

Solar Pumps and Energy-Water Nexus in Gujarat:

Assessing World's Largest Pilot Project on Grid-connected Solar Irrigation Pumps (SKY)

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Highlights

1. 485,000 unmetered electric tubewells are at the heart of Gujarat's Energy Water Nexus
2. SKY overcame resistence to metering and delivered behavioural change
3. SKY created positive sum game, benefitting the utility, the farmers, climate & environment;
4. KUSUM- the sequel to SKY, needs to be tweaked to attract unmetered .
5. SKY shows the way to meter India out of its energy-water nexus

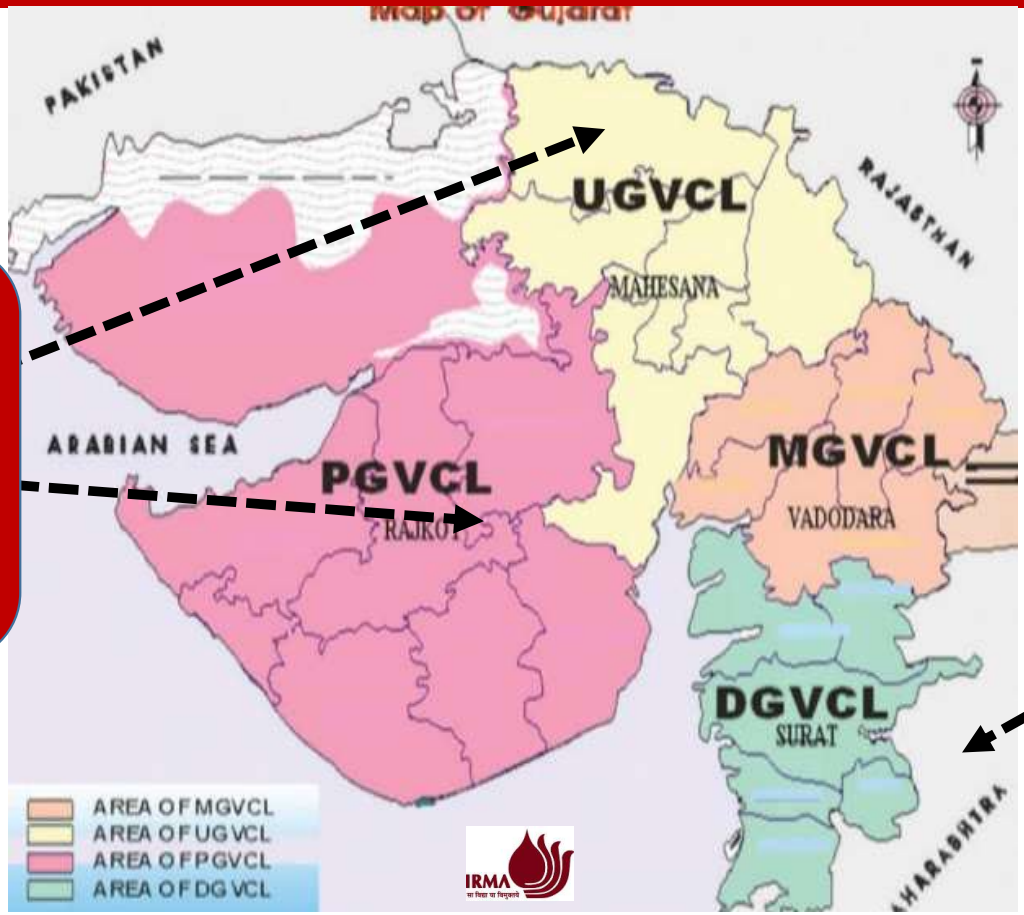
4,85000 unmetered electric tubewells are the root of Gujarat's energy-irrigation nexus

	Metered	Unmetered
Number of Agricultural connections	700398 (59%)	485144 (41%)
Average consumption per connection kWh/year (2014-15)	7104	25515
Total consumption million kWh (2014-15)	4975 (28.7%)	12373 (72.3%)
Total subsidy-2014-15 (US	133	1198
Subsidy per tubewell 20	(10%)	2469 (90%)
Subsidy per connected	5.3	12772.5

To lure unmetered farmers to meter, metered power supply is offered at 90 percent subsidy.

