Indian Perspective on Harnessing Solar Energy for Irrigation

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Solar irrigation: Background

- Solar irrigation refers to the use of solar energy to power irrigation systems, significantly enhancing water management in agriculture.
- Currently, agriculture consumes around 24% of power in India.
- Solar irrigation provides the solution to a two-pronged challenge:
  - It enables an uninterrupted supply of clean electricity during the daytime hours, and
  - It curbs rising electricity demand from the agricultural sector, which can further burden the already financially burdened DISCOMs.
- Moreover, grid-connected solar can become an additional source of revenue for farmers if farmers get attractive buy-back tariffs.

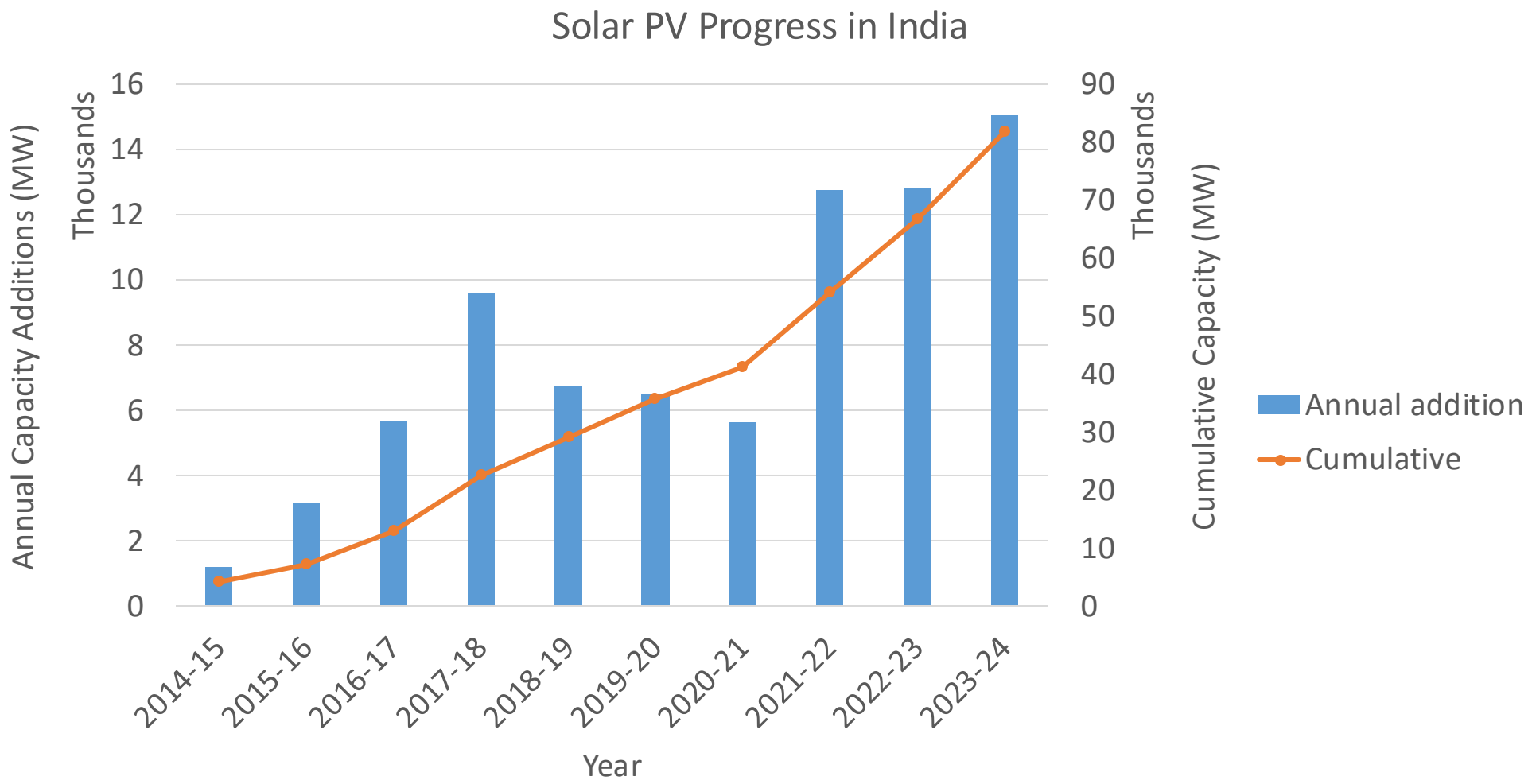
Solarisation of agricultural pumps can reduce electricity subsidies

- As of 2022, the Average Cost of Supply (ACOS) for power in India was INR 6.19/unit.
- The average tariff for agricultural consumers in India was only INR 1.03/unit.

