

WRETC – 2016, New Delhi
Make in India: Developing Solar – Wind Industry
22nd August, 2016

Subject	:	“Degradation Study and Life Expectancy of Canal Top Solar PV Plant : Can Canal Top Solar Plant be a Game Changer in Solar Industry?”
Duration	:	10 Min.

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Version : 1.0

Created/ Revised on : 21st August, 2016



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- World has installed 150 GW of Solar PV up to last year (2014), which caters to 11% of global energy generation and well towards a roadmap of achieving 16% i.e. 218 GW by 2050 to reduce CO₂ by 50%. (Source. IEA World Solar PV Roadmap, 2015)
- These 218 GWs would consume 4,411 sq. km of area (equivalent to the land mass of Denmark, or 85% of that of Republic of Trinidad and Tobago).
- Indian Solar Mission of achieving 100 GW solar PV plants shall consume an area of 2,023 sq. km, 1.5 times size of New Delhi (1,483 sq. km).



Basic Parameters

- Technology : Polycrystalline Silicon
- PV Modules : MEMC, 280 Wp (1m x 2m)
- Array : 8 Blocks(14 Row) , 16 modules per row, 2 rows per structure
- Canal length used : 750 Mts
- Capacity : 1.01 MW (3,616 modules x 280 W)
- Inverter : Power One /4 x 220 kW
- Power evacuation : 11 KV (through Compact Sub-Station)



Before...



After. Project
completed on
24/03/2012



Results of PIV Tests by NABL Laboratory

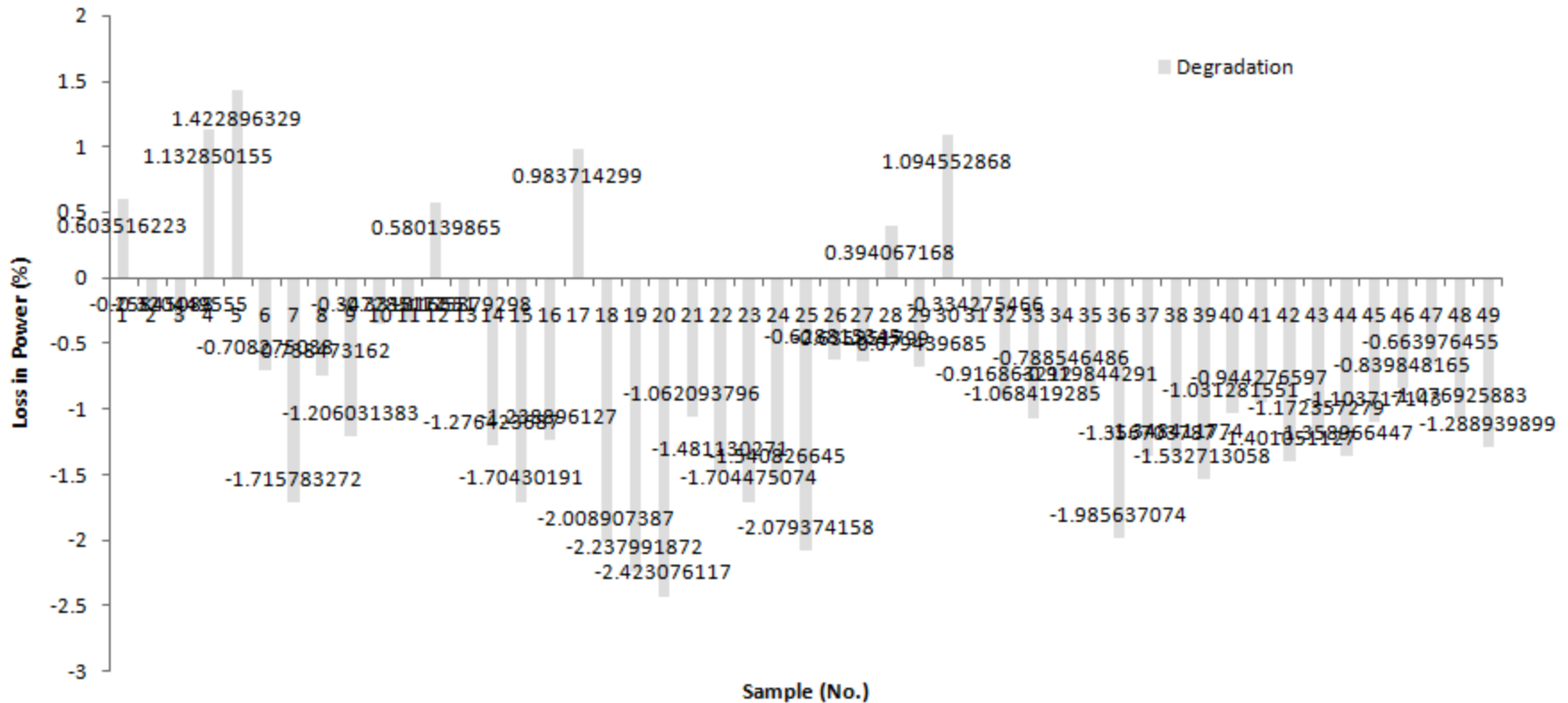
10.2					TABLE: Maximum Power Determination					
Cell temperature (°C) :					25					
Irradiance (W/m ²) :					1000					
Sample No.	Serial No.	Voc (V)	Isc (Amps)	Vmp (V)	Imp (Amps)	Module Efficiency (%)	FF (%)	Pmp (W)	Pmp (W) from Germi	Degradation
2142325	FMX11101302033	44.528	8.628	34.941	7.967	14.222	72.50	278.363	278.109	-0.09133