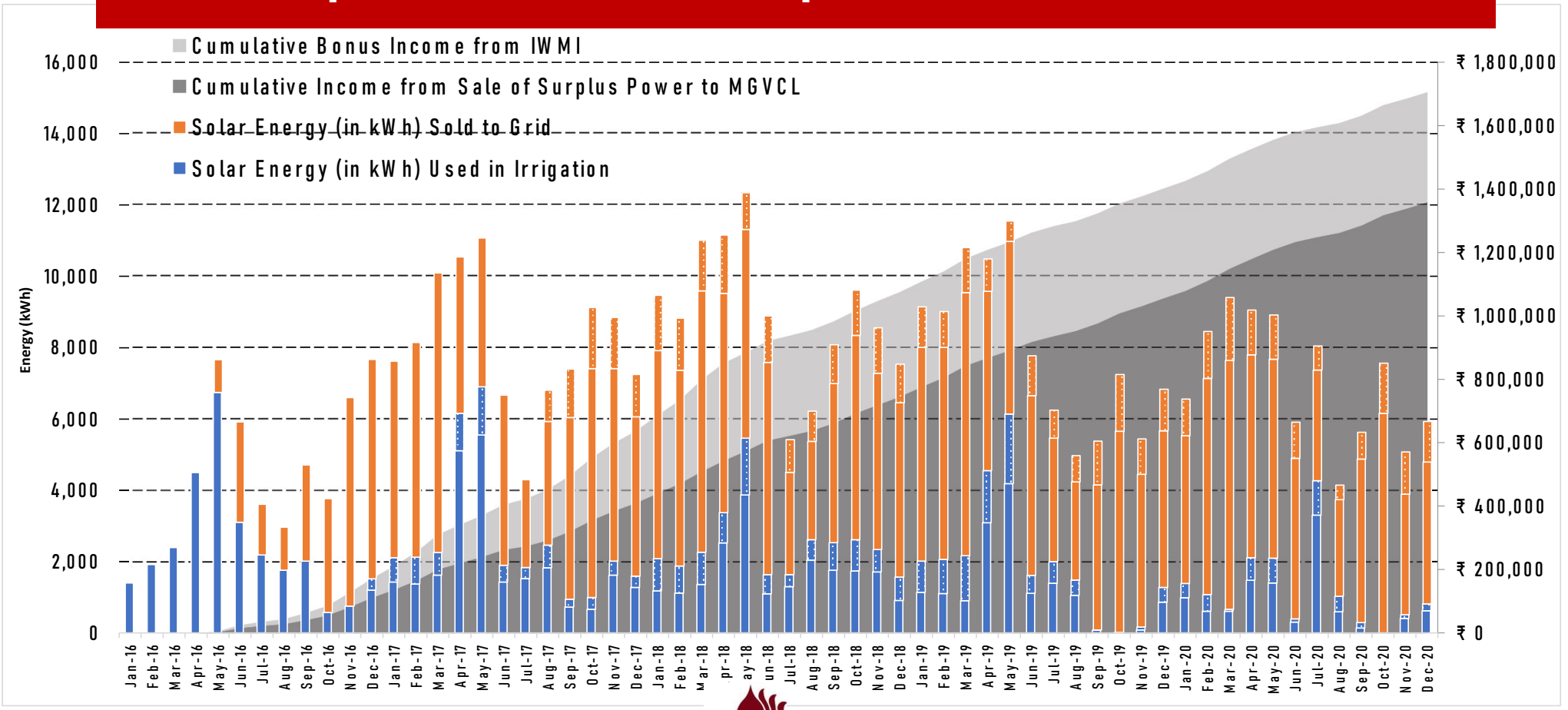
Resistence to metering is strident, often violent, in groundwater-scarce North Gujarat, Saurashtra & Kutch

High (>80%)agri load; majority unmetered connections; water scarce



(20%) agri load; few unmetered connections; water

Dhundi Solar Pump Irrigator's Cooperative Enterprise: 2015-to date



Suryashakti Kisan Yojana (SKY): 2018 (Solar Energy for Farmers' Scheme)

