



DST-UKIERI Work Shop **"SKY"-Surya-Shakti Kishan Yojna** for Solarization of Ag Consumers

Presented By:

Jatin Upadhyay, DE (R&D), GPRD Cell, GUVNL.dernd2@gprd.in



Out Line Of Presentation



- > Introduction of the SKY Scheme for its various key concerns.
- Introduction of Feeder level connection scheme for SKY
- Introduction to KEY components for SKY: Metering Console and Watch Dog Transformer/Device.
- Introduction to Monitoring software: Solar Energy Data Management(SEDM)
- > Discussion on one Case Study for various aspects after SKY implementation



Introduction Of SKY Scheme



- > Background and Objective of Scheme
- > Implementation Profile of the Scheme
- > Benefits to Farmers and Society
- > Financial Source, Income, Repayment
- > Future Indications





- Ensuring day time power to farmers
- Providing secondary source of income for farmers supporting Gol
 - objective of doubling farmers income by 2022
- > Reducing electricity subsidy burden of state government
- > Reducing cross-subsidy burden of other consumers
- > Improving financial health of DISCOM
- > Supporting Gol target of 175 GW renewable energy by 2022

Agriculture Consumption V/S Revenue







Agriculture : Electricity	Bill R	ecovery
Farmers	:	Rs. 1,103 Cr.
Government subsidy	•	Rs. 5,088 Cr.
Cross subsidy	•	Rs. 4,358 Cr.
TOTAL	•	Rs. 10,891 Cr.



Implementation Profile



- > Scheme applicable for Grid connected Farmers i.e. the existing Agriculture consumers.
- At least 70% of the existing consumers of the individual distribution feeder should participate in the scheme.
- > The capacity of grid Connected Solar PV would be 1.25 times of Contract Load in HP. Farmer can also install additional Solar PV Capacity with limited scheme benefit
 - e.g. 10 HP AG Connection \rightarrow 12.5 KW Solar PV System
- The selected feeder shall be provided 3-Phase Power Supply from for 12 Hours during Day time from sunrise to sunset
- Capital cost sharing
 - 30%, CFA
 - 30%, GoG Loan
 - 35%, GoG Loan on behalf of farmer, Loan period is for 7 years.
 - 5%, Farmer Upfront Payment
- > Farmer Revenue on net generation (i.e. generation minus consumption)
 - Rs. 3.50 /kWh, Feed-in Tariff by DisCom on net generation
 - Rs. 3.50 /kWh, Evacuation-based Incentive (EBI) as Govt. of Gujarat Subsidy, for 7 years, up to 1,000 kWh/KW/year

Note: EBI is a generation-based subsidy by Govt. of Gujarat to match MNRE's 30% capital subsidy.



Benefits To Farmers



- The ownership of Solar System is of Farmer after Loan period completion
- > Permanent Income to Farmer for injecting surplus energy into grid.
- > 12 Hours of power supply during day time with Grid support
- > It is possible to grow crop under the solar panel as well.
- Social Empowerment of farmer
- Consolidation of Rural Economy by Local employment generation opportunity





- Gujarat Power Research and Development Cell, GUVNL, IIT-Gandhinagar
- > One third reduction of generation of electricity through Non-Renewable sources and preservation of Environment.
- Due to distributed solar generation, land requirement for solar parks, expensive infrastructural modifications could be avoided.
- > Maximum utilization of installed distribution network.
- Reduction in Transmission and Distribution Losses.
- Reduction in burden of agriculture subsidy.
- Reduction in cross subsidy to other consumers
- Conservation of Energy and Water



Farmer's Cash Flow (Case: 10 hp, 12 kW)



Farmer's Expenses			
Total System Cost	(SPV Cost)		Rs. 6,03,540
Upfront Investment	(@5% of SPV Sys	stem Cost)	Rs. 30,157
Loan Amount	(@65% of SPV :	System Cost)	Rs. 3,92,301
Loan Terms			6% p.a., 7 years
Annual Loan Repayment			Rs. 68,771 /yr
Farmer's Income		During Loan Term (Up to 7 years)	After Loan Term (Beyond years)
Sale to DisCom	(@ Rs. 3.50/ kWh)	Rs. 46,200 /yr	Rs. 46,200 /yr
Evacuation-based incentive (1000Kwh/KW/year)	(@ Rs. 3.50/ kWh)	Rs. 42,000 /yr	-
Savings in electricity bill		Rs. 4,800/yr	Rs. 4,800 /yr
	Gross Income	Rs. 93,000/yr	Rs. 51,000 /yr
Annual Loan Repayment	(Less:)	Rs. 68,771 /yr	
Farmer's Net Annual Income		Rs. 24,229/yr	Rs. 51,000/yr