State	Annual electricity subsidy on agriculture (in Rs. Crore)	Investment required for installation and solarisation of pumps (in Rs. Crores)	Number of years needed if a yearly subsidy funds the investment
Haryana	7,278.7	24,194.4	3.32
Punjab	7,585.8	29,547.2	3.9
Rajasthan	16,303.1	54,874.8	3.37
Uttar Pradesh	9,492.1	42,639.2	4.49
Gujarat	6,591.2	33,001.2	5.01
Madhya Pradesh	9,753.8	44,396	4.55
Maharashtra	17,729.5	72,835.6	4.11
Andhra Pradesh	7,578.7	30,255.2	3.99
Telangana	12,510.4	48,028.4	3.84
Karnataka	15,263.3	51,375.2	3.37
Tamil Nadu	6,585.6	27,054.8	4.11
Total	116,672.2	458,202	3.93

Source: Ministry of Power and Ministry of New and Renewable Energy, Govt. of India

Solar PV Progress in India



Targeted solar PV capacity by 2047 = 1168 GW

Evolution of solar irrigation policies in India

- Agriculture in India is strongly linked with the power sector as electricity is the main source for lifting the groundwater to produce food grains.
- The country has dealt with the water-energy-food nexus by mainly relying on demand-side management instruments like rationing electricity, metering of agricultural electricity, setting up institutional permissions for new pumps etc.
- Irrigation continues to consume up to 20-25% of India's total electricity.
- Solar energy provides a viable option for India to decarbonize its agricultural sector.

Evolution of solar irrigation policies in India

- In 1993, the Ministry of New and Renewable Energy created a program to install 50,000 solar pump sets for irrigation.
- Unfortunately, that program failed to achieve the targeted number for several reasons: lack of attractive subsidies and low economic feasibility of solar pumping due to high solar PV cost and upfront costs during that time.
- ***JNNSM PHASE-I (2010- 2013)***
- Targeted to install a 1000 MW grid-connected solar photovoltaic system integrated with 33kV line or above and 100 MW rooftop systems integrated with utility below 33 kV line.
- Phase-I did not have a particular focus on agriculture and had no targets for solar irrigation pumps.

Evolution of solar irrigation policies in India

- ***JNNSM PHASE-II (2014-17)***
- It was targeted to achieve significantly higher scale solar PV generation up to 100 GW.
- The promotion of agriculture-based solar applications like solar pumping was proposed mainly under two schemes.
- *A. Solar Pumping Programme for Irrigation and Drinking Water*
- *B. Capital Subsidy Scheme for Solar PV Water Pumping Systems for Irrigation Purpose*

Evolution of solar irrigation policies in India

- ***JNNSM PHASE-II (2014-17):*** *Solar Pumping Programme for Irrigation and Drinking Water*
- The scheme aimed to meet irrigation, drinking and other water requirements in rural areas.
- The programme targeted to sanction 100,000 solar pumps for 2014-15 and at least 1 million solar pumps to be deployed by 2020-21 for irrigation and drinking water.
- The scheme achieved the installation of 246,074 solar pumps for irrigation and drinking water.
- Chhattisgarh had the highest number of solar pumps installed in the country, followed by Rajasthan and Andhra Pradesh.

