Rajasthan Agro-PV Integration Study

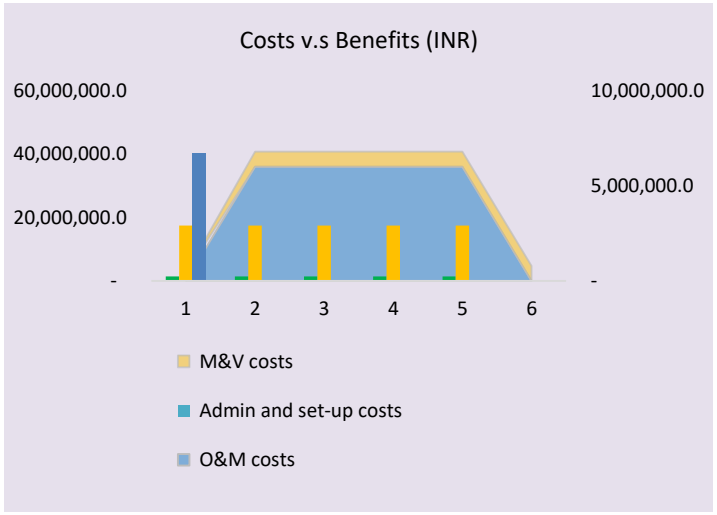
Distributed Energy Division,
Source Advisory

The Dashboard

To Bring You Up to Speed

10 Pumps would give savings of 0.1MU/ annum reducing total tariff by INR 0.001/ kWh with a payback period of <10 years/ per pump and the bottom line up by ~INR8 Cr.

Parameters (ECBA DISCOM)	Values
NPV of benefits (INR)	65,513,377.7
NPV of costs (INR)	47,983,382.1
Net benefit (INR)	17,529,995.6
Savings (kWh/annum)	**108,872.2**
Net benefit/ No. of units	**0.00094**



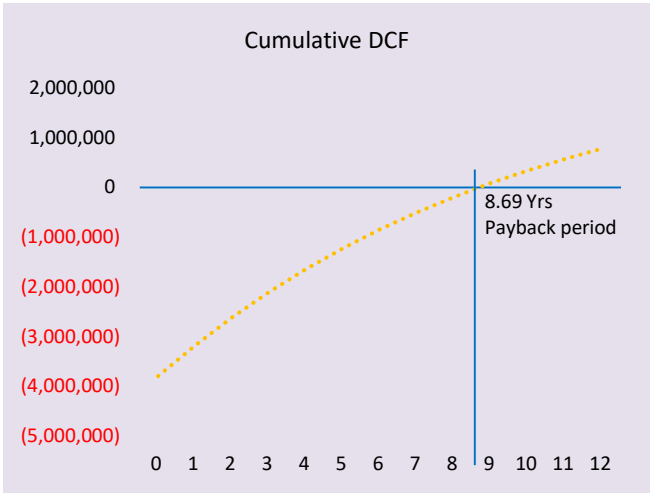
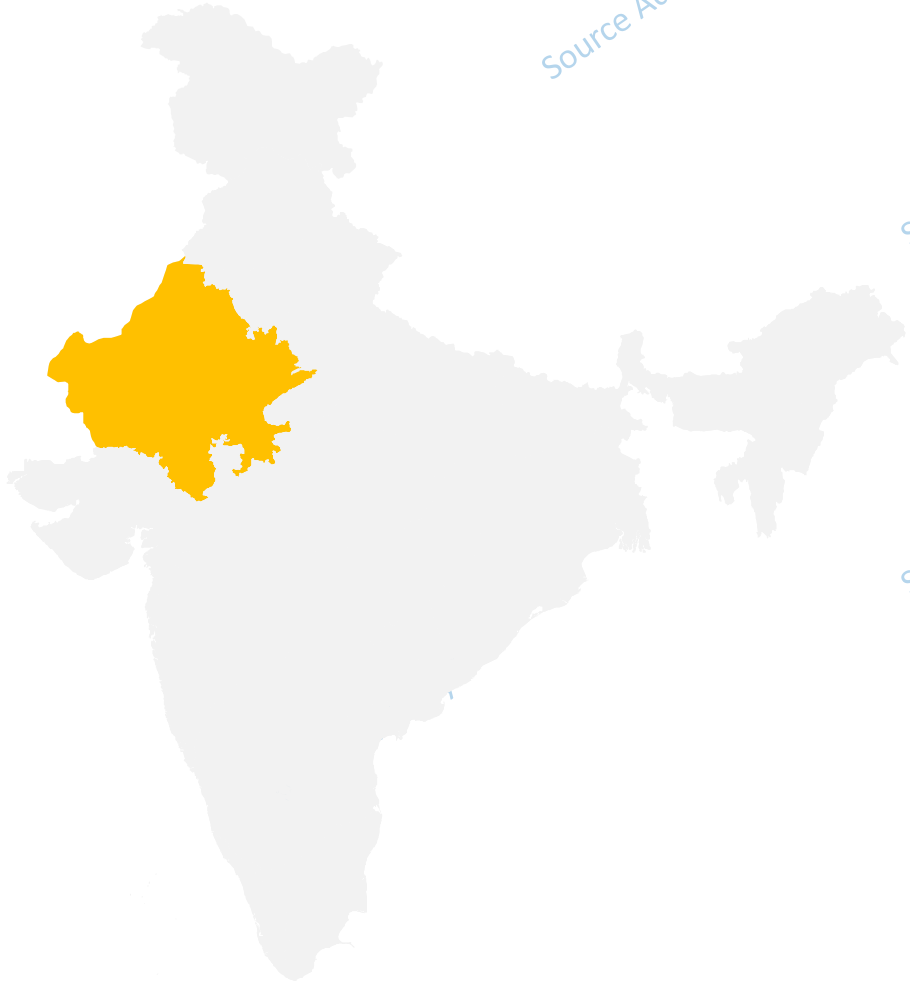


