Executive Summary

The agricultural sector in Karnataka accounts for 39% of the state's electricity (~21,344 MU). This is provided for free, or at heavily subsidised rates, to farmers. Moreover, electricity is not metered. This has led to an estimated revenue loss of INR 9,295 crores for the state DISCOMs. The Government has attempted several initiatives to reduce this loss. One option being followed is segregation of domestic and agricultural feeders. This enables regulating power supply to agricultural consumers and providing 24X7 power to domestic consumers. This has been implemented in 4,364 feeders out of a total of ~6,078 mixed feeders in the state.

The feeder separation provides an opportunity for use of solar energy to supply electricity to agricultural feeders. Karnataka not only has good solar radiation profile but is also a leading state in solar installations with a commissioned capacity of ~5.1 GW. This is expected to cross 10 GW by 2025. Therefore, there is a case to examine viability of solar power for supplying dedicated agricultural feeders (DAFs).

The Energy Department requested CSTEP to assess the technical and economic feasibility of supplying the DAFs with solar-based generation. The objective is to determine whether existing and proposed PV plants (1-5 MW) can supply these feeders directly, thereby reducing losses and increasing accountability in terms of metering. CSTEP undertook this study and analysed various system designs to construct an implementable roadmap with policy recommendations for the Energy Department.

CSTEP considered 5 system design options, of which 3 are off-grid and 2 are grid connected. These are tabulated as below:

- ***Case 1: Off-Grid PV Plant with Battery Storage***
- ***Case 2: Off-Grid PV Plant with Water Storage***
- ***Case 3: Off-Grid PV Plant with Battery Storage and Scheduling***
- ***Case 4: Grid-Connected PV Plant with One-Way Export to Grid:*** This further included 3 storage options: battery, battery and scheduling, and water storage.
- ***Case 5: Grid-Connected PV Plant with Import/Export Option:*** This included 2 options: feeder at LT side of substation and feeder at HT side of substation.

  The project conducted a detailed techno-economic analysis of the above mentioned 5 system designs. The levelised cost of electricity (LCOE) is provided in the table below.

System Design	*Off-Grid PV (Case 1-3)*			*Grid-Connected with One-Way Export (Case 4)*			*Grid-Connected with import/export option (Case 5)*	
	Battery Storage	Battery Storage & Scheduling	Water Storage	Battery Storage	Battery Storage & Scheduling	Water Storage	Feeder at LT Side of Substation	HT Side of Substation
LCOE (INR /kWh)	11-25	12-30	9-12	7-17	6-23	5.5-8	4-5	3.8-4.7
Comments	• Too expensive • Scheduling has political and social acceptance issues			• Reverse power relays are not present in the distribution sector till date • Water storage possible only in places with river/canal-based irrigation			• Issues of inaccurate metering • DISCOMs need to be more co-operative and proactive	

The main findings of the report are as follows:

- Based on the above, off-grid PV systems are too expensive because of the high cost of energy storage. Grid connected option with one-way export is also not economical. However, grid connected with import/export is economically feasible and can be implemented in the state.
- The Government can choose 10% of the existing DAFs across DISCOMs. 5% of these can be connected to existing solar plants connected at the HT side and the other 5% can be connected directly to existing Farmers' Scheme plants (1-3 MW) at the LT side of the respective substations. These pilots can then be monitored for two years to check whether metering protocols are being adhered to and there is substantial increase in accountability and reduction in losses for DISCOMs.
- Two other feeders can be chosen to test the feasibility of using off-grid PV with water/battery storage and one-way export to the grid with innovative relay technologies. One feeder can be in an area with river and canal-based irrigation practices (water storage option) and the other can be in any DISCOM area.
- DISCOMs will need to co-operate in terms of maintaining accurate meter readings and providing support to the solar developers who will connect to the feeders directly.
- Farmers will need to be more proactive when it comes to providing updated information regarding their IP sets and also pay a nominal rate of INR 0.25-0.5/kWh.
- Regular audits and inspections need to be undertaken by independent third-party organisations in order to provide objective and unbiased reports/recommendations/evaluations of the progress of such a programme.

KREDL, Energy Department, KERC and DISCOMs need to work in a collaborative manner to ensure the success and sustainability of such a programme.