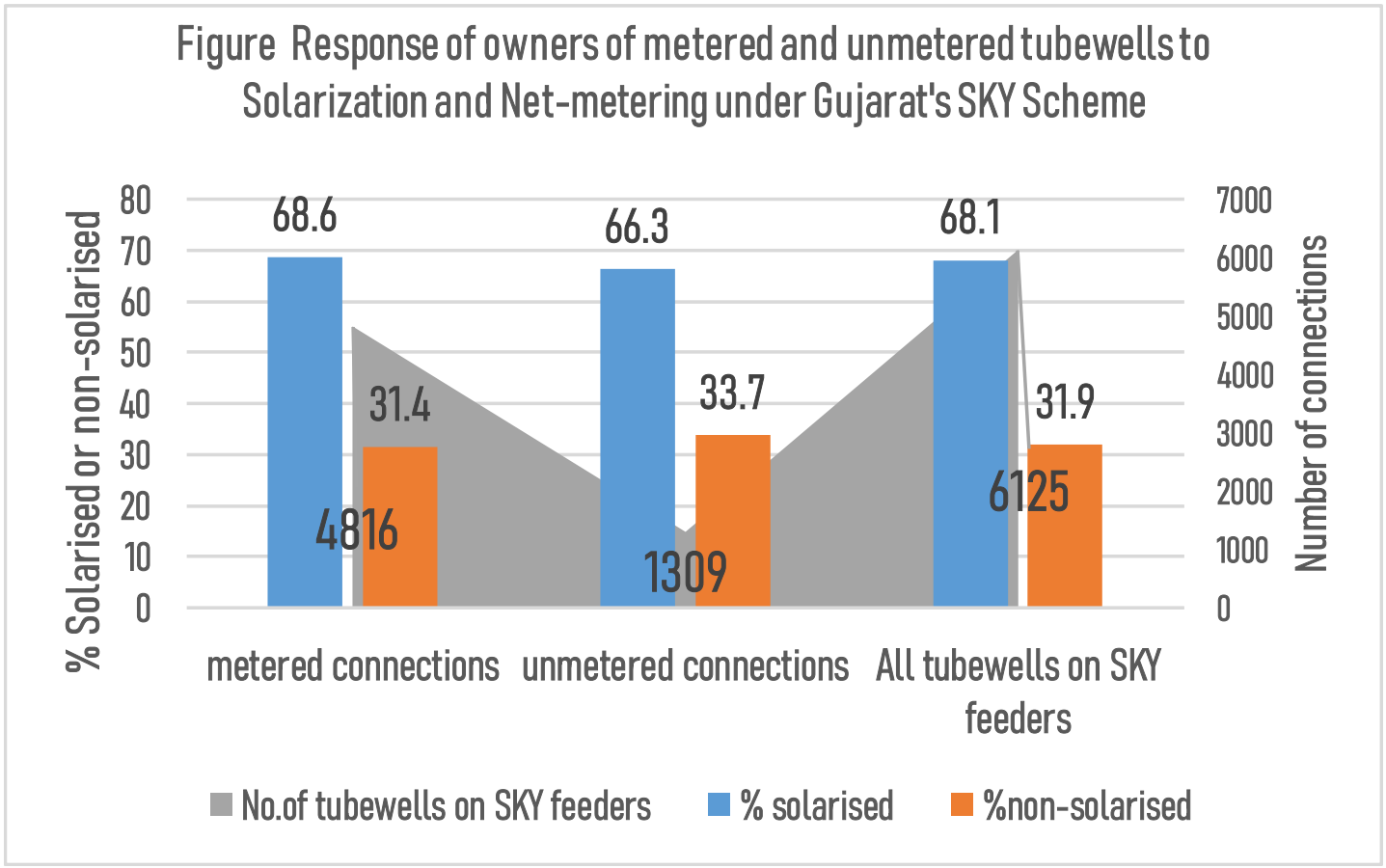
- 136 feeders; 33 districts; 12000 tubewells; 140,000 HP load, Rs 820 crore
- Solarised pumps to be net metered
- At least 70% of tubewells must sign up for a feed
- Line losses > 5% to be shared by solar farme