Table of Contents

Table of Contents

Chapter 1: Mharo (my) Rajasthan!



State: Rajasthan
Capital: Jaipur
Area: 342,239 km² (10.4% of India's geographical area)
Population: 6.89 crores (as per 2011 census)
Major industries: Agri-based, Cement, Tourism, IT, ITeS, Ceramics, Handicrafts, Chemicals, Textile, Marble and Steel

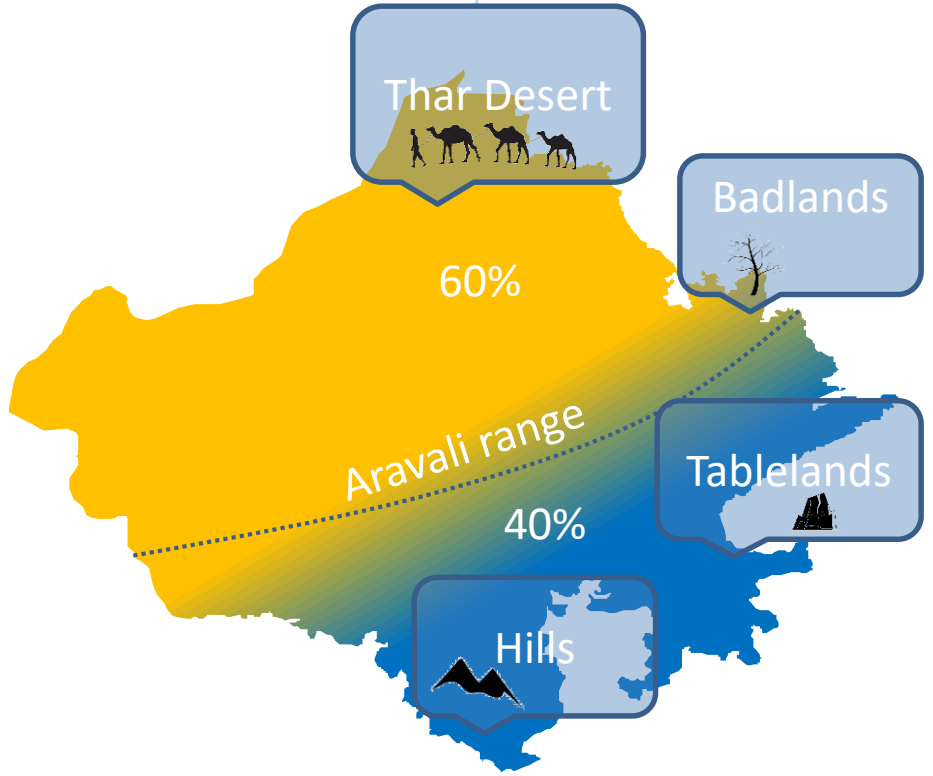
References:
[1] State economic survey – IBEF

Thar Desert situated to the North-west of the Aravali range occupies 60% of the Rajasthan

The Aravali range divides Rajasthan into two parts. To the northeast of the Aravali is Thar desert covering almost 60% of the land of Rajasthan. In the South there is hilly region of Mewar. [1]

Bundi and Kota in the east occupy the tablelands, whereas Bharatpur area in the North-east is covered in badlands. [1]

Rajasthan usually has dry climatic conditions throughout the year. Temperature varies from scorching hot 50 - 55° C in the summers to 0 - (-4)° C in winters. Northwestern Rajasthan experiences very little to no rainfall. The average rainfall in Rajasthan is somewhere less than 400 mm per annum. [1]



Maximum Temp.: 54°C
Minimum Temp.: Below freezing point
Rainfall: less than 400mm/ year

References:

