer; 40% subsidized loan from RRBs and other rural FIs	1,744 pumps till December 2016

[16] NABARD component is another implementation scheme under this. It is captured as a separate scheme as below

Government policy/ scheme	Nodal agency	Status of policy/ scheme	Year of Inception	State/ Central	Geography of focus	Objective	Target	Subsidy	Other Nuances	Achievements
Rashtriya Krishi Vikas Yojana	Ministry of Agriculture	Final	2007	Centre	Pan-India	Incentivize states to draw comprehensive plan for agriculture sector; pumps component aims to promote reliable power for irrigation by subsidizing solar pumps		State + center 75% 2HP and 50% 5HP	State is eligible only if it maintains or increases % expenditure on agriculture and allied sectors w.r.t state plan expenditure	
Andhra Pradesh Solar P V Water Pumping Programme	New & Renewable Energy Development Corporation of Andhra Pradesh	Final; Applicable FY2014-FY2016	2014	State	Andhra Pradesh	subsidize solar pumps to improve irrigation via reliable power	10,000 in 2016-17	3HP 86%; 5 HP:85%		2014-2015 and 2015-16: 6725
Solar pump scheme Andhra Pradesh		Draft	2018	State			NA	3HP 82%	Only areas where ground water is within 75mts	
Bihar RE policy	Bihar Renewable Energy Development Agency	Draft	2017	State	Bihar	Improve irrigation access	10,000 pumps by 2022			
Bihar Saur Kranti Sichai Yojna		Closed; 2012-13	2012	State		Subsidize solar pumps to improve irrigation via reliable power	2,85,000 pumps over 2012-2017 (phase 1 pilot 2012-13: 560 pumps)	90% (40% MNRE + 50% state)		527
Mukhyamantri Navin & Navnirman Urja Yojna		Final	2016	State			3,300 pumps till 2021-22 (2016-17 target 1,000)			993 (2016-17)
Saur Sujala Yojana Scheme	Chhattisgarh Renewable Energy Development Agency	Final	2016	State	Chhattisgarh	Empower farmers by providing them solar irrigation pumps on subsidized rates	51,000 farmers till 31 March 2019 (including 11,000 in 2016-17)	3HP and 5HP: 95-98%		Cumulative 7,448 till FY2016, rising to 18,586 till Jan 2018
Solar Water Pumping Scheme	Haryana Department of Renewable Energy	Final (phase 1 2016-17; phase 2 2017-18)	2016	State	Haryana	Subsidize solar pumps to improve irrigation via reliable power	2016-17 – 885 2017-18 - 2,195 2018-19 - 25,000	90%		

Government policy/ scheme	Nodal agency	Status of policy/ scheme	Year of Inception	State/ Central	Geography of focus	Objective	Target	Subsidy	Other Nuances	Achievements
Surya Raitha Scheme	Karnataka Renewable Energy Development Agency	Final	2014 pilot; 2018 extended to all	State	Karnataka	a) Reduce use of conventional source in power generation – pumps to supply 1/3rd of total energy generated to the nearby grid b) promote solar energy for uninterrupted power to farmers during the day and increase farmers' earnings by enabling sale of excess electricity to DISCOMs	310 pumps in phase 1 pilot	90% (this includes part interest-free debt from DISCOM to farmer; part of payments from DISCOM to farmer for electricity used to pay-off that loan)	Pump installed 1.5 times the capacity; Government purchases power at Rs 78/unit if subsidy not availed and Rs. 63 if availed	250 5-7HP pumps in pilot phase 1
Mukhyamantri Solar Pump Yojana Madhya Pradesh	Madhya Pradesh New & Renewable Energy Department	Final (2nd phase closed April 2017; scheme applicable till FY2018)	2015	State	Madhya Pradesh	Subsidize solar pumps to: a) arrange irrigation in off-grid areas; b) reduce pollution by diesel; c) reduce financial burden on farmers by using diesel		90% below 3HP, 85% 3-5HP[17]		
Solar Pump Scheme Maharashtra	Maharashtra Energy Development Agency	Closed 2016	2015	State	Maharashtra	Subsidize solar pumps to: a) equip farmers; b) reduce power cost for industrial power consumers by reducing Agri-power subsidy burden to DISCOM	5 lakh solar pump, including 10,000 in phase 1	60% (30% MNRE; 30% state)	5% upfront to be paid by farmer; 35% loan to farmer	6,500 farmers applied but only 600 ended up paying upfront cost
Punjab solar pump subsidy Scheme	Punjab Energy Development Agency	Closed; applicable only 2013-14	2013	State	Punjab	Subsidize pumps for irrigation access	500 solar pumps	70% (30% MNRE and 40% state)		105
Punjab solar photovoltaic pump program		Final; applicable 2017-18	2017	State	Punjab	Subsidize solar pumps to improve irrigation via reliable power	2,600 solar pumps	80% (22% MNRE + 58% state)	Eligible for only 1-5HP pumps	

