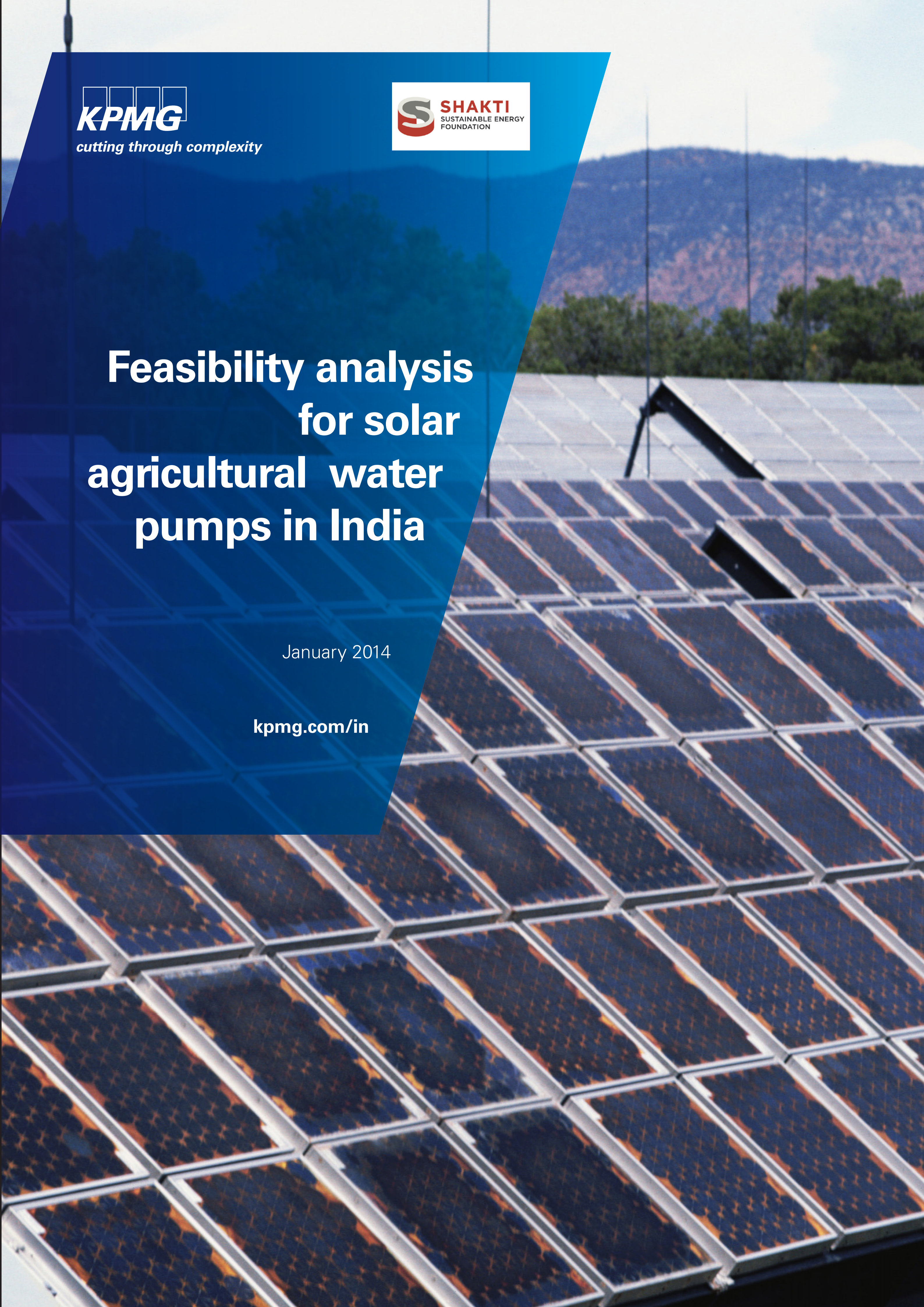

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SHAKTI SUSTAINABLE ENERGY FOUNDATION

Feasibility analysis for solar agricultural water pumps in India

January 2014

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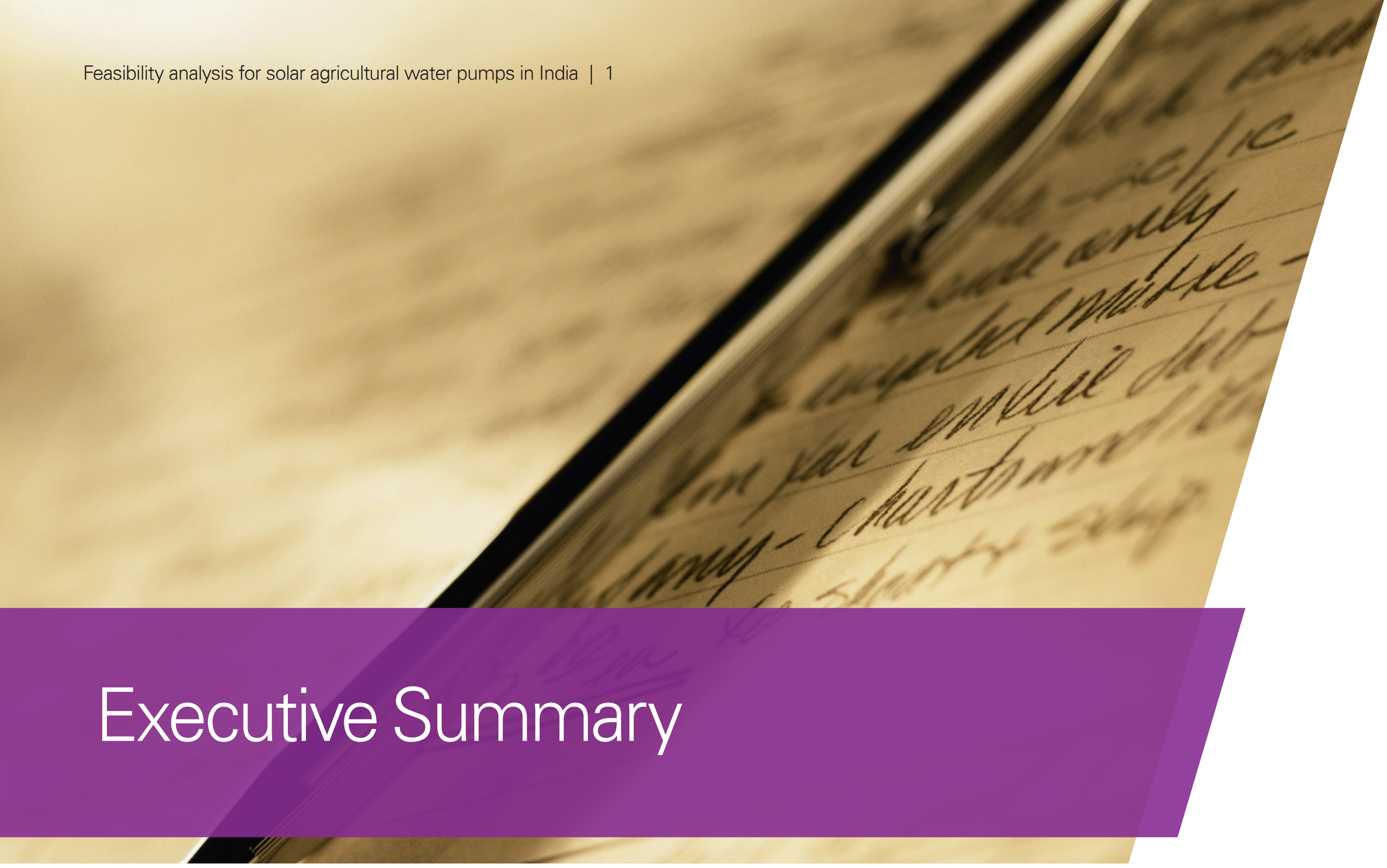
Annex 1:
Replacement Potential of solar agriculture pumps in Eastern States of India



Executive Summary

Agriculture in India contributes to 15% of the GDP and employs 50% of the country's workforce. Reliable irrigation, therefore, is a critical requirement not just for the farmer but also for the nation.