2. MODEL NO: MEMC-P280AMA-20

10.2					TABLE: Maximum Power Determination					
Cell temperature (°C) :					25					
Irradiance (W/m ²) :					1000					
Sample No.	Serial No.	Voc (V)	Isc (Amps)	Vmp (V)	Imp (Amps)	Module Efficiency (%)	FF (%)	Pmp (W)	Pmp (W) from Germi	Degradation
2142326	FMX11101300906	44.988	8.653	35.037	8.131	14.556	73.20	284.888	283.179	-0.6035
2142327	FMX11101300759	44.894	8.655	35.175	8.105	14.566	73.40	285.080	283.636	-0.5091
2142328	FMX11101301022	44.591	8.691	34.725	8.136	14.436	72.90	282.540	280.617	-0.6852
2142329	FMX11101300860	44.806	8.640	35.016	8.139	14.561	73.60	284.995	283.624	-0.4833

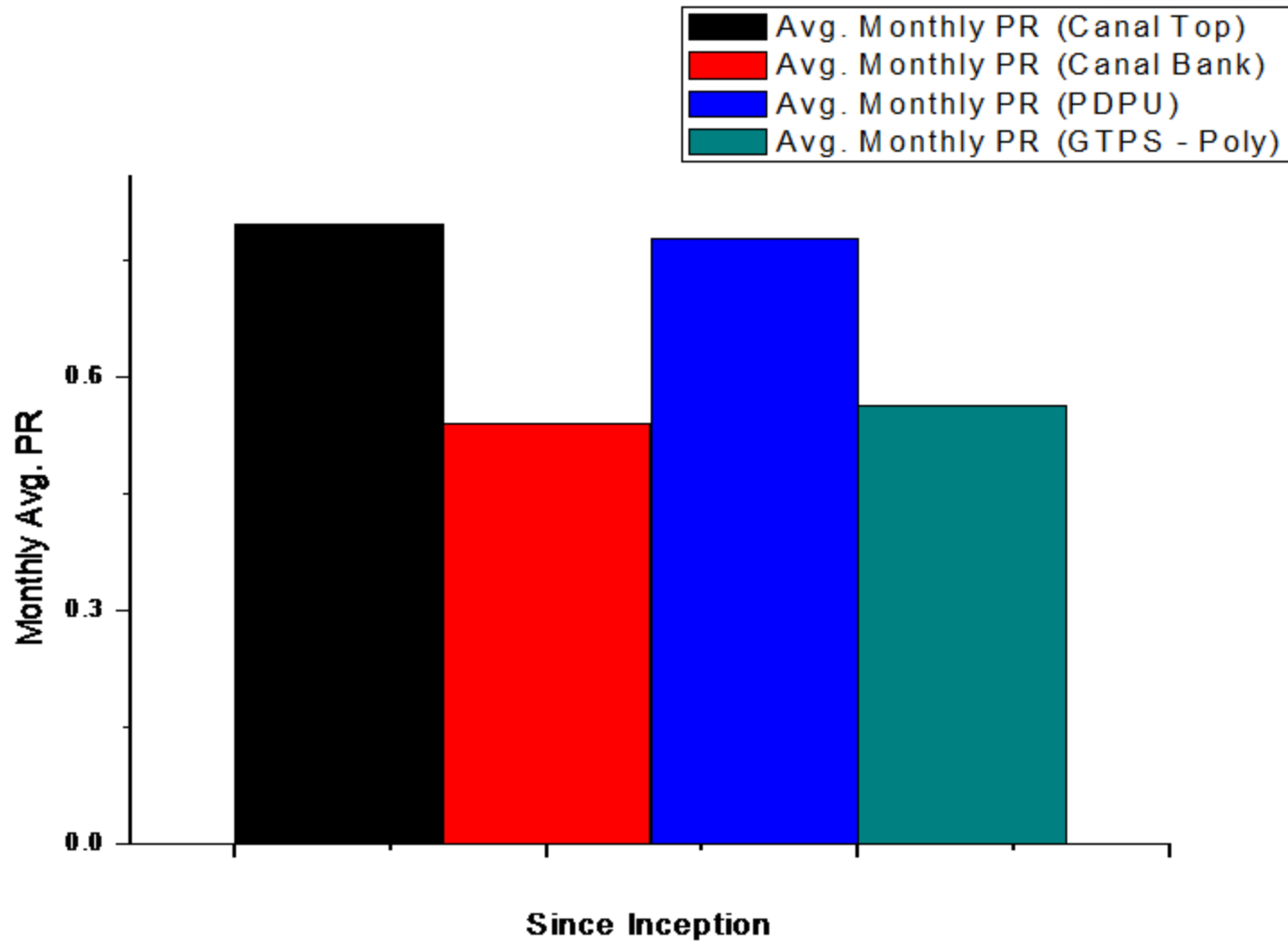
Results of PIV Tests on Large Sample

Degradation (%) in Polycrystalline Solar PV Module Technology at Canal Top



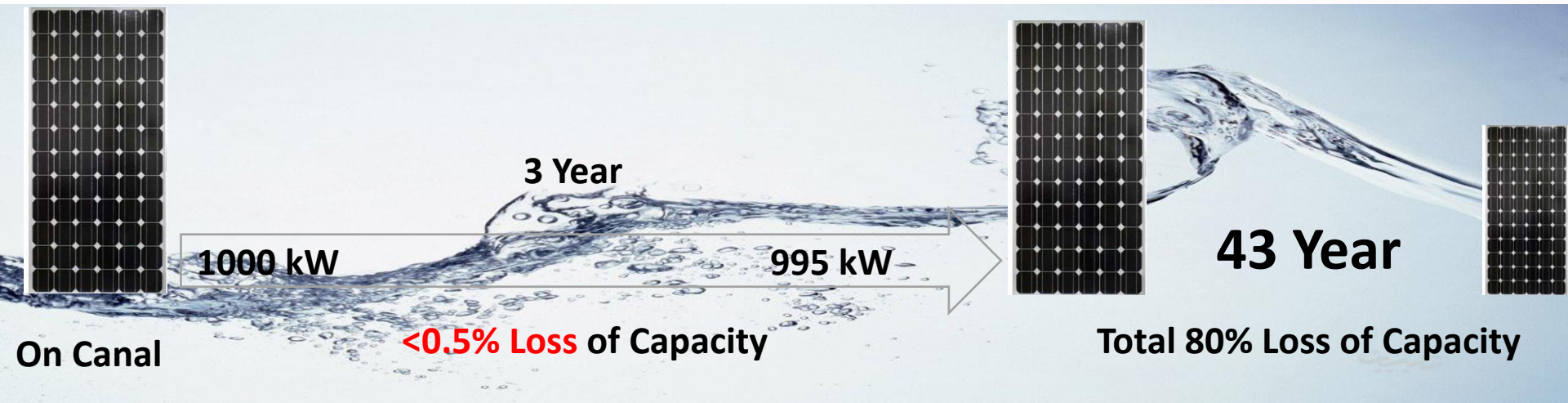
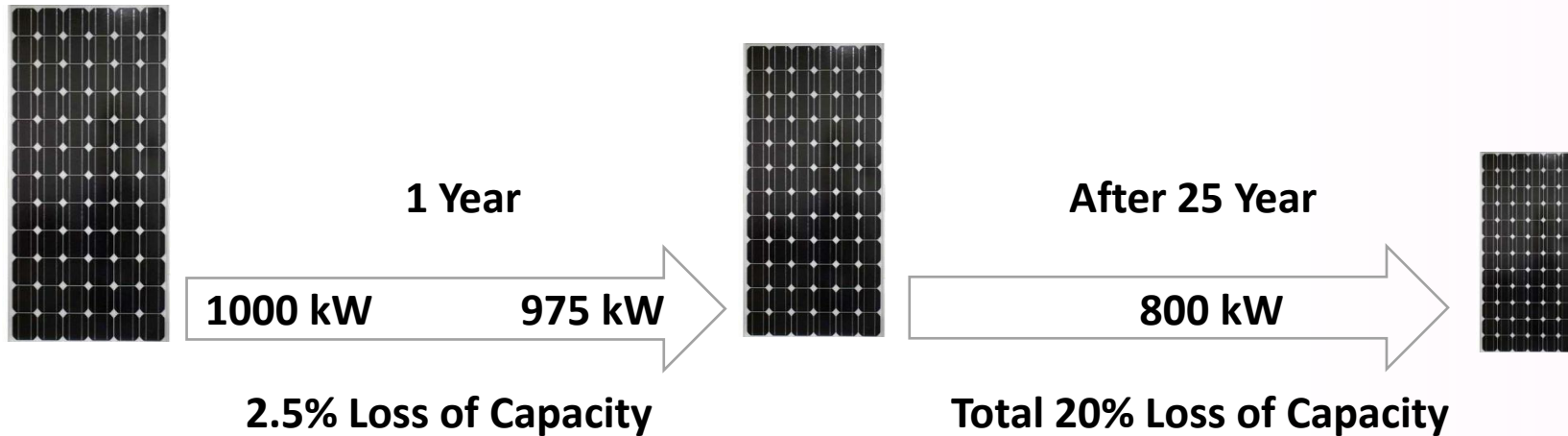
AVERAGE DEGRADATION OF 0.8% IS FOUND IN LAST THREE YEARS

Average Monthly PR (Since Inception)