[17] For more than 5 HP total grant limited to that applicable for 5HP in value terms

Government policy/ scheme	Nodal agency	Status of policy/ scheme	Year of Inception	State/ Central	Geography of focus	Objective	Target	Subsidy	Other Nuances	Achievements
Rajasthan solar pumps program	Rajasthan Renewable Energy Corporation Limited	Since 2014-15 (subsidy announced for 2018-19 draft)	2014	State	Rajasthan	Subsidize solar pumps to improve irrigation via reliable power	2014-15: 2,900 2015-16: 4,702 2016-17: 7,500 2017-18: 5,000 2018-19: NA	2014-15: 70% 2015-16: 60-75% 2016-17: 60-75% 2017-18: 50-70% 2018-19: 55% 3HP and 60% 5HP (draft) (includes MNRE component)	Subsidy varies by access to electric pumps: > no additional state subsidy for farmers already using electric pumps > Highest for farmers who have applied for electric pumps and willing to surrender connection than those for farmers who have not applied for electric pumps	
Solar Pump Scheme Tamil Nadu	Tamil Nadu Energy Development Agency	Final	2017	State	Tamil Nadu	Improve irrigation scenario in the agriculture sector (about 4.3 lakh farmers waiting for free power connections, while only ~40,000 connections given every year)	1,000 5-10HP pumps in phase 1	90% (MNRE 20%, State 40%, Tangedco 30%)	Farmers to pay 10% upfront and forfeit free power connection (or application for it)	
UP Solar Pump Yojna	UPNEDA	Final; Applicable 2016-17	2016	State	Uttar Pradesh	Subsidize solar pumps to a) reduce cost of irrigation b) 24x7 power to all and c) environment conservation	10,000 pumps in 2016-17; total target 50,000 pumps till 2022	70% on 2 HP; 65% on 3HP and 40% on 5HP		2016-17: 5,458 pumps
Indirect policies/schemes impacting solar pumps segment										
Mukhyamantri Agricultural Solar Feeder	Maharashtra Energy Development Agency	To be announced officially in April 2018	2017	State	Maharashtra	Set up solar panels for supplying 12 hours power via solar-powered feeders	All farms to be brought under this by 2021; 500MW by March 2018	NA	Farmers given electricity at Rs 1.20/unit	

Annexure 4: List of FIs with available capital for solar pumps in India

Organisation/FI (Fund Name/ Programme)	Type of Investor	Type of Capital			Capital Available/ Committed (USD mn) – FY2017	Investment Size	Tenure/ Investment Horizon (years)	Rate of Interest/ return expected	Key considerations for financing
		Direct/ Enabling	Returnable/ non-returnable	Instrument					
Acumen	Impact fund	Direct	Returnable	Equity	0.6	USD 250k-3m	7-15	20-25%	> Only early-mid stage companies >Financial stability in next 3-4 years > Scalability of business model
Bandhan Bank	Commercial Bank	Direct	Returnable	Commercial Loan (ST)	3	≤USD 3m	1-7	14.5%	> Profitable at corporate level > 1:3 DSCR > 2:1 D/E Ratio > 3 years operating track record
cKers Finance	NBFC/Debt Fund	Direct	Returnable	Concessionary Debt	0.5	USD 300k-1.5m	3-9	9.5-14%	> at least 2 years operating track record > Open to non-collateral construct based on business viability and promoters experience > Proven unit level economics
Doen Foundation	Donor/ Foundation	Direct	Returnable	Quasi-Equity	0.1	~USD 300k	7-10	Capital preservation (no particular upside)	> Only companies that have passed proof of concept and closer to market introduction
Doen Foundation	Donor/ Foundation	Direct	Non-returnable	Grant	0.1		NA	NA	> Only NGOs or very early stage companies
IREDA (KfW Access to Clean Energy Programme)	DFI	Direct	Returnable	Concessionary Debt	4.5	USD 0.5-4.5m		9.75-11.5%	> 3-4 years operating track record > 40% guarantee via trust & retention account > asset backed collateral > 1.3 minimum DSCR > Latest financial statements should not be loss making and no accumulated/ accrued losses on balance sheet
IREDA (KfW Access to Clean Energy Programme)	DFI	Enabling	Non-returnable	Guarantee	0.9		NA	NA	
IREDA	DFI	Direct	Returnable	Commercial Loan (ST)	0.5			9.75-11.5%	
Menterra (Menterra Social Impact Fund)	Catalyst/ Incubator	Direct	Returnable	Equity	0.1	USD 150-650k			> Operating track record not required > Ability to be profitable and scale in future
RBL Bank	Commercial Bank	Direct	Returnable	Commercial Loan (LT)	1	USD 1-5m	3-7 years; 8-10 years under	13-15%	> 3 years operating track record > Asset-based collateral for new borrower > Promoter's guarantee