- *Five-fold SKY Benefit Suit:*
- Farmers pay 5% upfront; 95% is subsidy
- 1.25 kWp subsidized solar panel per HP loa
- FIT of Rs 3.50/kWh for 25 years;
- Day-time power every day (agaist day & night
- 12 hours of daily power (non-SKY get 8 hours)

SKY policy hypothses:

1. Unmetered farmers will reject SKY due to metering
2. Those who join will resist behaviour change

Did Unmetered Tubewell Owners Buy



Anethema of Unmetered Tubewells:

Does SKY present a solution?

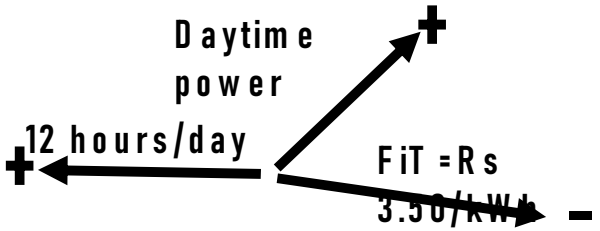
SKY data vindicates the "Excess Consumption Hypothesis"

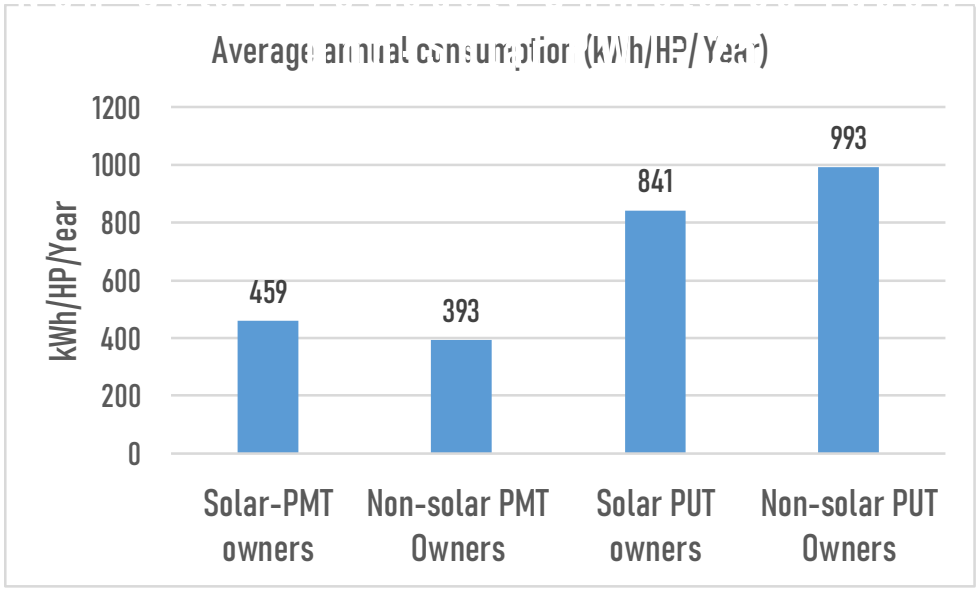
	Sample size	Average annual consumption (kWh/HP/Year)	Unmetered: Metered Consumption
CAG 2016: Metered connection	700398	718	1
CAG 2016: Unmetered connections	485144	1835	2.56
Nonsolar-Previously Metered	901	393	1
Nonsolar-Previously Unmetered	251	[illegible]	2.53