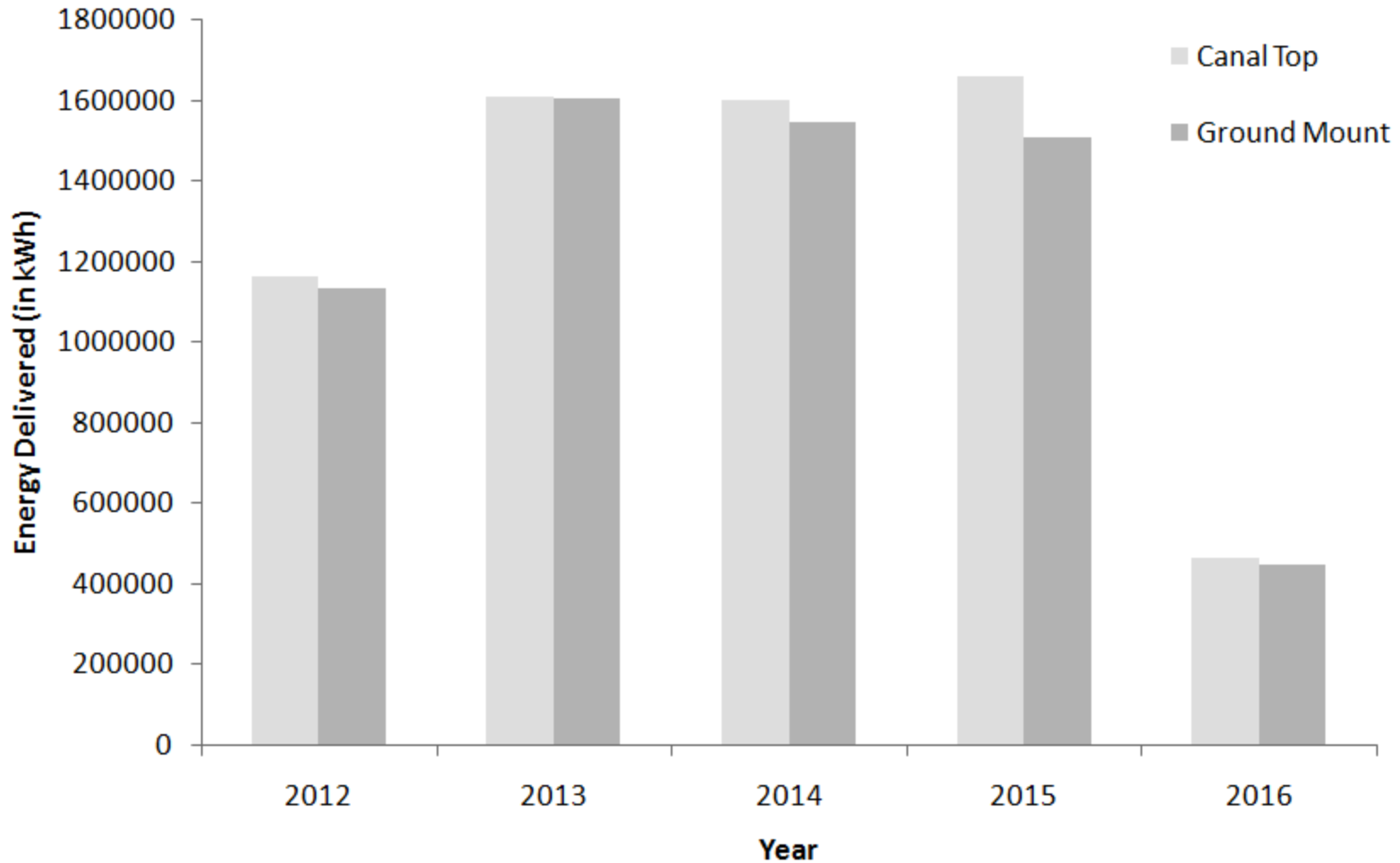


Extended Service Life and Energy Gain (Reduced Degradation of Semiconductor)