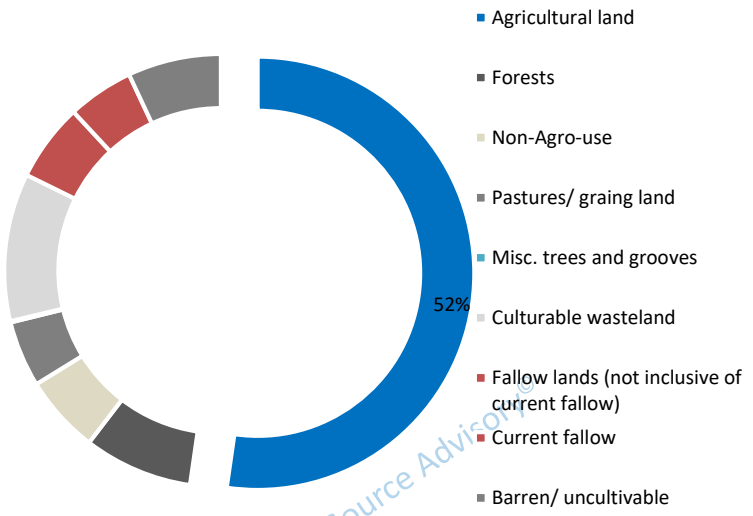
~52% of the total land is the net sown area

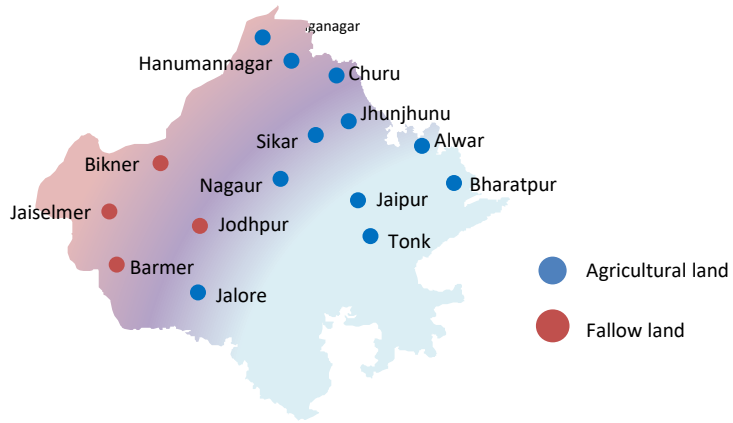
Rajasthan's land is primarily covered by Thar Desert. However, intervention of irrigation technology and canal systems have made major proportion of the land cultivable. [2]

Land use pattern in Rajasthan shows more than 50% of the land is under agricultural use. Major districts with high density agriculture include Ganganagar, Harirampur, Churu, Jhunjhunu, Jalore, Nagaur, Sikar, Alwar, Bharatpur, Jaipur and Tonk. [2]

Also, in some parts where only seasonal farming is possible is referred to as fallow lands. Fallow lands are also classified into two – Current fallow and non-current fallow. Current fallow is the land which is still in use for cultivation and agriculture and includes Jodhpur, Jaiselmer, Bikaner and Badmer. [2]

Land Use Pattern In Rajasthan [2]





References:
[2] Rajasthan economic review 2019-20

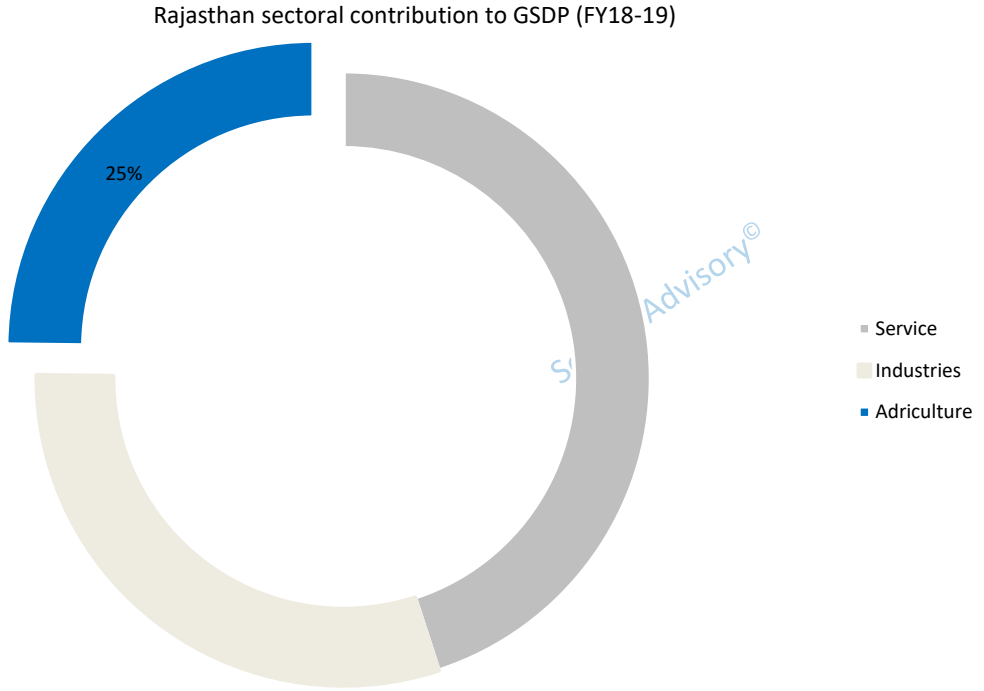
Agriculture makes 25% of the sectoral mix in the GSDP contribution