As a result, India today has around 19 million grid connected pump-sets and 7 million diesel pump-sets. However, erratic grid supply and high cost of diesel pumping continue to remain problem areas for the farmers. Poor irrigation as a result of these issues results in significant yield losses. While a scientific assessment on yield loss due to poor quality of irrigation has not been done, a high level sample survey of farmers reveals that farmers feel that the crop yield could easily improve by 10% if required volume of water is available when required. 'International Water Management Institute (IWMI) and TATA Water Policy Research Program' has been assessing the benefits of solar water pumping in Bihar and has highlighted the crop yield improvements expected due to timely and adequate water availability for irrigation .

India uses more than 4 billion litres of diesel and around 85 million tons of coal per annum to support water pumping for irrigation.

Current economics indicate an IRR of 10% for replacement of diesel pumps with solar pumps without factoring in crop yield improvement benefits due to water availability on demand. Considering even 10% yield benefit, the IRR would be 19%.

However, the upfront cost of a solar pump (say, 2.2 KW) is about ten times of a conventional pump (Rs 3.5 lakhs vs Rs 30,000) and hence it requires capital subsidy and financing support. Capital subsidy level required today is around 70% (Rs 2.5 lakhs for a 2.2 KW pump), which translates into a market potential of ~26 lakh pumps (Detailed calculations are shown as a part of the annexure). The capital subsidy can come down to 55% if bank financing support is made available.

With a market support program, costs can come down by 30% over the next 4-5 years and a financing ecosystem can develop. The capital subsidy requirement can then come down to Rs 70,000 per 2.2 KW pump compared to Rs 2.5 lakhs today.

Therefore, a Government supported market assurance program is recommended in 12th and 13th Plan periods. A market support for 2 lakhs pumps (50,000 per year) in 12th Plan and 8 lakh pumps in 13th Plan is recommended. This will require a total capital subsidy outlay of Rs 5,000 Crore in 12th Plan and Rs 5,600 Crore in 13th Plan.

The benefits to the Government are as follows –

- Replacement of 1 million diesel pumps with solar pumps would result in diesel use mitigation of 9.4 billion litres over the life cycle of solar pumps which translates into diesel subsidy saving of Rs 8,400 Crore and CO_2 emission abatement of 25.3 Mn Tonnes.
- Forex savings of USD 300 Million per annum on diesel imports for replacement of 1 million diesel pumps translating into forex savings of USD 4.5 Billion over pump life.
- Improved energy access and livelihood in rural areas
- Over a period of time, electric pump replacement can also be triggered leading to the path to substantial reduction in the burden on the electricity grid
- Better crop yields that can improve agricultural output by Rs 2,000 Crore per annum or Rs 30,000 Crore over the pump life

Subsidy is vital for short-term development of solar based pump set market. However, heavy dependence on subsidy for adoption of solar based pump sets is unsustainable in the long term. Some of the methods to bring down the levels of subsidy over a period of time required include:

Reduction in costs through market assurance – Market assurance from the Govt. will give manufacturers the confidence to invest more and achieve cost reduction through scale economies and localissed manufacturing. Reduction in system costs will proportionately bring down the subsidy requirement.

Reduction in costs through improved subsidy administration – Govt. could improve the current subsidy mechanism by taking steps towards expediting the disbursement process, monitoring installation post subsidy release, and guiding state nodal agencies in formulating guidelines for the mechanism. Enhancement of transparency and greater inclusiveness is likely to result in more competitive price discovery.

Facilitating adoption through greater customer assurance – Greater customer assurance could be achieved by providing customers with last mile service to address their concerns and by implementing pilot installations to create awareness about the solar pump solution and its benefits in terms of yield enhancements, fuel savings etc. This could build greater trust for the product and farmers may even consider investing part of their household savings to purchase it.

Facilitating adoption through showcasing other benefits - Given that the pumping itself would not fully utilisse the solar panels, a battery coupled with the system that could leverage the unutilised duration of panels for other purposes (lighting, mobile charging, TV watching etc.) would be an additional incentive for the farmer especially in villages with no or poor grid supply.

Facilitating adoption through innovative business models - Innovative business models for instance that offer 'water as a service' could act as game changers going forward. In the 'Water as a service' model, the solution provider would bear the capital expenditure of the solution and would charge the end user (farmer) based on per litre water delivered. This avoids prohibitive upfront costs for the farmer and also hedges him against system performance risks. Similarly, another model could be in which agri pump solution is bundled with financing. In this model, service providers tie-up with local financing agencies (banks/NBFCs) to offer solar agri-pump solution bundled with financing to the farmers (i.e. the customers), and the farmer could be charged an amount equivalent to farmer's diesel savings as EMI payments.

The enablers suggested above can, in our view, help in achieving system cost reductions of up to 25-30% over the next 3-5 years while increasing assurance for farmers at the same time.

Objective of the Study

The Ministry of New and Renewable Energy (MNRE) is keen on understanding the potential for solarisation of agricultural pumps in India. Among other things, this requires an assessment of subsidy requirements, financing mechanisms, other non-financial enablers and a view on a roadmap for a self-sustained solar agricultural pump market with little or no subsidy dependence.

Shakti Foundation is assisting MNRE and has appointed KPMG for conducting this study.

MNRE has been actively inviting pump manufacturers, system integrators and panel manufacturers to understand their concerns and involve them in decision making. This clearly evinces the Ministry's keenness in driving solar pump adoption forward.

Under Phase I of JNNSM, the Ministry supported sales of solar pumps for irrigation and community drinking water through financial assistance in the form of capital subsidy and interest subsidy. Under Phase II of JNNSM (draft document), the Ministry is considering setting itself a target for deployment of at least 25000 solar pumps by the end of FY 2017.

Context

Agriculture in India contributes to 15% of our GDP and employs 50% of the country's workforce. Reliable irrigation, therefore, is a critical requirement not just for the farmer but also for the nation.

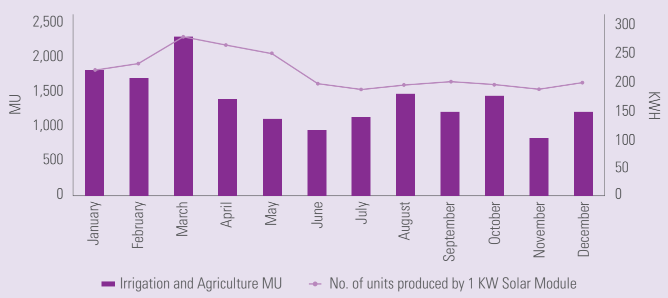
As a result, India today has around 18 million grid connected pump-sets and 7 million diesel pump-sets. However, erratic grid supply and high cost of diesel pumping continue to remain problem areas for the farmers. Poor irrigation as a result of these issues results in significant yield losses. While a scientific assessment on yield loss due to poor quality of irrigation has not been done, a high level sample survey of farmers reveals that farmers feel that the crop yield could easily improve by 10% if required volume of water is available when required. 'International Water Management Institute (IWMI) and TATA Water Policy Research Program' has been assessing the benefits of solar water pumping in Bihar and has highlighted the crop yield improvements expected due to timely and adequate water availability for irrigation .