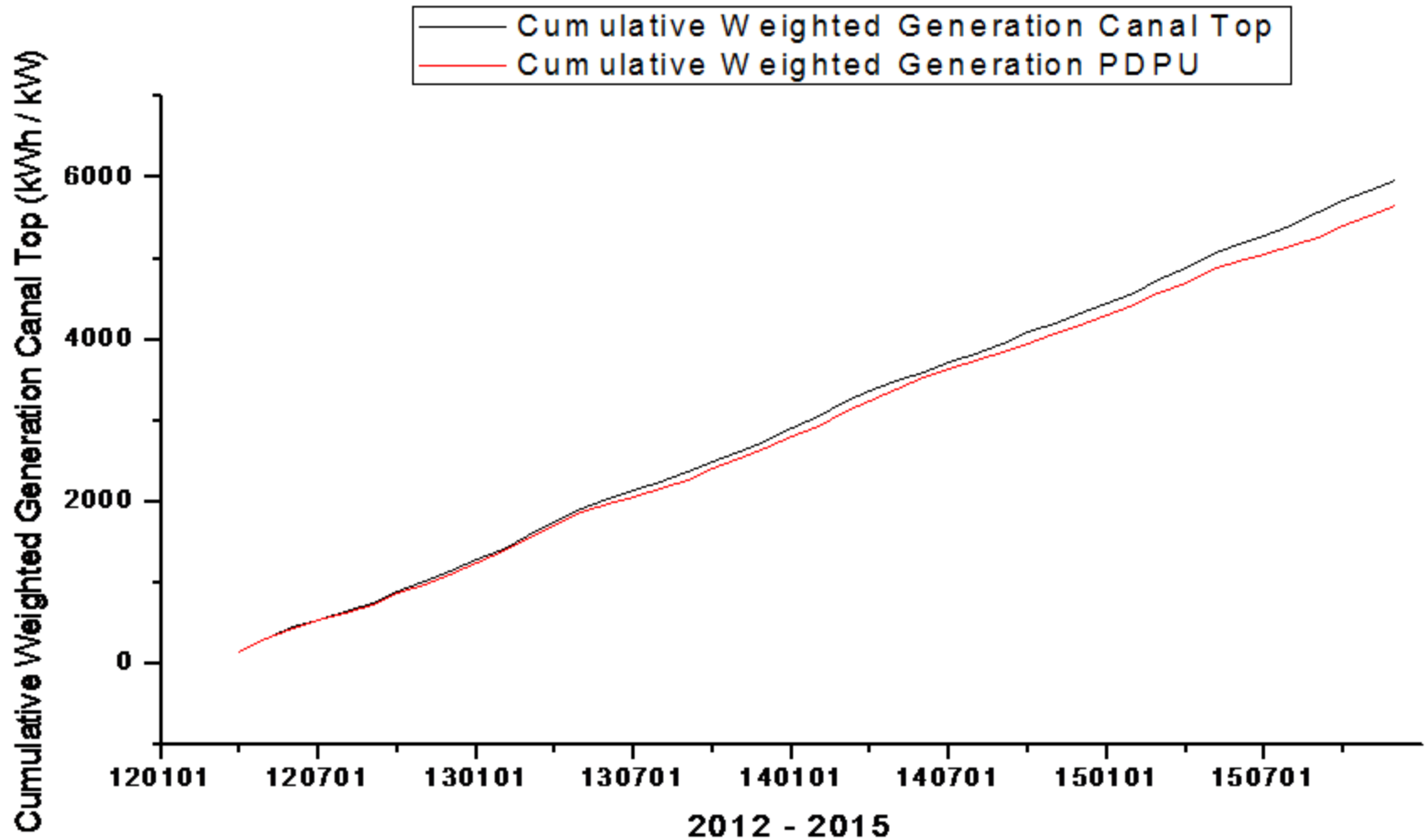
On Ground



Comparison (Canal Top V/s. Ground Mount)