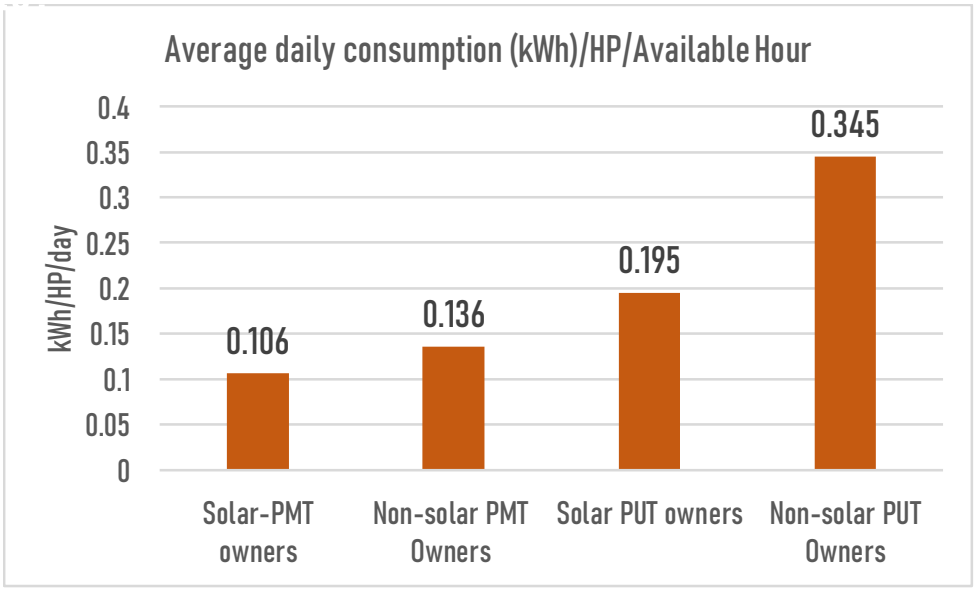
Prima facie evidence of excess consumption by unmetered

SKY feeders "selection bias":
1. more metered;
2. less losses;
3. Consumed vs sent;
4. equal weights to all DISCOMs

Solar Previously Metered Tubewells: Solar PMT = 2230
Solar Previously Unmetered Tubewells: Solar PWT = 549
Non-Solar Previously Metered Tubewells: Non-