The current installed base of pumps has implications for the Government too. Agriculture demand constitutes more than 20 per cent of total power demand that consumes 85 Million Tons of coal annually. This is roughly equal to the amount of coal imported in India in 2012. Additionally, more than 4 Billion litres of diesel is burnt by diesel based pump sets.

Solar powered pump sets could be a potential solution to this problem. Solar Power, with its ability to provide day time on-demand power, can meet the agricultural power demand without the need to be connected to the grid.

The correlation of solar power generation with the demand of the agriculture category in terms of timing of generation and demand is the highest amongst different consumer categories.

Correlation of agriculture power consumption & solar power production in the state of A.P.



For example, the correlation of monthly agricultural power consumption in the state of Andhra Pradesh and likely solar power production has been shown in the adjacent figure. Moreover, unlike industrial and residential consumption, water pumping can tolerate a certain level of intermittency in power output, which is a characteristic of solar power. This high degree of correlation only goes to suggest that solar could bring much needed power reliability to the agriculture sector. At today's costs, solar pumps do need Govt. capital subsidy support however, as the market gets created, scale economies, benefits of local production and innovations can potentially eliminate or reduce Govt. support to minimal level over the next 4-5 years.

Solar Pumping Technology – In brief

Solar pumps essentially are a collection of solar PV panels, AC or DC pumps and the associated electronics that have been optimied for high efficiency operations. These pumps when maintained well last for more than 15 years on the field. An illustrative diagram and an operational pump-set are shown below.

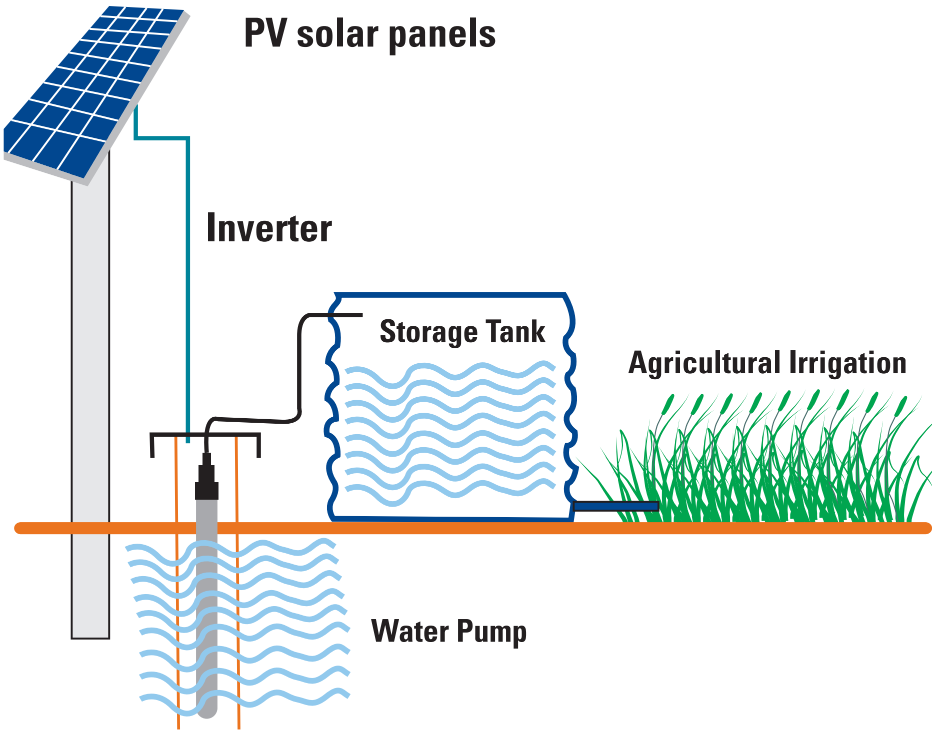


Figure 1: Illustrative diagram of a typical solar pump

These pumps are available in multiple configurations starting from 1 HP to 5 HP and higher and are suitable for water extraction from shallow water tables (less than 5 m) to higher water table depths.

Capacity of Pump	Type of Pump	Cost of Pump	Water Table Depth
1.8 kW	Surface/ Submersible	INR 2.60 Lakh	Upto 10m
2.2 kW	Surface/ Submersible	INR 3.50 Lakh	10-20m
3.0 kW	Surface/ Submersible	INR 4.40 Lakh	10-20m
5.0 kW	Submersible	INR 7.50 Lakh	20m onwards upto
7.5 kW	Submersible	INR 9.20 Lakh	100m

Image Courtesy: Tata Power Solar Pvt Ltd
Pump capacity is also expressed in HP. While technically 1 HP converts to 746 W, pumping industry typically takes a margin and 1 HP is equivalent to 900 W.
Cost of pumps is based on the prices witnessed in tenders and as per discussions with some manufacturers
There is a trade-off between water table depth from which a pump can draw and the volume of water drawn. The water table depth provided here should, therefore, be only considered as indicative.

While there have been discussions centred around possible wastage of water due to minimal operation cost that solar pump entails, it can be logically assumed that customer will install pumps that are optimally designed based on their needs to minimise their cost of investment.

Typically, the eastern states in the gangetic belt can be served by pumps upto 3 HP while some regions in states such as Punjab, Haryana, andRajasthan would require higher configuration pumps.

There are two types of pumps available in the market – AC and DC. DC pumps are largely imported in India. AC pumps are locally manufactured but around 60% of the AC pump market is unorganized. A significant section of the unorganised AC pump market is laden with sub-standard products that find their way into solar pump market as well. The efficiency of these pumps is very low.

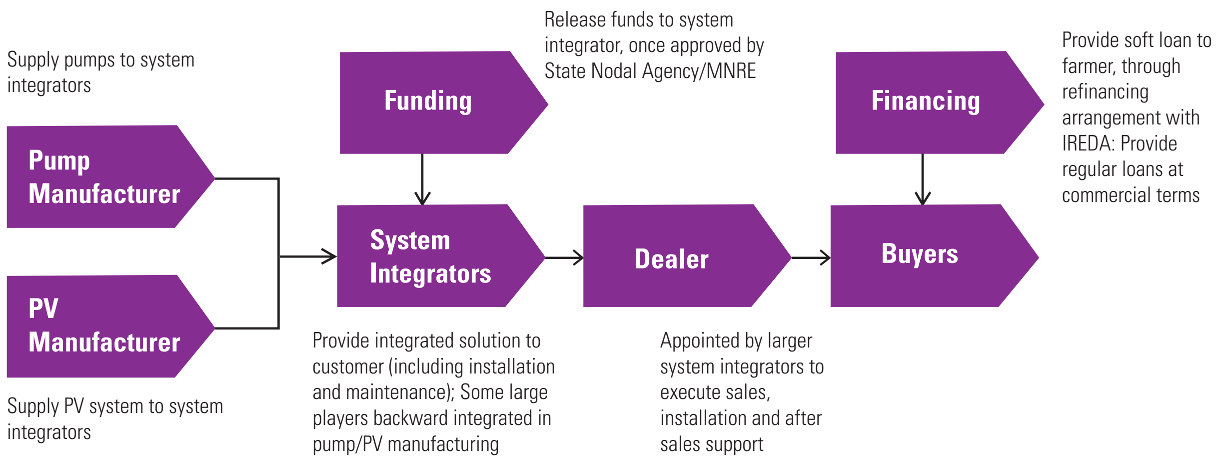
As a technology, while AC technology is now catching up, DC technology is considered to be more suitable given the wider operating range and higher efficiencies. However, after sales servicing of DC pumps in India is a nagging issue that has led to limited success for these pumps. Most of the technical manpower available in the country at local level is not conversant with DC technology. Additionally, availability of spare parts for DC pumps is also a concern.