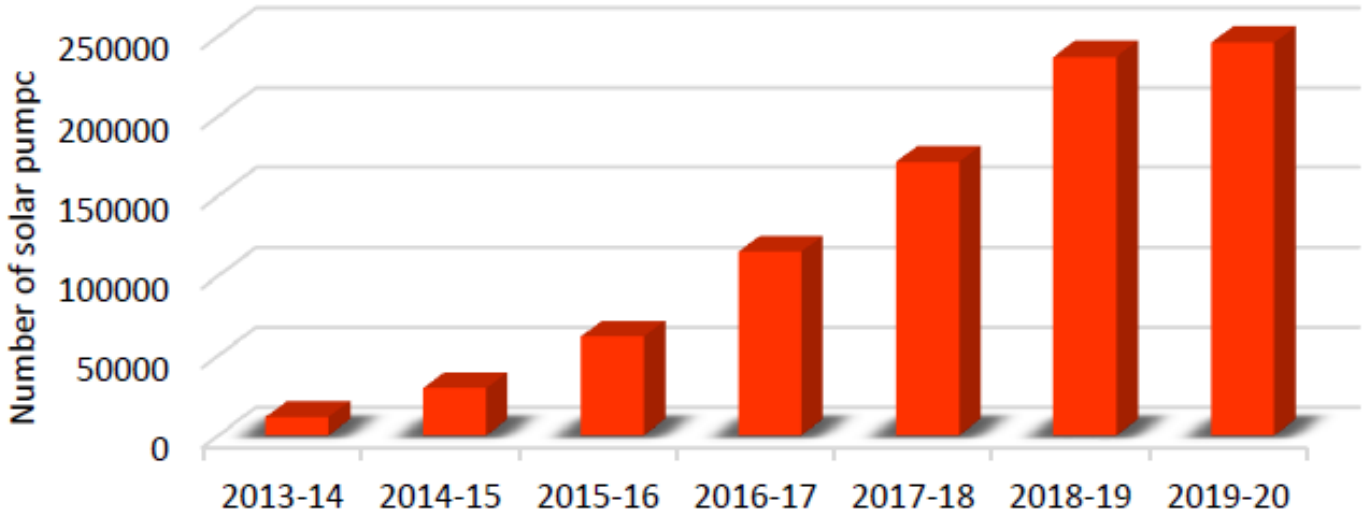
Evolution of solar irrigation policies in India

- ***JNNSM PHASE-II (2014-17):*** *Capital Subsidy Scheme for Solar PV Water Pumping Systems for Irrigation Purpose*
- The scheme aimed to replace the diesel pump sets with solar PV water pumping systems to meet the irrigation requirements.
- The program targeted the small and marginal farmers, where beneficiary farmers should contribute a minimum of 20% of the total financial outlay to be eligible for assistance.
- The repayment period for the loan was set to be ten years to make it attractive for small and medium farmers.
- The program targeted to support 30,000 solar pumps per year implemented through NABARD.

Evolution of solar irrigation policies in India

- ***JNNSM PHASE-II (2014-17):*** *Capital Subsidy Scheme for Solar PV Water Pumping Systems for Irrigation Purpose*
- However, the programme had failed to achieve its target, as only 700 farmers received the benefits from the capital subsidy scheme.
- Moreover, despite high subsidy (~80%) and solar loans, the program faced several challenges, including the high upfront cost for small and marginal farmers, collateral requirements, banks rescinding solar loans and a reluctance among farmers about solar power.

Evolution of solar irrigation policies in India



Year-wise deployment of solar pumps in the country

Evolution of solar irrigation policies in India

- ***Grid-interactive solar pumps – State Initiatives***
- *Mukhyamantri Saur Krishi Vahini Yojana, Maharashtra*
- In 2018, the government of Maharashtra planned to solarise the dedicated agricultural feeders by generating solar power through small to medium solar plants (2 to 10 MW).
- It was planned that the farmers would get electricity at Rs. 1.20 per unit under these feeders.
- The scheme had a target of installed capacity 5000 MW by 2025.
- As on March 31, 2022, a total of 731 MW capacity had been commissioned under MSKVY.

Evolution of solar irrigation policies in India

- ***Grid-interactive solar pumps – State Initiatives***
- *Mukhyamantri Saur Krishi Vahini Yojana, Maharashtra*
- The scheme faces challenges due to increasing import duty and Goods and Services Tax (GST) on solar energy, and the cost escalation due to the COVID pandemic, making the prevailing power tariff unviable.
- Land availability is another bottleneck that the scheme needs to overcome.
- To facilitate land availability, the distribution utility introduced a land portal to encourage farmers to rent out their lands.
- While this is a promising initiative, it is too early to assess its feasibility and impact.