Data Base for Pilot Project for 137 AGDOM feeders



Sr.	DisCom	No. of Feeders	Avg. Consumers /Feeder	Avg. 'HP' /Consum er	Avg. 'kW' /Consumer	Total Pilot Cost (Rs. Crore)	Metering Console Qty	WDD Qty
1.	DGVCL	21	118	6.31 hp	7.89 kW	Rs. 106.94	1663	683
2.	MGVCL	33	85	11.01 hp	13.76 kW	Rs. 193.40	2466	843
3.	UGVCL	23	49	22.11 hp	27.64 kW	Rs. 144.07	921	345
4.	PGVCL	60	99	11.86 hp	14.86 kW	Rs. 423.95	5160	1807
	TOTAL	137	91	11.49 hp	14.36 kW	Rs. 868.37	10210	3678



Technical Connection Scheme







Feeder-level Scheme Details



Gujarat Power Research and Development Cell, GUVNL, IIT-Gandhinagar



Farmer-level Metering Scheme

Gujarat Power Research and Development Cell, GUVNL, IIT-Gandhinagar

Metering Console

RESEARCH & APILITY DEPUTY

Salient features

- 1. 3-Phase **Bidirectional** Energy Meters with RS485-3 Nos (Whole current/CT meters)
- 2. i. Solar Generation Meter (Solar Generation Recording)
 - ii. Consumption Meter (Pump Consumption Recording)
 - iii. Net Meter (Consumer Tariff Meter for Import-Export Energy Recording)
- 3. Single Phase Unidirectional Energy Meter with RS485-1 No (If Sky consumer is with farm house connection)
- 4. Communication Device- IoT based DCU with RS485
 - Communication media: GPRS/GSM/Wi fi/Ethernet
- 5. Enclosure with double shutters make it pilfer proof
- 6. Weather proof, can be installed out door
- 7. Readymade meter wiring with incoming and outgoing terminal connectors
- 8. IoT device with local storage SD card
- 9. Single communication device will communicate all 4 meters, inverter
- 10. facility can be developed in future if required for Connect/Disconnect

Metering Console

Gujarat Power Research and Development Cell, GUVNL, IIT-Gandhinagar

Whole Current Meter Type

CT- Meter Type

Watchdog Device & Watch dog Transformer

Gujarat Power Research and Development Cell, GUVNL, IIT-Gandhinagar

Need For Watchdog device

- 1. There are 2 Types of Power supply Schedules for Agriculture feeders of Gujarat DISCOMs (1) 3 Phase (2) 1 Phase
 - During 3 Phase schedule Agriculture consumers avail 3 phase power supply for only 8 hours per day for remaining Hours avail 1 Phase supply
 - Schedule of 3 Phase power of each agriculture feeder supply changes every week.
- 3. SPV system to be installed under SKY scheme needs grid support during day hours i.e. 7am to 7pm
- 4. As per scheme provision, feeder will be covered under SKY with minimum 70% farmers participation
- 5. SKY feeders Shall be provided 3 phase power supply for day time 12 hours and for rest of the hours, single phase through SDT/PLMT as per prevailing practice
- 6. 3phase power supply for 8 Hours to non-SKY consumers shall be catered through Watchdog Transformer/Watchdog Device. For rest of the hours single phase power supply through WDT and SDT/PLMT.
- 7. Power supply schedule and various Parameters Can be remotely Configured as and when required.
- 8. If SKY feeders is made ON for 24 Hours, the non-SKY consumers can be scheduled in rotation mode during day/night hours also.

Watchdog Device & Watch dog Transformer

Gujarat Power Research and Development Cell, GUVNL, IIT-Gandhinagar

Watch Dog Device

Watch Dog Transformer

Key Components of WDD/WDT

- Energy Meter
- IoT Based DCU
- Contactors
- SMPS
- Power Terminal Block
- Door Sensor

Watchdog Device

WDD/WDT-Operation Modes

➢ Non Solarization Mode

- Similar to existing system, Feeder inputs = Feeder Output
- Input : 3 Phase Voltage → Output : 3 Phase
- Input : 1 Phase Voltage → Output : 1 Phase

Solarization Without Compensation Mode

- Duration and "Start/Stop Time" Based Mode
- Current Time Day Start Time <= Three Phase Running Hours Limits

Solarization With Compensation Mode

- Three Phase Output running hours based mode
- In case feeder is off for half an hour during three phase Start and Stop time, farmer will get additional half an hour extension because feeder will remain in Three phase for 12 Hours a day due to solar plant
- "Three Phase Output Running Hours" <= Three Phase Running Hours Limits