Having more than 50% of area under agricultural use, various crops like wheat, millets, barley, sugarcane, pulses etc. are grown in the state with Cotton and Tobacco being its primary cash crops. [1]

Agriculture contributes 25% of the GSDP mix in Rajasthan. Though agriculture contributes the least to the state's economy, yet Rajasthan stands out in its agricultural produce throughout the country. [1]

Rajasthan is the largest producer of rapseed, bajra, gaur seed and spices like – fenugreek, coriander, cumin, fennel and mustard. It is the second largest producer of edible oils and the third largest producer of soya bean and coarse cereal in India.

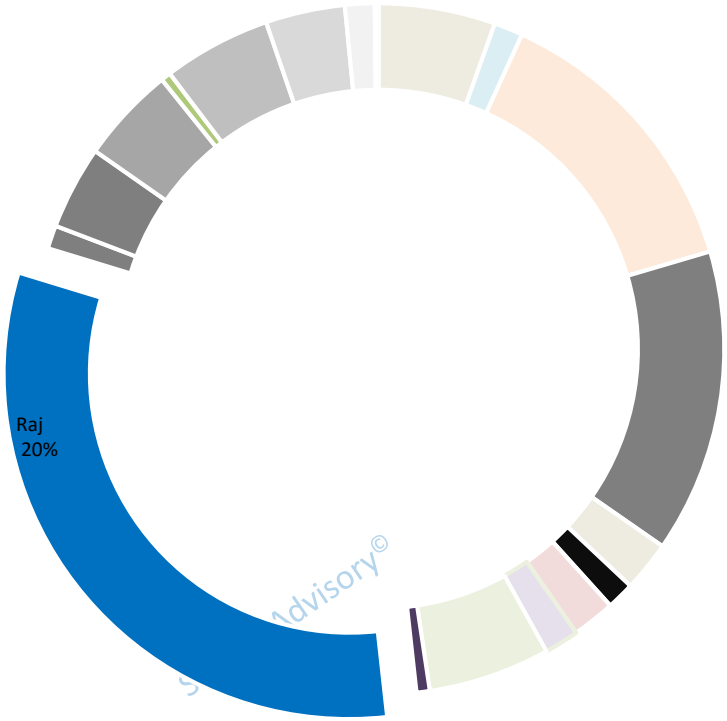
Though the climatic conditions in Rajasthan are tough for agriculture, yet one favorable aspect is the availability of sun round the year.



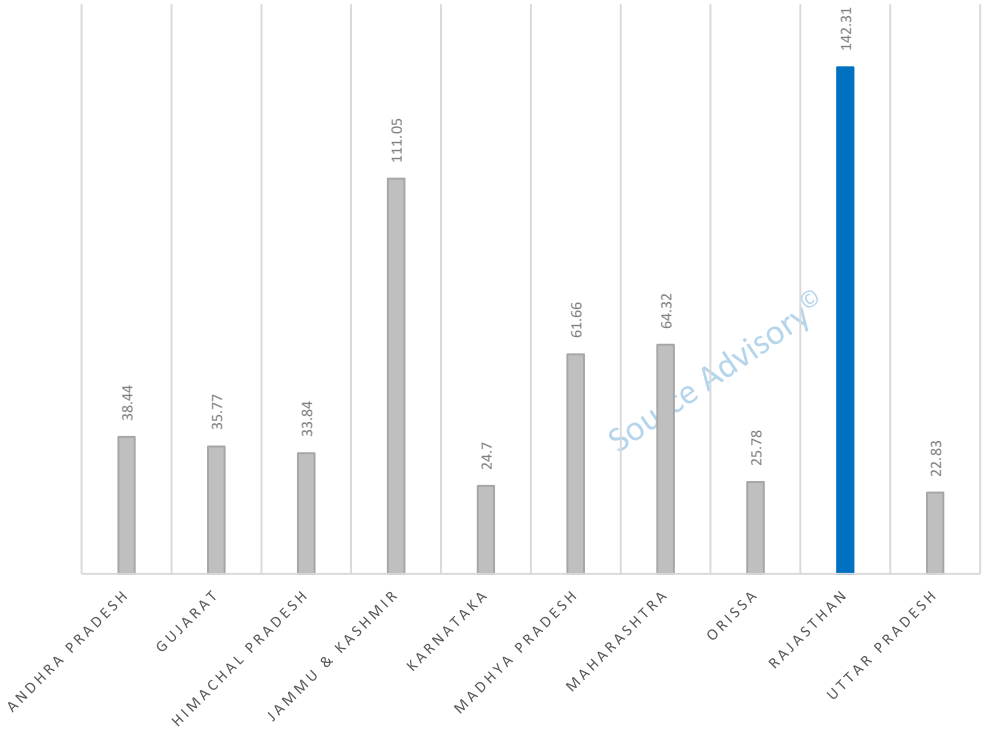
References:

Chapter 2: Sun shines on the land on kings

Indian States – Solar Potential (GW.p)[3]



Solar potential (in GW)[3]



References:
[3] Solar energy potential – MNRE

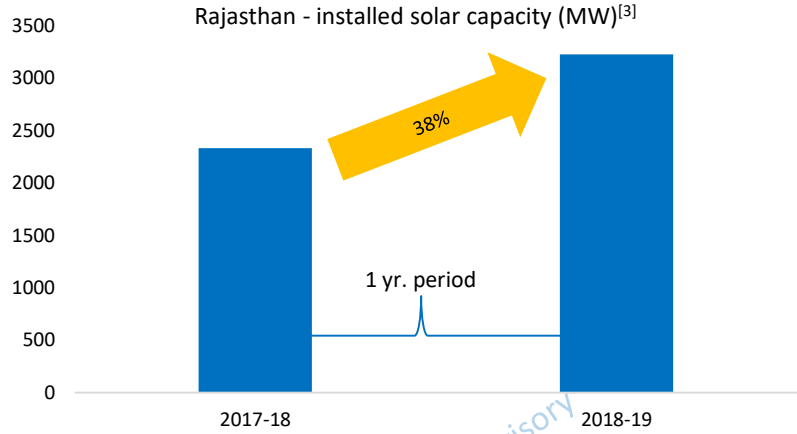
38% rise in installed capacity from last year, however only 20% of total solar pumps

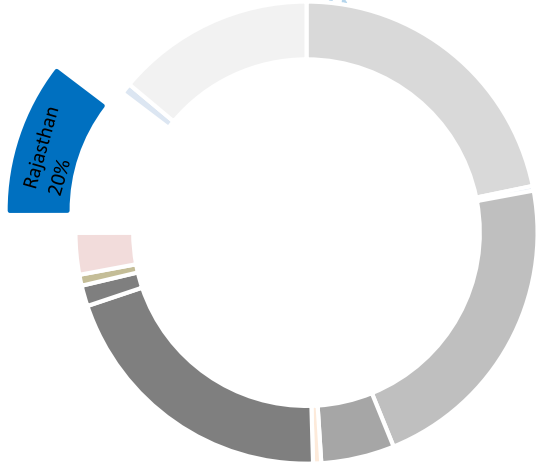
Rajasthan is blessed with humongous solar potential of about 145GW, which is highest among all states in India. In 2017-18 the installed solar capacity was somewhere in between 2 – 2.5GW. In one year the capacity rose by 38% to about 3.3GW. [3]

Also, Rajasthan has the second largest installed capacity in off-grid solar plants after Chhattisgarh. It is about 30MWp as of 31st March'19, which is ~14% of the total installed capacity of off-grid solar in India. [3]

Number of solar pumps installed in Rajasthan under various schemes totals to ~50k, which is estimated to be 20% of the total solar pumps installed in India. This is comparatively lower than other states. [3]

One possible reason is that the power network developers and operators (TRANSCo.s and DISComs.) have done a great job contributing to lower requirements of solar pumps. However, the unfamiliarity of the impact of solar pumps on the bottom line of the power distribution companies could be alarming. Let's ponder upon some interesting case studies in the next chapter about what other states and the rest of the world is doing?





References:

Chapter 3: Some interesting developments in last few years – Case Study 1 – Analysis of Gujarat's SKY from a farmer's P.O.V.

1

GUJARAT's AGRO-SOLAR POLICY[4]

Gujarat launched the Suryashakti Kisan Yojana (SKY) to encourage farmers to install solar panels in their fields:

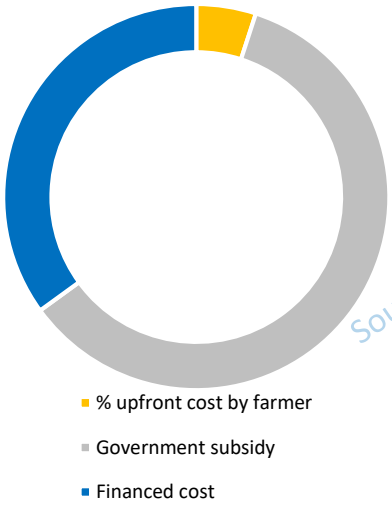
- Under the policy, only 5% of the cost will be paid by farmers, 60% cost would be subsidized by the government and the rest would be financed at ~4% annual interest rate
- These solar panels will be installed on poles by state-owned power generation utilities, so that farmers can grow their crops while the plant generates energy
- Farmers will be able to use as much electricity as required and sell the excess to these utilities
- Post the purchase of surplus energy, theses generation utilities will also share 30-40% share of their profit with the farmers