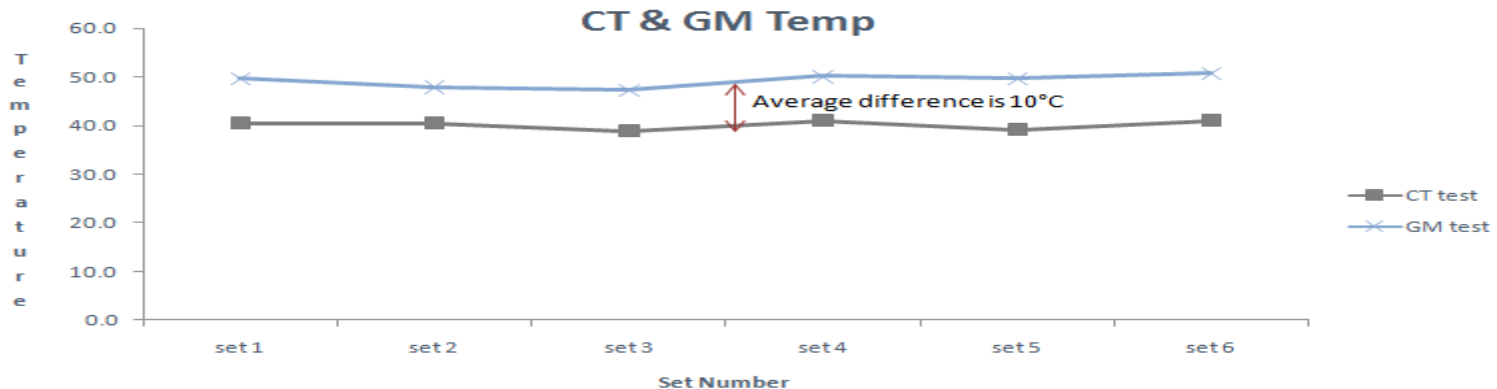
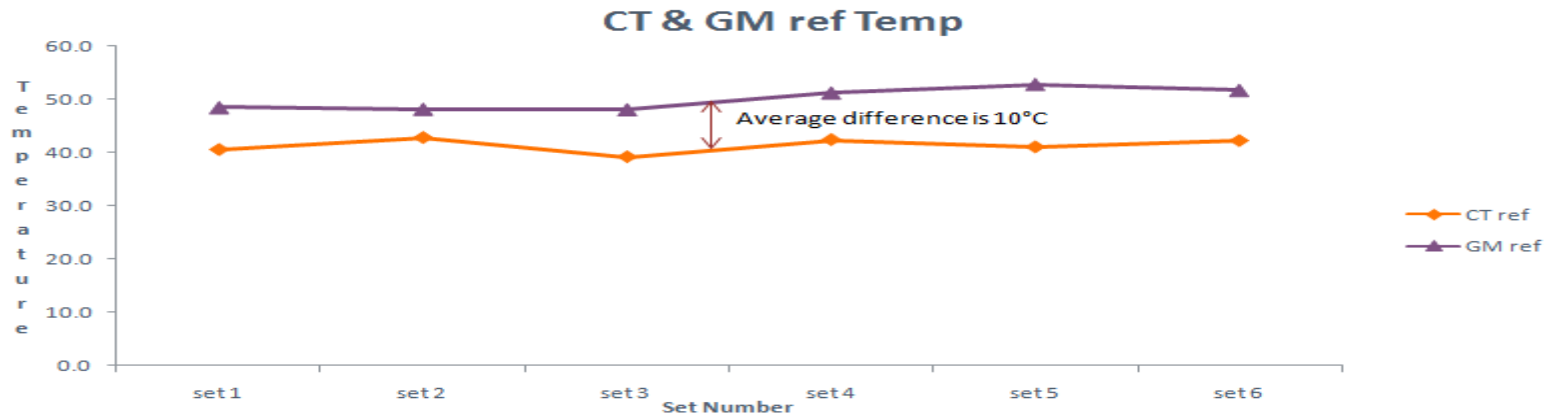