Domestic prices of solar agriculture pump systems are typically higher than those available in the international markets. On an average, the prices of domestic pump systems offered for state tendering are 10% to 15% higher than the most competitive international prices. Key reasons for this price differential are –

- Indigenous panel requirement implies that the price of solar panels is higher by around 15-20 cents per Watt than the most competitive international prices
- In case of DC pumps, since these are imported the cost of transportation and customs duty add to the pump cost
- The conservative terms and conditions of the tendering process run by most state nodal agencies result in limited competition causing an upward pressure on tender prices.

Value Chain

The following chart gives an overview of the value chain and key participants in the solar agriculture pump market



This chart is based on multiple interactions with different industry stakeholders including pump manufacturers, panel manufacturers, system integrators, Ministry, dealers, and financing organisations.

Pump Manufacturers

Pump manufacturers supply pumps to system integrators. While AC pumps are manufactured in India, DC pumps are typically imported.

Pump manufacturers typically have large distribution network covering all the target consumer segments. They have a good understanding of irrigation pump requirements but possess limited understanding on crop patterns, micro irrigation, productivity benefits etc. Given their limited capabilities in solar, they have been open in tying up with solar panel manufacturers to offer an end to end solar pump solution.

Panel (PV) Manufacturers

Supply PV panels to system integrators. Only indigenously produced PV modules with crystalline silicon cells (with min. 13% efficiency) qualify for subsidy. Currently the service network for servicing of PV panels is limited.

System Integrators

System integrators provide integrated solution to customer (Including installation and maintenance). They provide integrated warranty of up to 5 year to farmers and have back to back agreements with manufacturers. This warranty is administered by dealers and service partners. Some large players have backward integrated in pump/ PV manufacturing.

Dealers

Dealers are appointed by larger System Integrators to execute sales, installation and after sales support. Typically existing dealers already have presence in solar products or agriculture equipments and are used by large system integrators to increase reach. As the market is staggered across different states, larger players operating in this space have a robust dealer network and extensive rural reach.

Buyers

Buyers are typically farmers or institutions with irrigation or community drinking water needs that purchase solar pump solution. They mainly purchase through State Government or NGOs. Direct sales (without subsidy support) to retail customers are currently limited.

Current Installed Base Of Solar Pump Sets In India

India has an installed base of around 12,000 to 13,000 solar agriculture pumps. This is concentrated in a few states – Over 70% of these are estimated to be concentrated in Punjab, Rajasthan, Haryana and Bihar.

These pumps have been installed largely by State renewable development agencies with capital subsidy assistance from Ministry of New & Renewable Energy (MNRE). MNRE provides a 30% capital subsidy assistance that is coupled with state subsidy assistance that has historically ranged between 50-60% to offer subsidised pumps to farmers at 15%-20% of its total cost.

There is a small market for non-subsidised pumps that witnesses demand from Non Government Organisations (NGOs) and institutions. However, this is a small market currently.

The input on current status and performance of these systems is quite mixed. While some of the systems are working well and have access to quality servicing, some of the installed base has not been working because of various reasons. In certain cases, lack of spare parts for DC pumps (typically brushes) have rendered them non-functional while in certain cases, the quality of the solar panels was not up to the mark and output has diminished significantly or stopped altogether. In certain cases, it has also been observed that the high value solar panels have been sold off, thereby making profits on these subsidised panels while the farmers returned to their regular fuels for irrigation.

Future Cost Reduction Potential For Solar Agri-Pumps

Individual components in a solar agri-pump lend themselves to cost reduction opportunities. For instance, the cost of solar PV module production has reduced significantly in the past few years and the ongoing technological advances promise further cost reduction roadmaps.

Similarly, technological improvements have improved the efficiency of pump sets i.e. pump sets can now pump more water for every unit of electricity injected into them. Additionally, pumps are customised for optimal usage with solar power. This involves adjusting the flow rate, pump head and voltage operational range to work best with solar power profile. As the market grows and scale economies kick in, the cost of pumps optimised for solar power usage should come down.

Based on our interactions with manufacturers and solution providers, we are of the opinion that with scale economies, local manufacturing, cost reductions of solar modules and some solution innovations, solar pump cost can come down by 25% - 30% over the next 4-5 years.

This shall translate into a significant subsidy reduction for the Govt. However, for this to happen, market assurance will have to be created in the form of pump solarisation targets announced and implemented by the Govt. Manufacturers are essentially looking for a long term market assurance i.e. a traction period of at least five years with reasonable annual targets.

Hence the current market could be scaled to least 50,000 pumps per annum i.e. a total of 2 to 3 lakhs pumps over the remaining 12th Plan period could provide the requisite market assurance. Based on the discussions with the Ministry and Industry, it is possible to target deployment of 1 Million pumps by the end of 13th Plan period.

Economic case for solarisation of diesel pumps

The cost of solar pump (Rs 3.5 Lakhs say for a 2.2 KW) is an order of magnitude higher than a conventional pump (around Rs 30,000 for same sise). However, if we specifically look at diesel pumps, the cost of diesel annually for a 2.2 KW pump would be around Rs 30,000. Solar pump can almost completely mitigate this cost.

If we look at the economic case for replacement of diesel pumps with solar pumps i.e. not taking into account the impact of any subsidies – diesel subsidy or capital subsidy for pumps – the break-even period for solarisation is beyond 15 years without considering yield improvement. Considering yield improvement, the break-even period is 8 years.

We are of the opinion that with the necessary enablers (discussed subsequently in this note), the solar pumping system cost can come down by around 30% over the next 4-5 years. This, coupled with rise in diesel and crop prices, would translate into a break-even period for solarisation of diesel pumps of 7 years without considering yield improvement and 4.1 years with yield improvement.

Economic case for replacement of Diesel Pumps - No subsidy support

Note: The calculations below take into account time value of money at 11% annual discount rate. IRR calculations have been done over a time period of 15 years. The water table depth is assumed to be same for both 2.2 kW and 3.0 kW pumps.

Current break-even period and IRR for solarisation	2.2 kW Pump	3 kW pump
Price of Solar Pump	INR 3.5 Lakh	INR 4.4 Lakh
Incremental contribution required (solar pump less conventional pump)	INR 3.2 Lakh	INR 4.05 Lakh
Annual diesel expenditure saving	INR 36,500	INR 50,000
Benefit of crop yield improvement by 10%	INR 20,000	INR 30,000
Break-even period and IRR for farmer using diesel pump w/out taking into consideration crop yield improvement	Beyond 15 years IRR 10%	INR 9.20 Lakh
Break-even period and IRR for farmer using diesel pump taking into consideration crop yield improvement	8 years IRR 19%	
Break-even period and IRR five years hence		
Inputs: 1) Solar pump price reduction of 30%, diesel price increase of 3% per annum, crop price increase of 3% per annum		
Break-even period and IRR for farmer using diesel pump w/out taking into consideration crop yield improvement	7 years IRR 21%	
Break-even period and IRR for farmer using diesel pump taking into consideration crop yield improvement	4.1 years IRR 33%	

Given the host of benefits in solarisation (not just for the farmer but also for the nation as a whole as discussed subsequently) the break-even period of 4.1 years achievable over the next five years is quite promising and makes us believe that solarisation of pumps needs to be pursued in all earnestness.