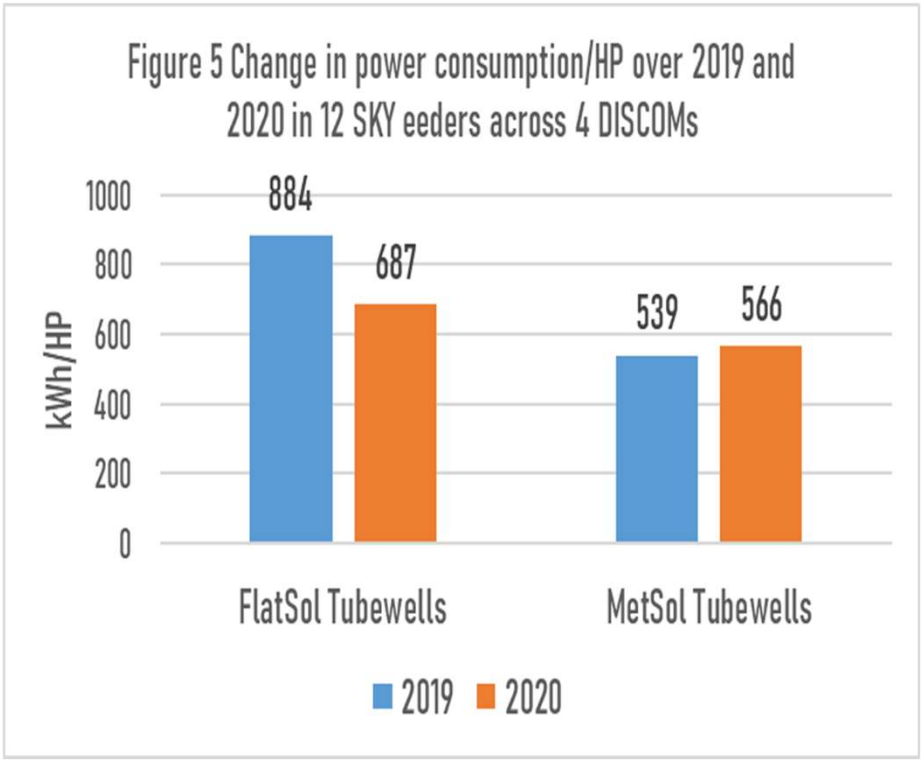




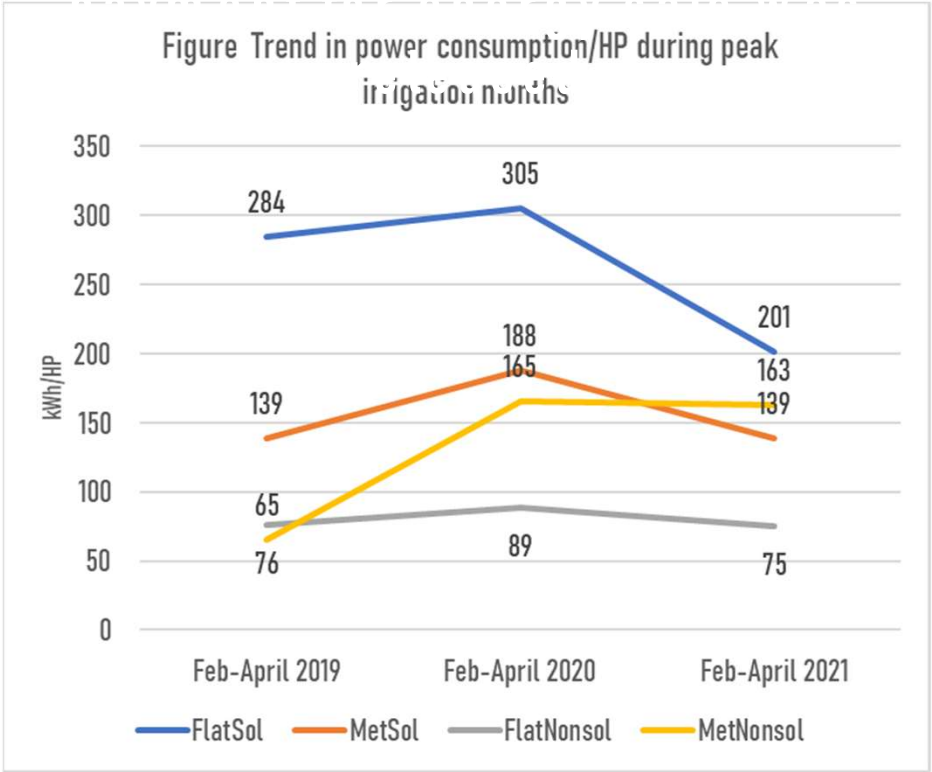


Adjustment process in operation?