Cumulative Weighted Generation Ground Mount V/s. Canal Top



EFFECT OF COOLING

Effect on Module Temperature



**One degree decrease in module temperature results in 0.35% gain in power.
i.e. 3.5% improvement in module power,
which may get reduced when it reaches to energy meter to around 2.5%,
this is matching with cumulative gain by canal top over ground mount project**

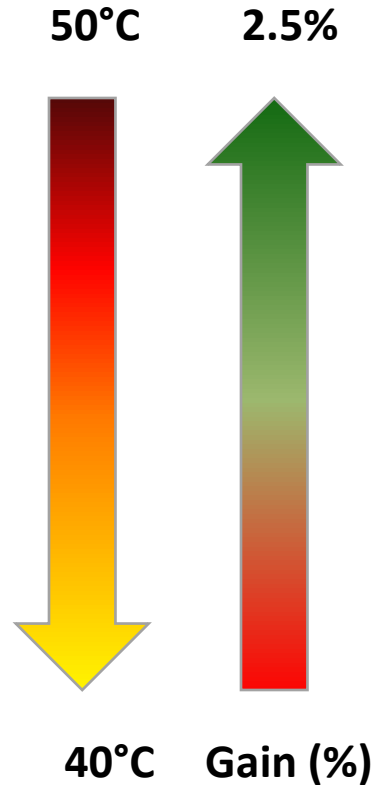
Enduring benefits: Enhanced Energy Generation (Cooling Effect)



Ground Installation



Installation Over Water Body (Canal)



Installation Over Water Body (Canal)