Wider Benefits to the Government

The benefits are not limited purely to economics of replacing diesel with solar. There are additional benefits at the national level. We show below an assessment of these benefits.

- Replacement of 1 million diesel pumps with solar pumps would result in diesel use mitigation of 9.4 billion litres over the life cycle of solar pumps which translates into diesel subsidy saving of Rs 8,400 Crore and CO_2 emission abatement of 25.3 Mn Tonnes.
- Forex savings of USD 300 Million per annum on diesel imports for replacement of 1 million diesel pumps translating into forex savings of USD 4.5 Billion over pump life.
- Over a period of time, electric pump replacement can also be triggered leading to the path to substantial reduction in the burden on the electricity grid
- Replacement of, say, 1 million electric pumps with solar pumps would result in reduction of ~2,600 Mn units of electricity and could translate into CO_2 emission abatement of 2.5 Mn Tonnes.
- Better crop yields that can improve agricultural output by Rs 2,000 Crore per annum (10% yield improvement for an installed base of 1 million solar pumps) or Rs 30,000 Crore over the pump life.
- Improved energy access and livelihood in rural areas. We quote a case study below to illustrate this point.

Farmer’s business case for adopting solar pump

A farmer, however, would not look at the break-even period in the above manner. Farmers typically do not look beyond 3 to 5 crop cycles while assessing a product utility. While solar based pumping solution is economically more advantageous to the farmer in the long term, a payback period longer than 5 years is too long an investment horison for him to replace his conventional pump.

He would simply decide on a solar pumping option based on economics against his diesel savings. Based on our understanding, we are of the opinion that his willingness to invest is equal to 2-3 years of his diesel savings i.e. Rs 60,000 – 90,000. He would expect the rest to be Govt subsidy contribution.

We show some illustrative calculations below showing the extent of capital subsidy support required for the farmer to attain a 2 year break-even on the incremental cost.

Replacement of Diesel Pumps – extent of subsidy support required

Considering that the farmer would be willing to contribute only 2 years worth of his diesel saving towards the incremental cost of solar pump, the current subsidy requirement comes to around 70% of capital cost as shown in the table below. Yield improvement benefits are additional.

Note: The water table depth is assumed to be same for both 2.2 kW and 3.0 kW pumps.

Particulars	2.2 kW Pump	3 kW Pump
Incremental contribution required	INR 3.2 Lakh	INR 4.05 Lakh
Annual diesel expenditure saving	INR 30,000	INR 42,000
Diesel savings over 2 years	INR 60,000	INR 84,000
Subsidy required	INR 2.6 Lakh	INR 3.2 Lakh
Subsidy (%)	74%	72%

Capital subsidy requirement reduces when financing is made available

The subsidy support can be brought down from 70% to around 55% if financing is made available to farmer even at commercial rates. Farmer pays only a portion of his diesel savings (to make him slightly better off) each year as EMI to the bank to finance his solar pumps. The following table shows illustrative calculations for a 7 year loan with a commercial lending rate @ 11%:

Note: The water table depth is assumed to be same for both 2.2 kW and 3.0 kW pumps.

Particulars	2.2 kW Pump	3 kW Pump
Annual diesel expenditure saving	INR 30,000	INR 42,000
EMI based annual repayment to bank set at a discount to diesel saving (7 year loan @11% interest rate)	INR 25,000 per annum	INR 35,000 per annum
Total financing from bank (cost borne by farmer through EMI payments)	INR 1.22 Lakh	INR 1.70 Lakh
Subsidy required from Govt.	INR 1.98Lakh	INR 2.35Lakh
Subsidy (%)	57%	53%

Additionally, the farmer will also benefit due to yield improvement.

Capital subsidy requirement with financing 5 years hence

Considering a pump cost reduction of 30% and higher farmer contribution due to rising diesel prices, subsidy level can come down from INR 1.98 lakhs per 2.2 KW pump to INR 70,000.

Note: The water table depth is assumed to be same for both 2.2 kW and 3.0 kW pumps.

Particulars	2.2 kW Pump	3 kW Pump
Annual diesel expenditure saving	INR 34,800	INR 48,700
EMI/Annual repayment to bank (7 year loan @11% interest rate)	INR 29,000 per annum	INR 40,500 per annum
Total financing from bank (cost borne by farmer through EMI payments)	INR 1.45 Lakh	INR 1.97 Lakh
Incremental cost of solar pump (after 30% cost reduction)	INR 2.15 Lakh	INR 2.73 Lakh
Subsidy required from Govt.	INR 0.70 Lakh	INR 0.76 Lakh

To summarise, a farmer (say, with a 2.2 KW pump) who is willing to invest 2 years of his diesel savings as capital cost and has no financing support would need around INR 2.5 lakh (70%) capital subsidy support today.

Over the next five years, as financing becomes available and capital costs of solar pumps come down by 30% coupled with a rise in diesel prices, the same farmer would need only INR 70,000 of capital subsidy support.

Economic case for solarisation of grid connected pumps

Grid provision of power to agriculture pumps is an expensive proposition. One time cost of grid network extension to reach farmers is around Rs 65,000 per new connection. This is coupled with an estimated cost of power delivery of Rs 14,000 per annum per farmer.

Cost of Grid power delivery	
Average network cost for releasing an agri connection (A)	INR 65,000
Cost of Power Delivery	
Cost of marginal power procured	INR/ KWh 4
T&D Losses	30%
Financial impact of T&D losses	INR/ KWh 1.71
O&M Cost of Power Transmission and LT network	INR/ KWh 0.66
Total cost of power at customer end	INR/ KWh 6.37
Annual power consumption of a 2.2 KW pump	KWh 2,220
Cost of Power to the Distribution Utility	INR 14,020

If we assess the Internal Rate of Return (IRR) of replacement of grid connected pumps with solar pumps, the IRR comes to 13% in the current context considering a 10% yield improvement because of better energy access. However, with rising electricity prices and expected cost reduction of solar pumps, this IRR is likely to improve to 30% over the next five years. The cash flow inputs considered for the IRR analysis are shown below.

Cash flow inputs for IRR assessment	**Current**	**After 5 years**
Incremental Cost of Solar Pump	INR 3,50,000	INR 2,15,000
Avoided network cost for releasing an agriculture connection	INR 65,000	INR 75,353
Annual savings on landed cost of power to the farmer (escalated at 3% per annum)	INR 14,014	INR 16,246
Annual benefit due to yield enhancements (escalated at 3% per anum)	INR 20,000	INR 23,185

With the current financial state of the distribution utilities in India, solar agri-pump solutions make all the more sense. The recently released ratings on operational and financial performance of distribution utilities by the Ministry of Power clearly showcase their conditions. The following table summarises the ratings of the distribution utilities in the Eastern states.