➢ Remote Control Mode

- Remote operations :
- 1. All Three Phase On
- 2. All Three Phase Off
- 3. Single Phase On

Dash Board – Feeder Status

- Consumer Summary
- Communication Summary
- Input Status Summary
- Power Summary
- Voltage Summary
- Output Status Summary

Communication 1		Feed	er Input 🅽	Status 1	
LIVE	? : 10/12	SINGLE PHASE	: 0/10	THREE PHASE AVAILABLE	: 10/10
DISCONNECTED	? : 0/12	THREE PHASE	: 10/10	PUMP ON	: 4/10
GOOD SIGNAL STRENGTH	? : 2/12	FAULT	: 0 /10	INVERTER ON	: 0/10
AVG SIGNAL STRENGTH	? : 5/12				
POOR SIGNAL STRENGTH	? : 3/12				
PORT ERROR	: 9/12				

Consumer End Voltage 🕽		Feeder Po	ower (kW) l	Fault status - SEDM : WDDJ		
	v min.	: 250.33	TOTAL NET KW	: -244.09	FEEDER FAULT	: 0/10
	v max.	: 259.94	TOTAL PUMP KW	: 109.87	OVER CURRENT TRIP	: 0/10
			TOTAL SOLAR KW	: 354.36	UNDER VOLTAGE TRIP	: 0/10
			TOTAL DC KW	: 0.00	CONTACTOR FAULT	: 0/10
			TOTAL AC KW	: 0.00		

- > Map View and Grid View
 - Geo Location of Consumer
 - Separate Indication based on Current Status
 - Consumer Details
 - Consumer Type & Ratings
 - Communication Status
 - Power Status
 - Output Status
 - Voltage Status
 - Hyperlink for Detail Analysis of Individual Consumer

No. 🗠	Consumer Details	Load Details	Type & ratings 🗘	Communication Status	Communication 🗘	Voltage 🗘	Feeder Power (Fdr to Cons : +, Cons to Fdr : -)	Ŷ	Status 🗘
1	26232005520, PATEL PRAKASHBHAI AMBALAL	Contract Load (HP) : 36 Pump (HP) : 36 MD Limit (KW) : 26.84 AC Plant Capacity (KW) : 50	Category : Sky- Solar Rating : 100/5	X	RSSI:Good (25) PORT :	R : 253.67 Y : 256.05 B : 254.04		4-02-2019 13:28:01] 4-02-2019 13:28:01] 4-02-2019 13:28:01]	∱ ₽ ₩

Gujarat Power Research and Development Cell, GUVNL, Gandhinagar

➤ Map View

- Longitude, latitude of actual installed location has been mapped
- Identification of System based on Current
 Status

- Live, Generation Off, Pump Off ∠
- Live, Generation Off, Pump On
- Live, Generation On, Pump Off
- Live Generation On, Pump On

Consumer wise all four Meter Instantaneous Data & Trend Analysis

Consumer and meter wise Power Trend and Export energy Chart

WDD/WDT Consumer Monitoring

Gujarat Power Research and Development Cell, GUVNL, Gandhinagar

		TOTAL SKY CONSUMERS	TOTAL N SKY CONSUMERS N SKY NON A	AG. TOTAL PUMP LOAD TOTAL SOLAR CAPAC
⊨ Energy Audit			Interpolation	Summary Grid 13/02/2019 - 13/02/2019
Total Pump Consumption (kWh) Feeder to Consumer (Draw	l) (CI) Net Energy (kWh)	Substation to Feeder (FI) (kWh)	Net Feeder Energy (kWh)	Avg Consumption/Day/HP (kWh)
2298.00 921.71	-388.47 🔺 🔒	684.00	-222.00	4.73
Solar Generation (kWh) (kWh)	ion) (CE) Energy Check (5.94) (kWh)	Feeder to Substation (FE) (kWh)	CUF (%)	Avg Generation/Day/kW (kWh)
2692.41	0.16 %	906.00	17.81	4.27
3 System Uptime Interpolation for 13/02/20	9- 13/02/2011 9 Feeder Loss calculation			
Comm. DownTime (%)	Feeder Loss (166.47) (kWh)	• Fixed Loss (99.71) (kWh)	e Accour	ntable Loss (AL) (66.76) (kWh)
8.39	8.35 %	5 %	3.35	5%
Feeder DownTime (%)	Consumer to Feeder After Loss (kV	Vh) 😧 Feeder To Consumer After I	Loss (kWh) 😧 Net En	ergy After Loss (kWh)
0.38	1266.32	952.57	-313	3.75