Evolution of solar irrigation policies in India

- ***Grid-interactive solar pumps – State Initiatives***
- *Mukhyamantri Saur Krishi Vahini Yojana, Maharashtra*
- A consistent observation from farmers revealed a reduction in load shedding after MSKVY was implemented.
- An improvement in voltage quality during daytime power supply has also been reported with the advent of the scheme, fulfilling farmers' irrigation needs with less duration of supply.

Evolution of solar irrigation policies in India

- ***Grid-interactive solar pumps – State Initiatives***
- *Suryashakti Kisan Yojana (SKY), Gujarat*
- Launched in 2018; the state targeted to solarise 137 agriculture feeders covering about 12,000 farmers with a total capacity of 175 MW.
- SKY offered a capital subsidy of up to 30% of the total cost, 65% as loan and 5% as down payment by farmers.
- Net metering was done to calculate the net energy evacuated to the grid after subtracting the energy drawn for agricultural use.
- Farmers receive Rs. 3.50 per kWh as feed-in tariff (FiT) by utilities and Rs. 3.50 per kWh as an evacuation-based incentive (EBI) by the Government of Gujarat to reduce the farmers' loan burden.

Evolution of solar irrigation policies in India

- ***Grid-interactive solar pumps – State Initiatives***
- *Suryashakti Kisan Yojana (SKY), Gujarat*
- The EBI is capped up to 1,000 kWh per hp per year of contract load and is applicable for the first seven years.
- Other than decarbonising, it is anticipated that the buy- back tariff incentivises the farmers to reduce the energy consumption for irrigation which eventually is a step for groundwater conservation and reduces government subsidy on electricity.
- As of Jan. 2022, against an original target of 137 feeders, 12000 consumers, 175 MW and 140 khp, the progress has been 68.6%, 37.6%, 46.2% and 56.8% respectively. Additional injection of 28.5 MU.

Evolution of solar irrigation policies in India

- ***Grid-interactive solar pumps – State Initiatives***
- *Suryashakti Kisan Yojana (SKY), 2024, Gujarat*
- A revised version of the scheme has been launched in 2024.
- The state and central governments will jointly provide a 60% subsidy (30% each) to the farmers to install solar panels in their fields.
- The farmers will have to take a 35% loan on the total capital cost (at an interest rate of 4.5% to 6%), while they will have to make an upfront payment of 5% of the capital cost.
- Farmers will receive Rs 7 per unit for the first 7 years and Rs 3.5 per unit for the next 18 years for the electricity they sell.

Evolution of solar irrigation policies in India

- ***Grid-interactive solar pumps – State Initiatives***
- *Surya Raitha Scheme 2019, Karnataka*
- Envisaged achieving the solar energy targets as well as generating additional income for farmers.
- The programme targeted farmers who already have a connection (up to 10 HP pumps) to the agricultural feeder.
- The solar PV capacity installed is 1.5 times more than the energy required for the old pumps.
- It was estimated that one-third of the energy generated can be fed to the grid at a buy-back tariff of Rs. 9.56 per unit if farmers have not taken a loan and Rs 7.2 per unit if farmers have taken a loan.

Evolution of solar irrigation policies in India

- ***Grid-interactive solar pumps – State Initiatives***
- *Surya Raitha Scheme 2019, Karnataka*
- The government to provide a 90% subsidy on the capital cost, and only 10% needs to be paid by the farmers.
- The program did not mention any targets.

Evolution of solar irrigation policies in India

- ***Grid-interactive solar pumps – State Initiatives***
- *Grid-connected BLDC Pumps, 2018, Andhra Pradesh*
- The scheme offers a 100% grant for installing grid-connected solar pumps, but all the farmers who have a connection to the feeder must agree to get solarised and form a cooperative.
- The panel capacity installed is slightly higher than the current power rating of the pumps, the excess energy generated is fed to the grid at the rate of Rs. 1.5 per kWh.
- It is anticipated that the farmers can earn about Rs. 6000 per annum from the excess energy sold to DISCOMs.