State	Discom	Ratings	Operational/ Financial Performance capability	Rating agency
West Bengal	West Bengal State Electricity Distribution Co. Ltd.	A	High	ICRA
Uttar Pradesh	Poorvanchal Vidyut Vitran Nigam Ltd.	C+	Low	ICRA
	Pashchimanchal Vidyut Vitran Nigam Ltd.	C	Very Low	ICRA
	Madhyanchal Vidyut Vitran Nigam Ltd.	C	Very Low	ICRA
	Dakshinanchal Vidyut Vitran Nigam Ltd.	C	Very Low	ICRA
	Kanpur Electric Supply Company Ltd.	C	Very Low	ICRA
Bihar	Bihar State Power Holding Company Limited	B	Below Average	ICRA
Jharkhand	Jharkhand State Electricity Board	C+	Low	CARE
Assam	Assam Power Distribution Co. Ltd.	B	Below Average	ICRA

IRR assessment summary

Note: The calculations below take into account time value of money at 11% annual discount rate. IRR calculations have been done over a time period of 15 years.

Particulars	IRR (Current)	IRR (after 5 years)
Replacement of Diesel Pumps		
With Yield benefit	19%	33%
Without Yield benefit	10%	21%
Replacement of Grid connected Pumps		
With Yield benefit	13%	30%
Without Yield benefit	0.3%	11%

Essentially, this shows that five years hence, even the case for solarisation of grid connected pumps would be strong. However, for now, our focus should be primarily on solarising diesel pumps.

Facilitating adoption

Given that the case for solar agri-pumps in India is strong, the pertinent question is how adoption can be facilitated. In our view, a multi-pronged approach needs to be followed that takes into consideration -

- Customer assurance on performance and service; building awareness
- Cost reduction measures through market assurance and better subsidy mechanism
- Innovative business models that leverage the power of community and provide ancillary benefits

Facilitating adoption through greater customer assurance

Farmers may be willing to invest part of their household savings to purchase the solar pump solution if they have greater trust in the product.

Some enablers that would help build greater assurance among the potential adopters include –

- Performance assurance – The pump should deliver as promised – volume of water and the head required to irrigate the field are important considerations on which the pump should perform. While the farmer can plan to manage irrigation with an alternate source during, say, winter foggy season when solar output would get affected, he should not get any surprises due to performance inconsistencies.
- Sales and service assurance – Since solar pumps are technically more complex than conventional pumps, local technicians generally do not have servicing capabilities (more so in case of imported pumps). Solution providers need to ensure that the farmer's issues are addressed quickly as water is critical to his crops and any delay could be unsettling. This is possible by building last mile reach through channel partners. Alternatively, the industry could collectively help in creating a pool of local skilled labor through designing courses that could be adopted by local industrial training institutes.
- Awareness and positive precedence – Working installations tend to build confidence among the neighboring community. Conversely, any poor installation makes the entire community apprehensive and restoring confidence becomes a herculean task. It is, therefore, important that initial programs are designed and executed well. Close monitoring of pumps installed under initial programs to ensure that these operate efficiently would not only display their workability but also other benefits such as yield enhancement, fuel savings etc. and pave the way for further installations.

Facilitating cost reduction through market assurance

Cost reduction can reduce the subsidy burden on government as the reduced amount in system costs will proportionately bring down the subsidy requirement.

As discussed in above sections, there is potential for pump set cost reduction through scale economies, localised manufacturing, technology R&D and solution innovations. All that the manufacturers require is market assurance. If the Govt can promise a reasonably certain solar agri-pump program over the next few years, pump manufacturing capacity in India is likely to scale up leading to about 15-20%

cost reduction. Additionally, this will also incentivise the much needed R&D for customising pump sets to solar characteristics and development of sales and service network.

Facilitating cost reduction through improved subsidy administration

As discussed earlier, there are some limitations in the current subsidy mechanism as administered by most state nodal agencies. Enhancement of transparency and greater inclusiveness is likely to result in more competitive price discovery.

Expediting Subsidy release process

Currently, there are multiple processes as shown below that constitute the overall subsidy disbursal activity. After aggregating request from the farmer, system integrator sends proposals to the state nodal agency for subsidy approval. Post evaluation by the nodal agency, the report is submitted to MNRE, and the whole process takes ~3-4 months before approval is received by the system integrator. This process can be simplified if the state nodal agencies are provided guidelines by the MNRE to carry out this process in minimal time. In addition to that, local banks can also be empowered to directly disburse subsidies by providing them with subsidy pool. This can cut down in the subsidy processing time. We understand that the Ministry has initiated efforts to empower the banks to disburse subsidy directly. This, in our view, is a welcome step forward.

Post disbursement monitoring

There have been cases where farmers have taken the subsidy benefit from the govt. and later on sold the solar pumping system in the open market. Hence, post subsidy disbursement, it is important that the Govt. ensures that subsidy is serving the desired purpose and is not used as a means to create a parallel market for these systems. Therefore a robust subsidy monitoring mechanism needs to be in place to check this.

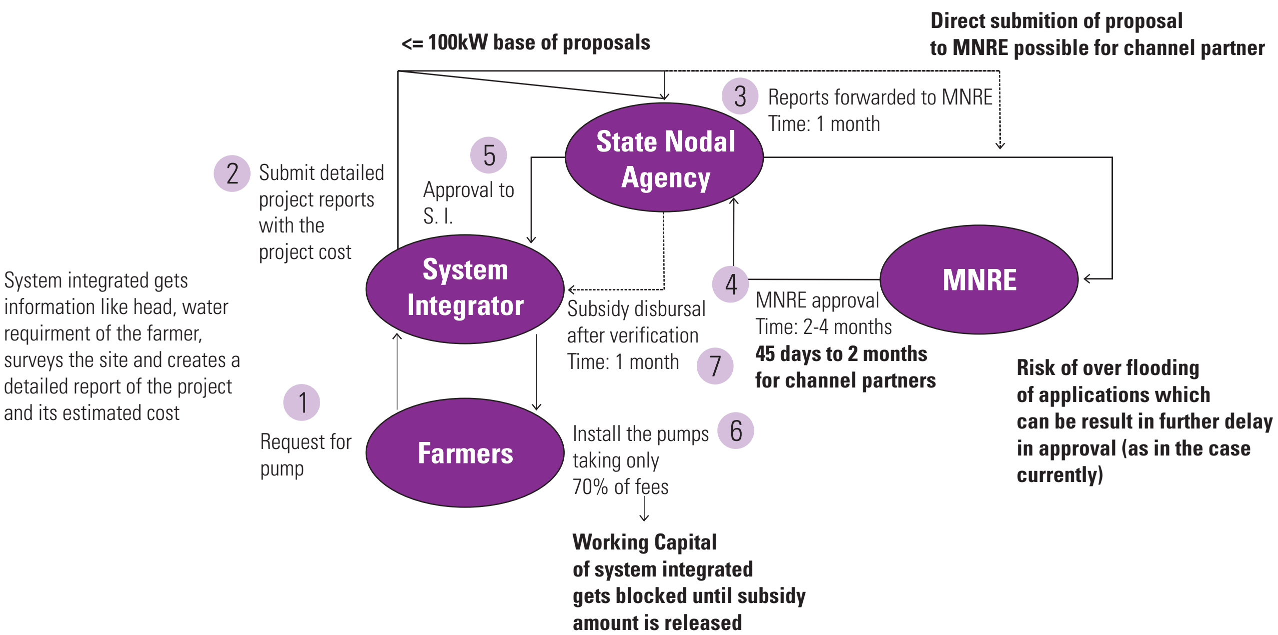
This can be done either by conducting on-field evaluations of the performance of the solution or by exploring technologies that can offer remote monitoring access. It is pertinent to mention here that some system installers have set up remote monitoring centres for solar agri-pumps that get real time updates on the functioning of these pumps.