Sensitivities	
% upfront cost by farmer	5%
Government subsidy	60%
Financed cost	35%
Interest rate	4%
Electricity Tariff (INR)	5
Profit sharing by utilities (%)	40%
Per year degradation %	2%
Debt tenor (years)	25

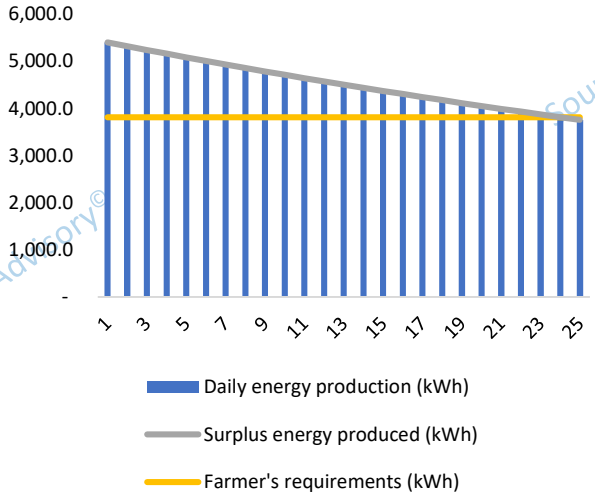
Major Outputs [5]	
NPV of cashflows (INR)	320,265.5
Average DSCR	1.12x

Sources and Uses of finds [5]	
Farmer's equity (INR)	42,700.0
Farmer's loan (INR)	298,900.0
Government's subsidy (INR)	512,400.0
Total asset value (INR)	(854,000.0)
Check	-

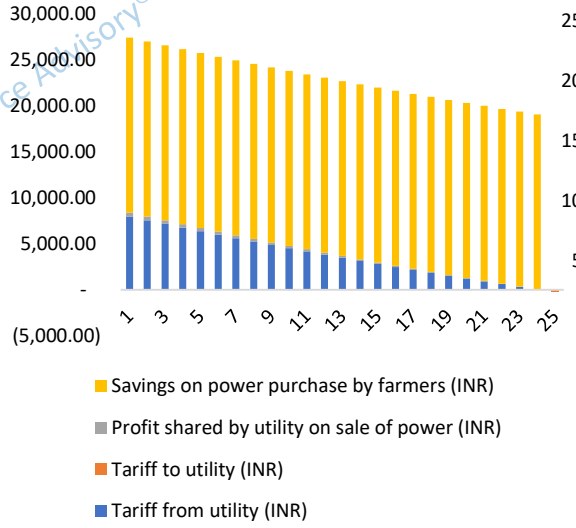
Funding structure [4]



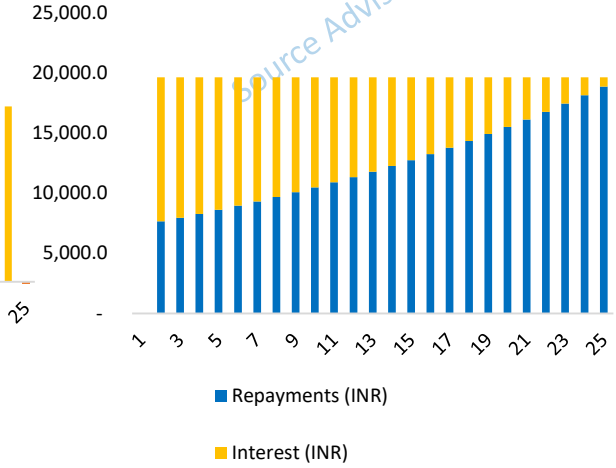
Energy Accounting [5]



Operating cashflow [5]



Debt Payments [5]



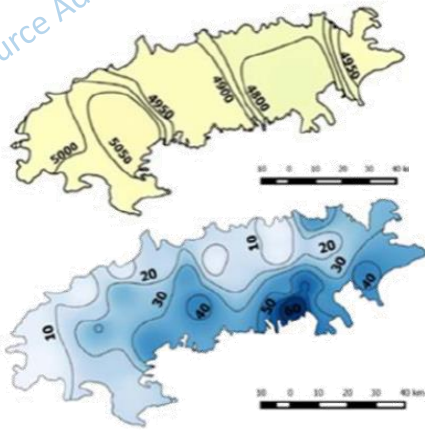
References:
[4] GERMI-Gujarat
[5] Source Advisory's analysis

Case Study 2 – Solar into Agro-Energy Corporative Districts of Spain and Morocco

2

Integration of Solar Energy Resource into Agro-Energy Cooperative Districts – Spain and Morocco
Similarities to Rajasthan: [6]
- Mediterranean area was a vast expanse of dry plains
- The area was put to use as agricultural land using irrigation technologies