Evolution of solar irrigation policies in India

- ***Grid-interactive solar pumps – State Initiatives***
- *Grid-connected BLDC Pumps, 2018, Andhra Pradesh*
- Initially, this scheme was implemented in the Vizianagaram district, and about 250 pump sets were installed, covering about 32 villages.
- Now the Andhra Pradesh government is implementing the scheme in Visakhapatnam, Srikakulam, Vizianagaram, and other districts of the state.
- Special advantages of BLDC pumps:
  - Have lower inertia and better torque control and are 20-25% more efficient than conventional AC motors.
  - drawl of power from the grid for operating the pump is not possible

Evolution of solar irrigation policies in India

- ***Grid-interactive solar pumps – State Initiatives***
- *Saur Sujala Yojana, 2016, Chhattisgarh*
- The Saur Sujala Yojana is to set up solar irrigation pumps for the irrigation needs of the farmers, by providing irrigation pumps to the farmers at subsidized rates.
- Under the plan, there is a provision for setting up solar pumps of 3 hp and 5 hp capacity.
- Beneficiaries under the scheme are selected by the Agriculture Department. Under the scheme, more than 1 lakh solar pumps have been installed.

KUSUM – A new solar policy for agriculture

- MNRE launched the Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyaan program (KUSUM) in July 2019.
- KUSUM aimed to add a solar capacity of 25,750 MW (25.75 GW) by 2022 with central government support of ₹344.22 billion (~US $4.99 billion (2019 US$)).
- The program had been divided into three components:
    - ***Component A:*** Setting up of 10 GW of decentralised ground-mounted grid-connected solar projects of individual project size of up to 2 MW
    - ***Component B:*** Installation of 2 million stand-alone solar-powered agriculture pumps of individual capacity up to 7.5 HP
    - ***Component C:*** Solarisation of 1.5 million grid-connected agriculture pumps of individual capacity up to 7.5 HP

KUSUM – A new solar policy for agriculture

- The program aims to provide clean energy access for irrigation, create an additional income source for farmers who sell electricity back to the grid and reduce costs for farmers relying on diesel pumps.

- **Component-A : Decentralized Grid Connected Solar Power Plants**
- Small solar power plants of capacity upto 2MW can be set-up by individual farmers/ cooperatives / panchayats / Farmer Producer Organisations (FPO) on barren/ fallow/marshy/ pasture or cultivable lands.
- In case, cultivated fields are chosen for setting up solar power plants, the solar panels are set up above a minimum height so that the farmer can continue to grow crops below solar panels.

KUSUM – A new solar policy for agriculture

- **Component-A : Decentralized Grid Connected Solar Power Plants**
- Power generated from solar plants will be purchased by the Distribution companies (DISCOMs) at tariffs determined by the respective State Electricity Regulatory Commissions (SERCs).
- The plant can be installed by the farmer or he can provide his land on lease to a developer, who will install the plant.
- MNRE has issued a model Power Purchase Agreement (PPA) and a Model Lease Agreement.
- The scheme will open a stable and continuous source of income to the rural land owners for 25 years.

KUSUM – A new solar policy for agriculture

- **Component-A : Decentralized Grid Connected Solar Power Plants**
- It has been estimated that farmers will earn up to Rs. 25000 per acre per year if the plant is installed by a developer/ CPSU on the land leased by the farmer, and up to Rs. 65000 per acre per year if they install the plant themselves by taking loan from the banks.
- The RBI has included this Component under priority sector lending.
- Financing options:
  - Farmers can take loan directly from bank and pay EMI from the revenue generated from sale of power to DISCOMs. The balance revenue will be the farmer's income.
  - DISCOMs may take loans on behalf of farmers by signing a tripartite agreement between the farmer, the bank and the DISCOM. The DISCOM will directly pay EMI from revenue generated from sale of solar power and transfer the balance amount to the farmer's account.

KUSUM – A new solar policy for agriculture

- **Component-A : Decentralized Grid Connected Solar Power Plants**
  - Public or private solar power developer/EPC contractor may also take loans on behalf of farmers by signing quadripartite agreement between the EPC contractor, the farmer, the bank and the DISCOM. The DISCOM will directly pay EMI from revenue generated from sale of solar power and transfer the balance amount to the farmer and the EPC contractor in the agreed ratio.
- After the loan is repaid, the total revenue from sale of solar power will constitute the farmer's income.
- The solar power plants will be preferably installed within five km radius of the notified sub-stations in order to avoid high cost of transmission lines and losses

KUSUM – A new solar policy for agriculture

- **Component-A : Decentralized Grid Connected Solar Power Plants**
- DISCOMs will notify sub-station wise surplus capacity upto which generation from solar power plants can be added.
- DISCOMs will invite applications from interested beneficiaries.
- The selected applicants will have to sign PPAs for 25 years with DISCOMs and install the plant as per the provisions of the scheme guidelines and applicable rules and regulations.
- The central Government will provide an incentive of 40 paise/kWh or Rs.6.60 lakhs/MW/year, whichever is lower to the DISCOMs, for buying the power produced under this Component for a period of five years from the Commercial Operation Date of the plant.