MNRE guidance to State Nodal Agencies

We would also like to suggest that the Ministry could draft certain guidelines for state nodal agencies that not only help them in meeting their additional local objectives

The below schematic depicts the current subsidy disbursement process:

Subsidy disbursal process for direct retail model (Not through state tendering)



but also prevent the subsidy administration process from becoming restrictive and inordinately long.

Facilitating adoption through showcasing other benefits

Solar power generated from panels can find a host of other uses e.g. for lighting, mobile charging, TV watching etc. Given that the pumping itself would not fully utilise the solar panels, a battery coupled with the system that could leverage the unutilised duration of panels for other purposes mentioned above would be an additional incentive for the farmer especially in villages with no or poor grid supply.

This is also likely to increase farmer's willingness to spend on the system and reduce subsidy dependence in the longer term.

Facilitating adoption through innovative business models

Agri-Pump Solution bundled with financing

In this model, service providers tie-up with local financing agencies (banks/NBFCs) to offer solar agri-pump solution bundled with financing to the farmers (i.e. the customers). Under this financing arrangement, farmer could be charged an amount equivalent to farmer's diesel savings as EMI payments. We have already seen that under such a model the subsidy requirement from the Govt. reduces considerably even at commercial lending rates (from 70% to 55% of the solar pumps cost). Since agriculture sector is categorised under the priority sector lending, banks have an additional incentive to finance solar agri pumps . Additionally the upfront payment requirement for the farmer is minimal under this model.

Indian rural markets have witnessed several successful examples of market off-take as a result of bundling the product with finance. Two wheeler and tractor financing offered by the NBFCs of the manufacturers themselves are cases in point.

Micro-grid model

In rural areas, instead of selling solar pumps separately, solution providers could set up a micro grid and charge farmers (customers) based on the electricity consumption. This model is inherently scalable. In such a model, the service providers will be looking for an anchor load that will help them in achieving minimum desired cash flows and set the tone for further scaling up. Therefore, agri-pumps can act as base load for the micro grids, and the whole set up could be scaled up to provide power to rural households (for their routine requirements such as lighting, charging etc.), small scale industries, telecom towers etc. – thereby catering to the entire community.

Consequently, the solution provider would be able to realise scale benefits and bring down its costs.. Most importantly, the farmer would not have to bear any upfront capital burden and would need to pay for electricity consumed.

The risk of this solution would get split between the solution provider and the customer. The solution provider would have to bear the power generation risk, whereas the asset performance risk (of the pump) would lie with the customer.

This risk can also be mitigated if the entire rural community is engaged in the form of a cooperative and becomes a stakeholder in the business model. This would ensure a robust energy management system minimising risk of power/asset thefts, over-drawal of power etc. The following case study of micro-solar power stations in Sunderbans is a successful example of such a model that is currently operational.

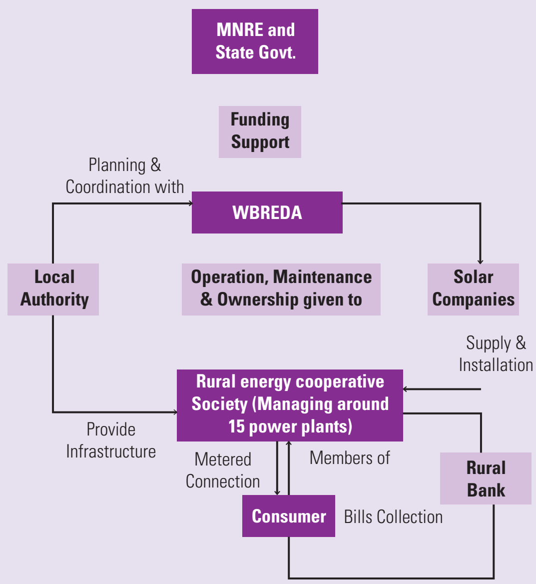
Case Study – Micro-grid model in Sunderbans

More than 1,400 households and commercial establishments are getting electricity from mini-grids of 11 SPV power plants, having 800 kWp capacity, for about 5 hours every day on an average.

Most of these power plants are operated on commercial basis through the local rural electric co-operatives, functioning under the guidance of WBREDA .

Solar power on Sagar Island constitutes about 60% of the total electricity consumed on the island . Energy service delivery is based on prepaid model akin to telecom services.

At present the revenue collected from consumers, covers 100% of the operational costs of the power plants and about 20% of the capital costs. Rest of the capital investment comes from Central and State Govt in the form of grants.



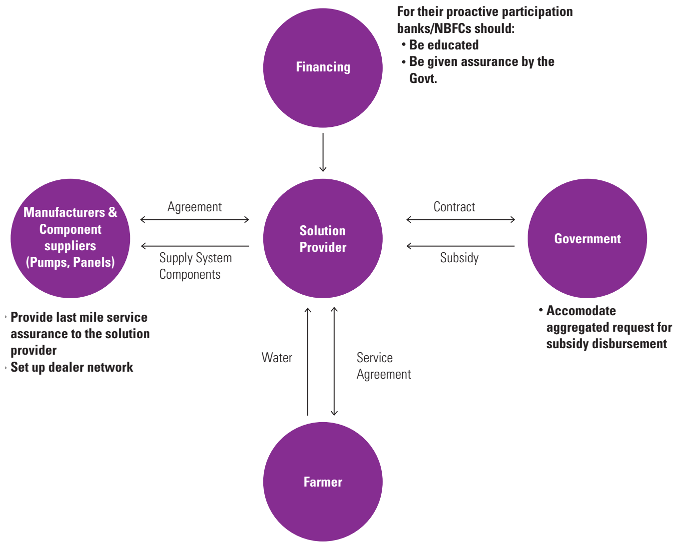
Water as a service model

We are of the view that innovative business models that offer 'water as a service' for instance could act as game changers going forward.

In the 'Water as a service' model, the solution provider would bear the capital expenditure of the solution and would charge the end user (farmer) based on water quantum delivered. This avoids prohibitive upfront costs for the farmer and also hedges him against system performance risks.

Since the risk of the system performance and the upfront cost get transferred to the solution provider, the whole proposition becomes much more attractive for the farmer. This would also help in building scale benefits (through

The following chart showcases stakeholder activities for this model:



water requirement aggregation) and reducing costs for the solution provider.

Financial institutions can forge partnerships with solution providers for financing of pumping systems. Solution providers who participate as water service companies will need 3 pronged support –

- **Government** – The water service company will need assurance that the aggregated request for subsidy disbursal is cleared without blocking their working capital for long.
- **Financing agencies** – NBFCs and banks need to be proactive and participate in a major way. For this, they need to be educated and assured about the solution. Water service companies would have better ability to run and maintain systems compared with individual farmers. This would help in building assurance among financiers.
- **Manufacturers** – One of the key drivers to the market will be availability of after sales service. For the water service company, it is essential that their final product 'water' is available without fail. Hence, last mile service assurance with spare parts and components is key to the success of this model.

In summary, benefits of such a model are three fold:

- Serious players with a long term view get attracted to the market.
- Shared pumping infrastructure improves utilisation with a commensurate impact on costs
- Financing becomes easier as the risks are managed by professional organisations. Banks are not apprehensive about farmer's ability to keep the system running.
- Wastage of water is minimal – the solution provider will optimally manage the solar pumping assets to pump water as per the demand

Case Study – Water as a Service Model in Bihar

Thirty four existing tube wells, set up under National Bank for Agriculture and Rural Development (NABARD) Phase VIII program (2004-2005), were selected for energisation. The tube wells are located in 20 villages of five blocks of Nalanda district. The tube wells have 7.5 HP submersible pumps with discharge capacity of 70 m3/hour. For each tube well, six sets of solar panels, each producing 1.4 kWp, have been installed on about 1000 square feet area on the land adjacent to the pump houses that together generate about 600 Volts.