Organisation/FI (Fund Name/ Programme)	Type of Investor	Type of Capital			Capital Available/ Committed (USD mn) – FY2017	Investment Size	Tenure/ Investment Horizon (years)	Rate of Interest/ return expected	Key considerations for financing
		Direct/ Enabling	Returnable/ non-returnable	Instrument					
							USAID Guarantee		> 1.25 minimum DSCR > Quality of cash flows > Strength of balance sheet
ResponsAbility (Global Energy Access Fund)	NBFC/Debt Fund	Direct	Returnable	Commercial Loan (ST)	0.9	USD 3-4m	>3	~16%	> At least USD 1m in revenue over past 12 months > at least 2 year operating track record
Sangam Ventures	Catalyst/ Incubator	Direct	Returnable	Equity	0.3	USD 0.5-3m	8-10		> high social impact > seed-early stage > promoter's experience
USAID (PACESetter)	Donor/ Foundation	Direct	Non-returnable	Grant	0.4	USD 50-300k	NA	NA	> Early stage firm (between concept and scale-up)
USAID (Development Innovation Ventures)	Donor/ Foundation	Direct	Non-returnable	Grant	0.5	USD 25k-15m (varies by stage of firm)	NA	NA	
USAID (DCA - RBL Bank)	Donor/ Foundation	Enabling	Non-returnable	Guarantee	0.2		NA	NA	

Key TA programs for solar pumps in India

UNDP – India Access to Clean Energy Project	• In partnership with MNRE, UNDP started a program in 2015 for livelihood-based applications of DRE • Co-funded by the Global Environment Fund and MNRE, it is a USD 23 million program to be run till 2019 • One of the productive application identified under it is solar pumping for rural agriculture sector - the program aims to enable deployment of 5,000-6,000 pumps in Orissa
GIZ – IGEN-Access Program	• IGEN-Access (in continuation to IGEN-RE) was launched in 2015, to support private sector development, access to finance and public support programs for rural decentralized renewable energy sector • It aims to assist in the development and adoption of two National or State level programmes for solar pumps and biomass cookstoves. Under solar pumps, it envisions supporting the Government of India in providing power for all by 2019, installing 100,000 pumps in the next few years
US-India Clean Energy Finance Facility	• It was launched in 2016 by a consortium of US-based Foundations (Good Energies Foundation, MacArthur Foundation, Packard Foundation and William and Flora Hewlett Foundation) and the Government of India • Supports project preparation activities of enterprises in the distributed solar space to catalyze long-term debt financing for the sector • The grants are awarded over periodic rounds, where the first round commenced in 2017

Annexure 5: List of interviewees

Given below is list of stakeholders engaged in this study.

Stakeholder Type		Name of Entity	
DISCOM		• Maharashtra State Electricity Distribution Company	• Madhya Gujarat Vij Company
State Nodal Agencies		• MNRE • Punjab Energy Development Agency • Bihar Renewable Energy Development Agency • Madhya Pradesh New & Renewable Energy Department • Chhattisgarh State Renewable Energy Development Agency • New & Renewable Energy Development Corporation of Andhra Pradesh	• Karnataka Renewable Energy Development Ltd • Uttar Pradesh New and Renewable Energy Development Agency • Haryana Department of Renewable Energy • Maharashtra Energy Development Agency • Tamil Nadu Energy Development Agency • Rajasthan Renewable Energy Corporation Limited
Catalysts		• International Water Management Institute • GIZ	• UNDP • USAID
Developers		• Claro • Gautam Solar • Gold farm • Punchline Energy • Shakti Pumps	• Topsun • Rotosol • EESL • Tata Solar
FIs – enterprise financing	Equity investors	• Acumen	• Doen Foundation (non-returnable capital also)
	Debt Investors	• Bandhan Bank • cKers Finance • Canopus Foundation	• IREDA • Maanaveeya • responsibility • RBL[18]
FIs – end-user financing		• Andhra Pradesh Gramin Vikas Bank • Axis Bank • Bank of Baroda • Bank of India • Canara Bank • Central Bank of India • ESAF	• IDFC • Karnataka Vikas Gramin Bank • Madhya Bihar Gramin Bank • Pallavan Grama Bank • Pandyan Grama Bank • Prathama Bank • Yes Bank