KUSUM – A new solar policy for agriculture

- **Component-A : Decentralized Grid Connected Solar Power Plants**
- Since these power plants will be located closer to the consumers in a decentralized manner, it will ensure availability of reliable day-time power.
- The solar power purchased under this component will also help the DISCOMs to meet their Renewable Energy Purchase Obligation (RPO) target.

KUSUM – A new solar policy for agriculture

- **Component-B : Installation of Standalone Solar Powered Agriculture Pumps**
- Individual farmers can replace their existing diesel pumps with solar pumps.
- The replacement of existing diesel pumps with solar pumps will not only reduce the irrigation costs of around Rs.50,000 per year (for 5HP pump) but also lead to reduction in the pollution.
- This Component will benefit 20 lakh farmers in off-grid areas, where there is no source of electric power for irrigation. Priority will be given to small and marginal farmers.
- In order to minimize water usage for irrigation purposes, preference will be given to farmers using micro irrigation systems.

KUSUM – A new solar policy for agriculture

- **Component-B : Installation of Standalone Solar Powered Agriculture Pumps**
- Central Financial Assistance (CFA) upto 30% of the Benchmark cost (fixed by MNRE every year) of the standalone solar pump will be provided.
- The State Government will give a subsidy of 30%; and the remaining 40% will be provided by the farmer. Bank finance up to 30% out of 40% share can be availed by the farmer, so that farmer has to initially pay only 10% of the total cost of the pump.
- However, in North Eastern States, Sikkim, Himachal Pradesh, Uttarakhand, Jammu & Kashmir, Ladakh, Lakshadweep and A&N Islands, higher CFA upto 50% of the benchmark cost of the standalone solar pump will be provided.

KUSUM – A new solar policy for agriculture

- **Component-B : Installation of Standalone Solar Powered Agriculture Pumps**
- Since pumps are generally used for limited period, say 150 days in a year, the installed solar capacity can be utilized for remaining days by using Universal Solar Pump Controller (USPC).
- A USPC enables the farmer to use solar power for other activities like operating his Chaff Cutter, Floor Mill, Cold Storage, Dryer, etc. Installation of USPC is permitted under this Component.
- All solar pumps installed under this Component will be provided with remote monitoring systems so that the functioning of any pump can be monitored on a real time basis.

KUSUM – A new solar policy for agriculture

- **Component-B : Installation of Standalone Solar Powered Agriculture Pumps**
- Selected vendors for installation of solar pump and panel will mandatorily provide repair & maintenance for a period of 5 years from the date of commissioning of the pump.
- They will have one authorized service centre in each operational district and a helpline in local language in each operational State.

KUSUM – A new solar policy for agriculture

- **Component-C : Solarisation of Agriculture Feeders**
- Where feeders have already been separated for agricultural purposes, the feeders may be solarised under the scheme by installing solar power plants of sufficient capacity, either through:
  - DISCOM's own expenditure (CAPEX mode) or
  - utilising services of independent Renewable Energy Service Company (RESCO mode) (selected through competitive bidding on tariff of solar power for 25 years)
- For installation of feeder level solar power plant, CFA of 30% (50% in case of NE States, hilly states/ UTs and Island UTs) will be provided for CAPEX/ RESCO Mode by Central Government and balance will be met through loan from NABARD/PFC/REC.
- The farmers will get day-time reliable power for irrigation free of cost or at tariff fixed by their respective state.

KUSUM – A new solar policy for agriculture

- **Component-C : Solarisation of Agriculture Feeders**
- DISCOM will save expenditure as the electricity delivered by this mode would be much cheaper than present cost of power delivered at distribution sub-station.
- In CAPEX mode, the annual subsidy being presently provided for supply of electricity to agriculture pumps by State Government can be used to repay the loan in five to six years.
- After that solar power will be available free of cost and outflow from State Government's exchequer on account of electricity subsidy for agriculture will come to an end.