Feeder Analytics

- Energy Analytics
- Feeder Energy Analytics
- Loss Calculations and Distribution
- Energy Summary Reports
- Performance Analytics
- System Analytics

Pump Consumption Monitoring

- Total Pump Consumption Indicator
 - Sum Of Consumption of All Consumers in chosen duration
 - Consumption = Last Reading Initial Reading
- Total Pump Consumption : Feeder Trend
 - Day Wise Total Pump Consumption in chosen Duration is plotted in bar chart
- Consumer wise Consumption :
 - Consumer Wise Total Pump Consumption in chosen Duration is represented in table/grid
- Consumer Consumption Trend:
 - Day Wise Pump Consumption of selected Consumer for chosen duration is plotted in bar chart

Total Pump Consumption (kWh)	0
2298.00	*

Solar Generation Monitoring

- Solar Generation Indicator
 - Sum Of Generation of All Consumers in chosen duration
 - Generation = Last Reading Initial Reading
- Solar Generation : Feeder Trend
 - Day Wise Solar Generation in chosen Duration is plotted in bar chart
- Consumers wise Solar Generation :
 - Consumer Wise Solar Generation in chosen Duration is represented in table/grid
- Consumer Solar Generation Trend
 - Day Wise Solar Generation of selected Consumer for chosen duration is plotted in bar chart.

Solar Generation (kWh)	
23308.25	ê

- > Substation to Feeder (FI) Indicator
 - Feeder Meter Import Energy in chosen duration
- ➢ Feeder to Substation (FE) − Indicator
 - Feeder Meter Export Energy in chosen duration

Feeder – Loss Calculations

- > Feeder is a Star Point receiving from multiple sources and providing it to multiple loads
 - All Input to Feeder = CE + FI (Consumer Export+ Feeder Import)
 - All Output From Feeder = CI + FE (Consumer Import+ Feeder Export)
 - Loss = All Input to Feeder All Output from Feeder
 - Loss (KWh)= (CE+FI) (CI+FE)
- Fixed Loss = (Feeder Input Energy * 5%)
 - Feeder Input Energy (FIE) = Feeder Import Energy + Consumer Export Energy
- Accountable Loss (AL) = Total Feeder Loss Feeder Fixed Loss
 - Loss is less then Fixed loss then Accountable loss is Zero (0)
- Loss to be distributed only on SKY Consumers (Not on NSKY, Non AG). If Accountable loss is zero (0) then no loss should be applied to Consumers.
 - Consumer to Feeder After Loss = CE-((AL/FIE) * CE)
 - Feeder to Consumer After Loss = CI + ((AL/FIE) * CI)
 - Net Energy After Loss = CI After Loss CE After Loss

Performance Analytics

- Avg. Consumption Per Day Per HP
 - Average of Sum Of Consumption of All Consumers per HP in chosen duration
 - Total Pump Consumption / No of Consumers / HP
- > Avg. Generation Per Day Per kW
 - Average of Sum Of Generation of All Consumers / kW in chosen duration
 - Generation / No of Consumers / kW
 - Avg. Generation Feeder Trend
 - Day Wise Average of Generation / kW in chosen Duration is plotted in bar chart
 - Avg. Solar Generation Consumer Trend
 Day Wise Generation of selected Consumer / kW for chosen duration is plotted in bar chart.

Performance Analytics

- Avg. Consumption Per Day Per HP
 - Average of Sum Of Consumption of All Consumers per HP in chosen duration
 - Total Pump Consumption / No of Consumers / HP
- Avg. Generation Per Day Per kW
 - Average of Sum Of Generation of All Consumers / kW in chosen duration
 - Generation / No of Consumers / kW
 - Generation : Feeder Trend
 - Day Wise Average of Generation / kW in chosen Duration is plotted in bar chart
 - Consumer Trend
 - Day Wise Generation of selected Consumer / kW for chosen duration is plotted in bar chart
- > Avg. System Three Phase Availability
 - Average of Three Phase Supply Hours available of all Sky Consumers in chosen duration.
 - If Three Phase supply is available to Consumer then IoT System calculates three phase available minutes

SKY-Nityanand feeder of UGVCL

Gujarat Power Research and Development Cell, GUVNL, Gandhinagar

34

Site Photographs for installation & Commissioning

Site Photographs for installation & Commissioning

Installation of Harmonic Analyzer on SKY Feeder

HEELARCH & OFFICE UGVCL CUSAL CUSAL

Gujarat Power Research and Development Cell, GUVNL, IIT-Gandhinagar

Thank You