As the implementing agency, Claro Ventures has the responsibility of operations and management of the solar energy related installations for five years.

Claro solar pumps are fitted on community tube wells. Each tube well was established on 100-110 m2 of donated private land, whose owner was made the tube well operator. The operator was to serve a group of eight neighboring farmers formed in to a Water Users' Association (WUA), and charge them a government-fixed irrigation service fee (ISF).

Claro Ventures has the responsibility of operation and management of solar energy related installations for first five years. Presence of a local office with competent technical staff has helped in extending quick response and solutions. Beyond outlets farmers are expected to carry water through plastic pipes. Water Users Committees are expected to manage the irrigation, collect fee and maintain the infrastructure. A Secretary and an Operator attached to each tube well manage the day to day affairs of irrigation. Water Users Committees attached to community tube wells with solar pumps are expected to manage the irrigation and collect fee from beneficiaries. The rates of irrigation are very nominal. The irrigation rates vary between, Rs.55 to Rs.75 per acre according to the season and the number of irrigations applied.

Currently, Operators are maintaining records of irrigation in terms of beneficiaries' name, area of irrigation, duration of irrigation to calculate the dues. Operators are expected to make entries in the log book on daily basis. In most cases, operators have updated the records. In the studied systems, the tube well functionaries informed that large part of the irrigation fee has been collected.

The enablers suggested above can, in our view, help in achieving system cost reductions of up to 25-30% over the next 3-5 years while increasing assurance for farmers at the same time.

For the above mentioned market enablers to fall in place, we recommend a Government supported market assurance program is recommended in 12th and 13th Plan periods.

A market support for 2 lakhs pumps (50,000 per year) in 12th Plan and 8 lakh pumps in 13th Plan is recommended. This will require a total capital subsidy outlay of Rs 5,000 Crore in 12th Plan and Rs 5,600 Crore in 13th Plan.

Market creation support needed from Govt over the next four years and 13th Plan period

- A program to support 2 lakh pumps in next 4 years can stimulate the ecosystem
- This will spur cost reduction and develop financing ecosystem
- The total capital subsidy required would be around Rs.5000 crores over 12th Plan period
- The level of subsidy considered is 70% of capital cost (Rs 2.5 lakh per 2.2 KW pump)
- Encourage financing of solar pumps by local banks. This can potentially reduce subsidy requirement to 55%-60%
- In 13th Plan period, with 30% cost reduction and bank financing support, the level of subsidy support can reduce to Rs 70,000 (per 2.2 KW pump).
- Target solarisation of 8 lakh pumps during the 13th Plan period
- The total capital subsidy required would be around Rs.5600 crores over 13th Plan period with financing support

Annex 1: Replacement Potential of solar agriculture pumps in Eastern States of India

This analysis has been done for the eastern states of India including West Bengal, Uttar Pradesh, Orissa, Bihar, Jharkhand, and Assam. Other prominent eastern states are not part of this analysis as their agriculture data was dated and, in the absence of current data, the analysis would not have been meaningful.

These states have unique set of climatic, geographical and socio-economic features.

- The water table depth is relatively shallow in these states (>80% of area with water table depth up to 10 meters below ground level). Up to 10 meters water table depth, surface pumps can function and they are relatively cheaper than submersible solutions.
- The summer season is extremely hot and receives little to no rainfall. In absence of reliable supply of water, some farmers lose the opportunity of growing third crop of the year during the summer season. On the other hand, the winter season witnesses heavy fog typically in the months of December and January. Foggy and cloudy conditions tend to weaken the output from solar panels.
- Most of these states have very poor electric grid reach, especially for agriculture purposes. These states account for ~60% of the diesel agriculture pump sets installed in the country and only about 8% of the agriculture electric pump sets installed in the country. Even if grid is available, supply of electricity is either unreliable or at odd hours.

As a result, despite availability of desired levels of subsidy, farmers would be constrained by some non-economic considerations that can impact solar pumps adoption such as –

- Weather limitations – limited usability of solar pumps during foggy days in Northern and Eastern parts of India
- Security issues – theft of panels, vandalism etc.

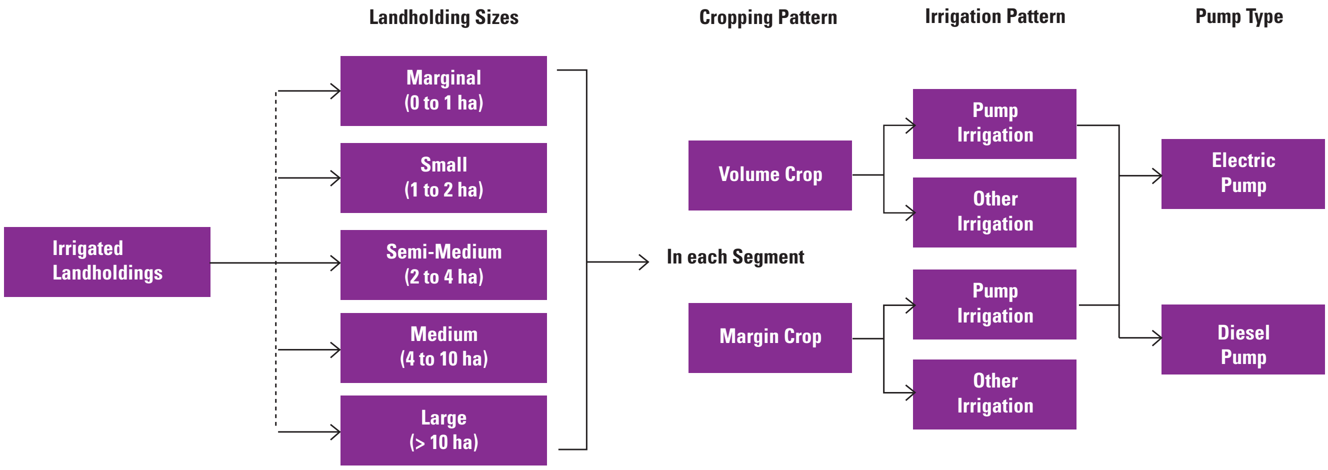
- Limited awareness and lack of after sales service support

Through various industry discussions and farmer interactions, it has been estimated that these non-economic considerations can constrain adoption of around 40% of economically viable pumps.

The overall analysis has been done assuming that the farmers will be willing to contribute to the solution cost only the amount that they save against the fuel expense they would have incurred over a 5 year timeframe. This is in line with the primary interactions and farmers may seek loan to cover this upfront cost at an EMI which must not exceed the average monthly fuel spend.

The sub-groups used for the purpose of the study are as follows –

Identification of pump distribution



Identification of subsidy requirement

Willingness to pay for the solution = fuel savings only (for 5 years)

Segment-wise subsidy requirement = [Cost of pump – Loan Amount (Annual EMI = Annual electric bill savings / Annual diesel cost savings)] * No. of pumps in each segment

The following table summarises state-wise replacement potential of diesel based agri-pumps with solar pumps at a subsidy provision of 70%:

State	Potential (Number of diesel pumps replaceable) – lakh
West Bengal	3.2
Uttar Pradesh	17.8
Orissa	0.4
Assam	-
Bihar	4.0
Jharkhand	0.9
Total	26.3

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