KUSUM – A new solar policy for agriculture

- **Component-C : Solarisation of Agriculture Feeders**
- Where agriculture feeders are not separated, loan for feeder separation may be taken from NABARD or PFC/REC.
- The savings on account of electricity subsidy on agriculture and the income from the surplus electricity generated by the solar power plant when it is not being used for irrigation can be used to pay off the loan taken for feeder separation.
- The DISCOMs shall assess the average power requirement by farmers of an area depending upon pump capacity and various other factors. This power requirement will be treated as their benchmark consumption.

KUSUM – A new solar policy for agriculture

- **Component-C : Solarisation of Agriculture Feeders**
- The DISCOMs shall incentivise farmers for consuming power less than benchmark consumption.
- Such saving of power shall be treated as surplus power injected by farmers and they will be paid by DISCOMs against this saved power at pre-determined tariff.

KUSUM – A new solar policy for agriculture

- **Progress under KUSUM (as of end-2023)**
- PM-KUSUM Scheme has been extended to solar power capacity addition of 34.8 GW by 31.3.2026 with total central financial support of Rs. 34,422 Cr.
- Targets achieved so far:
- Component-A: Target: 10 GW; Sanctioned: 4.766 GW; Installed: 0.141 GW
- Component-B: Target: 2 million; Sanctioned: 0.971 million; Installed: 0.278 million
- Component-C:
  - Individual Pump Solarisation: Target: 0.75 million; Sanctioned: 0.134 million
  - Feeder Level Solarisation: Target: 0.75 million; Sanctioned: 2.912 million; Installed: 4594

Challenges in implementation of KUSUM

- **Feeder segregation**
- Had been a challenge in initial years. Situation has improved with sustained investment in this regard.
- However, still 31,119 feeders out of a total of 80,631 rural feeders are yet to be segregated. The estimated cost for this is around Rs. 43,000 crores.
- **Supply constraint of "made in India" solar cells**
- New production capacity in the domestic market is not developing rapidly as cell manufacturing is highly capital intensive, and most module manufactures are small and medium enterprises.

Challenges in implementation of KUSUM

- **Sanctity of Power Purchase Agreements (PPAs)**
- Although states have followed competitive bidding to hand over the power purchase agreements (PPAs), a few states are cancelling or revisiting their PPAs because of reduced solar panel prices.
- Finally, the MNRE stated that no contractual agreements could be revisited as this would disturb the national goal of renewables and impede the investors' confidence and trust.
- **Financial viability of the DISCOMs**
- As the financial viability of the DISCOMs will be an essential factor in achieving the targeted number, adequate financial support to DISCOMs to meet its solar PPA commitment is crucial.

Challenges in implementation of KUSUM

- **Appropriate incentives for investors and farmers**
- For farmers to invest in solar pumps, setting an appropriate buy-back tariff is essential.
- Currently, KUSUM guidelines do not provide any estimated range for the buy-back tariff.
- If the tariff is set low, farmers are better off pumping more water for self-consumption and selling to other farmers through informal water markets, rather than conserving water and energy to sell back to the grid.
- **Farmers limited financial capacity**
- The main problem faced by farmers under Component A is that they cannot fulfil the financial requirement to set up decentralised power plants. Banks are hesitant to issue loans by keeping agricultural land as collateral.

Challenges in implementation of KUSUM

- **Technical challenges**
- Need for adequate in-house technical capacity to design the system and design a real-time remote monitoring system.
- Currently, KUSUM has not set up an adequate scope for R&D activities to overcome the challenges faced under the scheme, which need to be addressed.

Summary

- Intensive schemes for solar powered irrigation in India – both at Central as well as provincial levels.
- Innovative design of schemes – benefiting both the farmers as well as the DISCOMs.
- Linking of water and energy conservation with solar pumping transition.
- Not-so-impressive ground implementation despite all the above features.
- Need for better understanding of farmer demographics and needs.
- More effective communication to and awareness campaigns for farmers.
- Need for enhancing the financial viability for farmers.

Thank You