Introduction to the experiment:
- Water pumping requirements traditionally resolved using diesel generators
- Changing energy policies leading to change of p.o.v. to resolve the pumping issue using renewable energy
- To make the project more eco-friendly, the project also considers optimal use of ground water



Methodology [6]	
1	Solar pumping map deduced from aquifer layer and irradiance maps
2	Specific zones are selected according to the applicability layer
3	The characteristics of the plots in terms of crop area, water requirements are analyzed
4	Solutions based on different water requirements are proposed
5	Diesel and solar solutions compared

Classification of solution	Proposed Solution	Working[6]
Cooperative	Diesel	• 2 groups of 64 kVA in Spain and 4 groups of 64kVA in Morocco • These diesel groups are able to provide the power demanded by the water pumping necessities, aiming to cover the irrigation of the set of the plots. • The irrigation patterns are based on the farmer's schedules
	Solar	PV solar system in charge of providing the same power as the previous system, to take care of the crop irrigation requirements.
Cooperative with reservoir	Solar	• For the Spanish case, around 25% of energy requirements are needed to pressurize the water and 75% to pump ground-water • For the case of Morocco, 80% of the total energy is required to obtain water from the aquifer • Installation with reservoir enable to run along the whole year • This system requires a smaller PV system • Reduced number of modules required

References:
[6] Integration of Solar Energy Resource into Agro-Energy Cooperative Districts: A Case Study based on Solar Powered Irrigation Pumps

Chapter 4: THE BOTTOM LINE!

Parameter for JdVVNL	Unit	Value	Remarks
Average power purchase cost	INR./kWh	4.0638	As per ARR of FY 2019-20 Approved by comission,page 208
Highest marginal cost of power purchase	INR./kWh	12.50	As per ARR of FY 2019-20,Consedering power purchased from NTPC FGUTTPS –II
Total utility sales	MU	18639.39	As per ARR of FY 2019-20
Transmission losses	%	4.25%	As per ARR of FY 2019-20
Distribution losses	%	18.00%	As per ARR of FY 2019-20
Average tariff for the category (Agri)	INR./kWh	6.33	Weighted average of selected consumer categories
Utility administration costs	%	1.0%	Taken from source advisory input
M&V costs	%	2.0%	Taken from source advisory input
O&M costs	%	15.0%	Taken from source advisory input
Utility investment	%	0%	Taken from source advisory input
Hours of use	HouINR	4	Taken from source advisory input
Cost of Agri-Solar system	INR.	380,000.00	Taken from source advisory input
Salvage value of old technolgy	INR.	-	Survey input
Cost of new technology + Installation + Removal + Disposal	INR.	4,000,000.00	Taken from source advisory input
Total Consumption of old technology	kW	74.57	Survey input
Total Consumption of new technology	kW	-	Taken from source advisory input
Life of technology (Considering the warrient life)	YeaINR	5	Assumption
Annual days	Days/year	365	Survey input
Number of replacements	No.s	10	Assumption
Diversity factor	%		
Escalation rate for highest marginal power purchase	%	0%	Taken from source advisory input
Discount rate	%	10.5%	Taken from source advisory input
Avoided power purchase		138664.20	

Observations regarding Jodhpur DISCOM's Power Purchase:
It is observed that Jodhpur Discom is showing highest deficit among the three Dsicoms of the state.
It is making highest sale to Agriculture Category though it purchases electricity at the same rate

How to ease the DISCOM's burden:
State Govt. may consider to review allocation of existing PPA(s) among Dsicoms to provide benefit of low cost PPA(s) to Jodhpur Discom, which may reduce its input cost