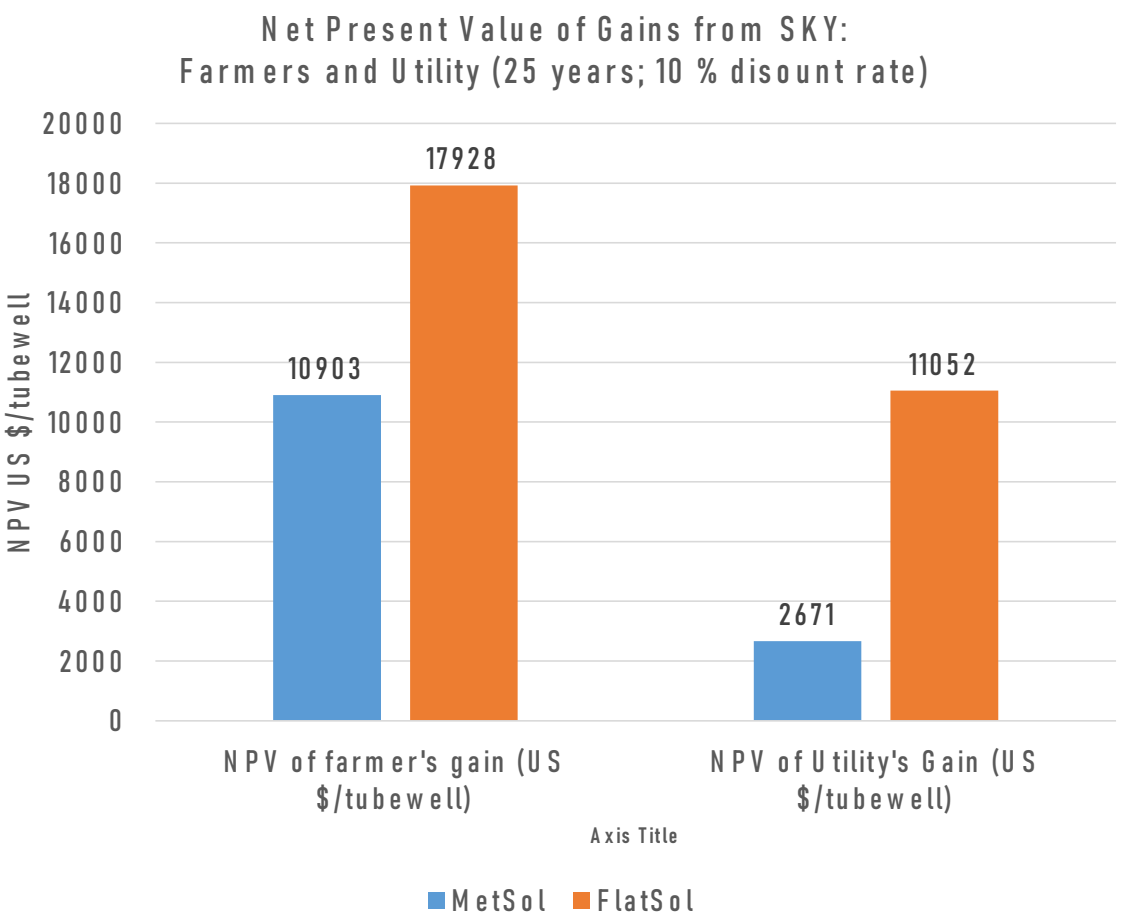
On 12 SKY feeders solarised in 2018, consumption/HP/year declined from 2019 to 2020



On 12 SKY feeders solarised in 2018, consumption increased during Feb-April on all in 2019 but declined 2020 after first



Financial Cost-Benefits of SKY



Farmers' Gain from SKY = PV [Value of energy use in irrigation @ US $ 48.6/MWh *plus* Value of energy sold @ US $ 39.3/MWh *plus* tariff saved *less* loan instalment] less 5 % of capital cost

Utility's Gain from SKY = PV [Saved cost of serving grid power @ US $ 82/MWh less tariff forgone] *less* 95 % of capital cost

Will KUSUM-C Scale Out SKY? Most likely no.

		SKY: five-fold SKY benefit suit	KUSUM-C Gujarat guidelines
1	P/L ratio (kWp/HP)	1.25 times	1.75 times
2	Farmer contribution to capital cost	5%	40%
3	Hours of day-time power supply	12 hours daytime	8 hours daytime
4	Saving in grid power tariff	Yes	Yes
5	Feed-in-Tariff (FiT) (Rs/kWh)	Rs 3.50/kWh	Rs 2.83/kWh
6	Minimum % of tubewells to on-board for feeder solarisation	70	70

SKY OFFERED FARMERS IRR >100; STILL 35% OPTED OUT OF SKY. WHY?

Recommendation:

Compulsory Free-of-cost Solarization of all grid-connected

	[1] PMKUSUM-CO I	[2] PMKUSUM-CO II (UNMETERED)	[3] PMKUSUM-CO II (METERED)
Panel (kWp) to load (HP) (P/L) ratio	1.31 kWp/HP	1 kWp/HP	0.5 kWp/HP
MNRE subsidy	30%	30%	30%
GoG subsidy	30%	70%	70%
Farmer contribution	40%	0	0
FiT (Rs/kWh)	2.83	2.83	2.83
Tariff on net energy import (Rs/kWh)	2.83	2.83	2.83

Unmetered farmers get 1 kWp/HP and metered farmers get 0.5 kWp/HP FREE With net metering.

All have option of adding panels by contributing 40% capital cost up to 1.75 kWp/HP of solar panels

Net exports get paid @ US $ 39.3/MWh; Net imports get charged @ 39.3/MWh

All tubewells not solarised get metered by target date and charged at US $ 39.3/MWh