[18] Both end user and enterprise financing

Annexure 6: Policy Landscape

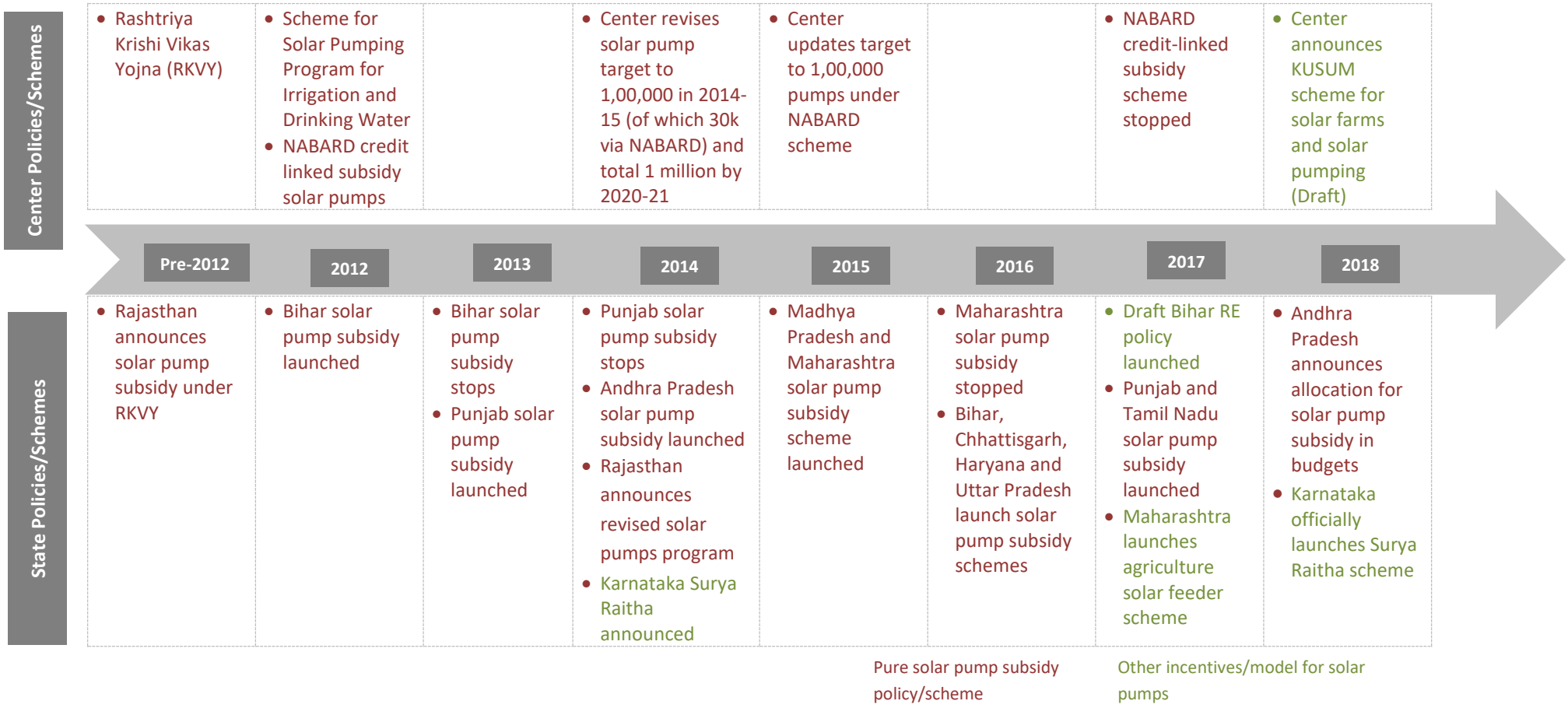


Figure 5: Center and State-level Key Policy/Scheme Developments for Solar Pumps in India