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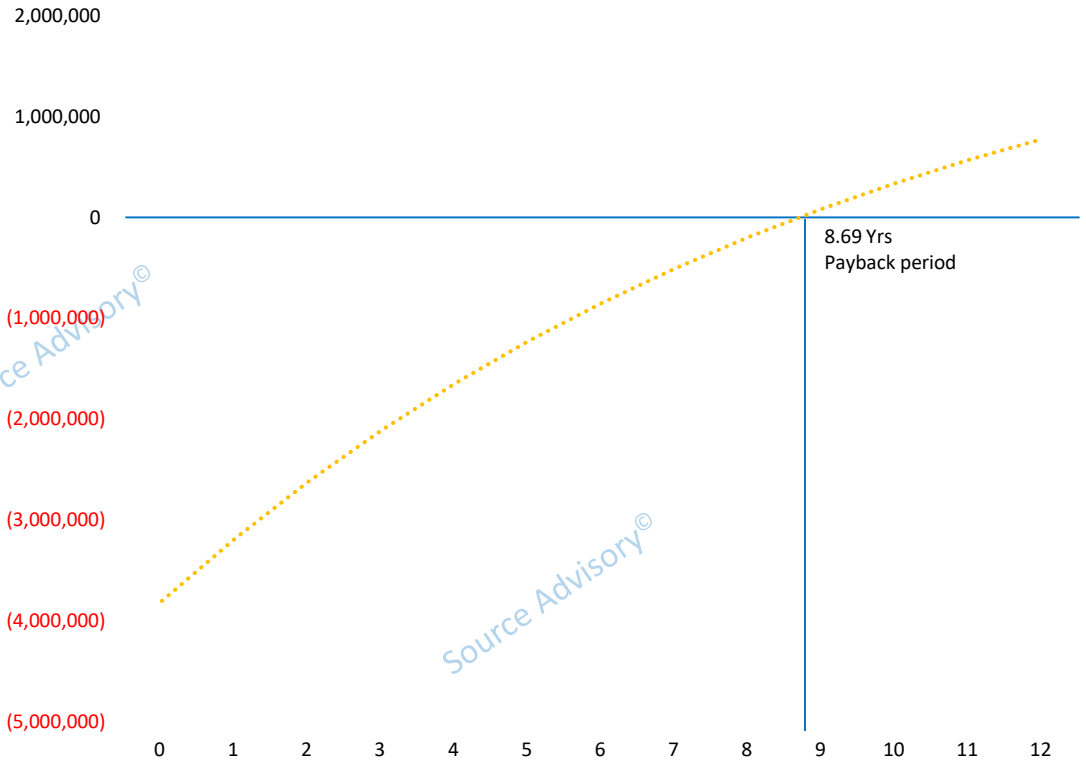
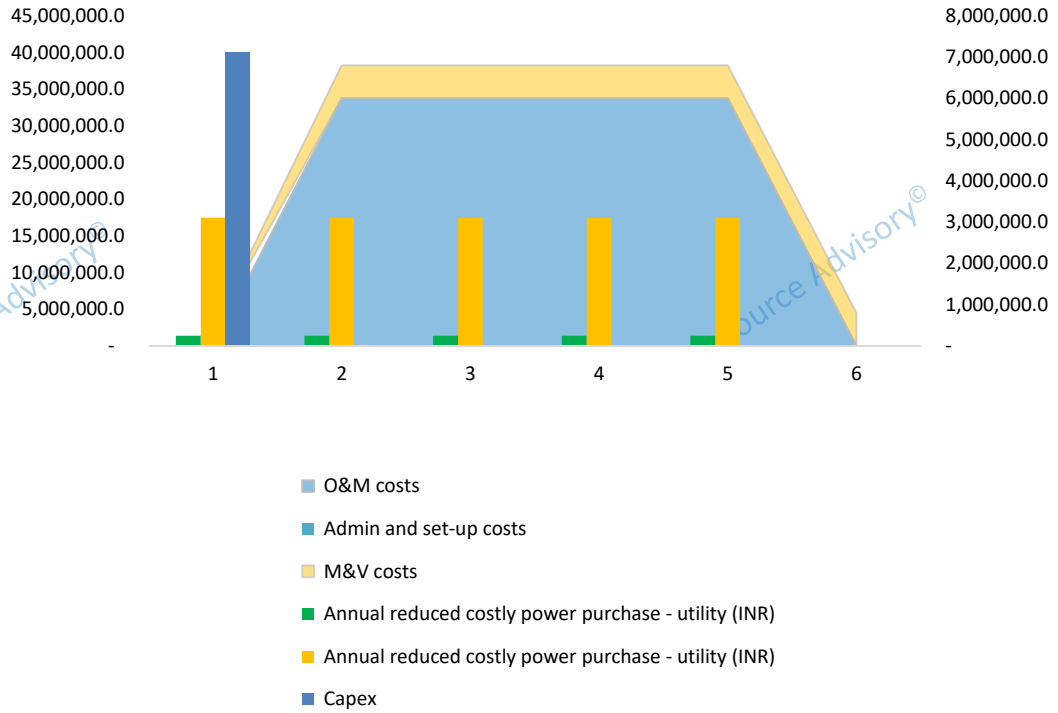
References:
[7] ARR – RERC

10 Pumps would give savings of 0.1MU/ annum reducing total tariff by INR 0.001/ kWh with a payback period of <10 years/ per pump* and the bottom line up by ~INR 8 Cr.** [5]

Cumulative DCF [5]



Costs v.s Benefits (INR) [5]



*Could be achieved earlier if depreciation considered
**Pre-tax profit

References:

References

[1] State economic survey – IBEF
[2] Rajasthan economic review 2019-20
[3] Solar energy potential – MNRE
[4] GERMI-Gujarat
[5] Source Advisory's analysis
[6] Integration of Solar Energy Resource into Agro-Energy Cooperative Districts: A Case Study based on Solar Powered Irrigation Pumps
[7] ARR – RERC

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