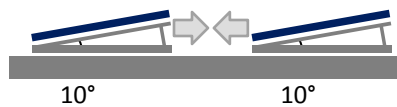
Ground Installation

Canal-Top Performance Under Ideal Conditions

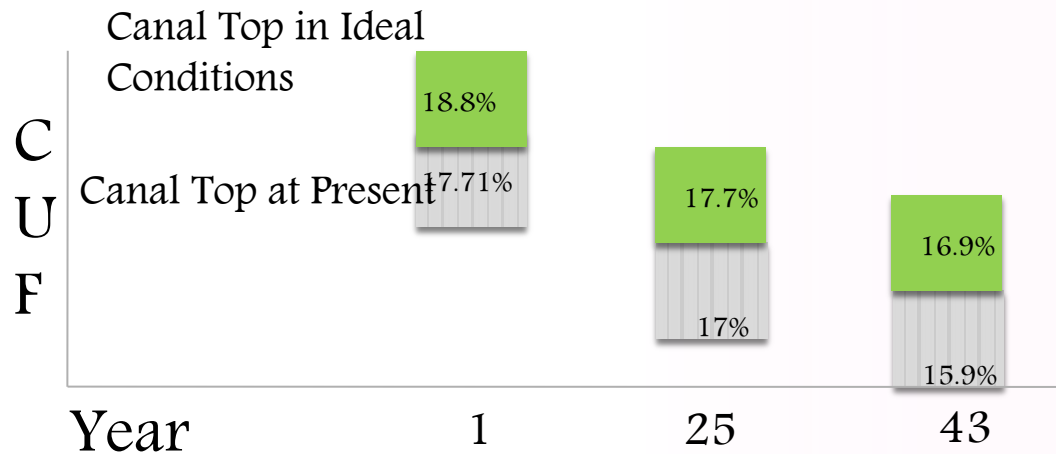
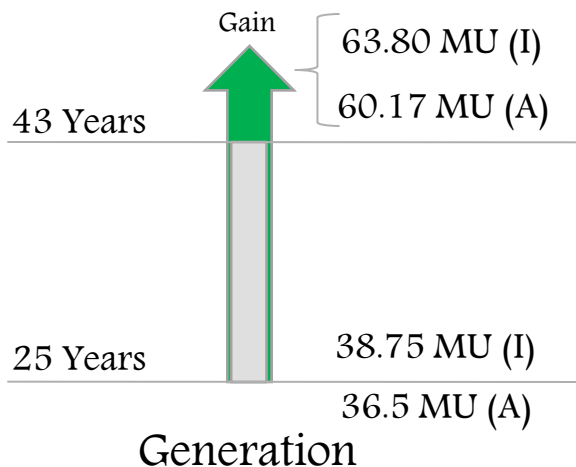
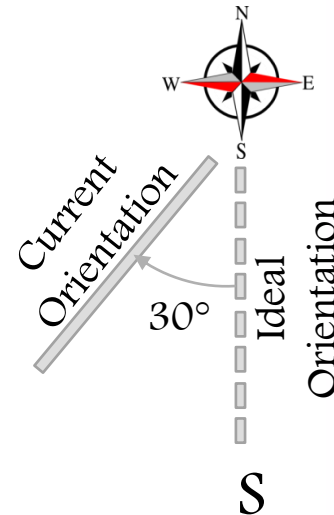
Ideal Conditions vs. Techno-commercially Optimized in Actual Conditions



Increased pitch for maximum solar collection.



Techno-commercially optimized inclination and pitch.



Saving of Water

ESTIMATE

*Central Water Commission, Gol,

*Evaporation 1.8 – 2.1 m / m²

Loss: 12819 m³

Saving ~9000 m³

**Evaporation @ 0.5 m / m²

Loss: 3561 m³



Area under Solar PV Module – 7122 m²

Equivalent Un – Shaded Area – 7122 m²

EXPERIMENT



2015

6

6.71 kWh / m²

9.678 L/m²

4.00 L / m²

Annual

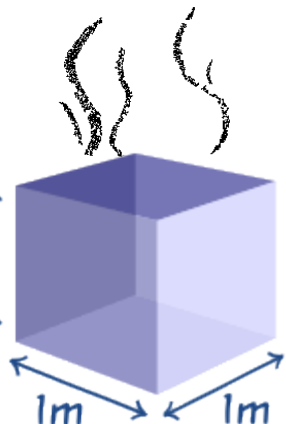
365

2066 kWh / m²

21200 m³

8774 m³

Saving ~12400 m³



Summary



- Saving of LAND by 5 acres per MW.
- Saving of CO₂ Emission by 1,280,000 kg per Year.
- Reduce water loss due to Evaporation by 90 Lakh Litres per annum per MW.
- Increase Solar Generation Efficiency by 2.5 % compared to similar Solar Plant on the ground - Up to 5.75% increase can be achieved.
- Strengthening the grid.
- Energy generation being close to consumption point helps in reduction of T&D losses.
- Concept is Replicable globally in entirety.
- Retard the growth of algae in the water

Replication Potential

- 458 km of open Main Canal in Gujarat alone!
- Plus sub-branches:
 - 20,000 km already built
 - Final aim: 85,000 km
- 30% of 20,000 km canal can host:
 - 18,000 MW of SPV Plant.
 - Hence, conserves 44,000 hectare land
 - And about 16,20,000 Lakh Litres of water every year.
- Canals in any direction can be used: East-West, North-South, etc.
- No restriction in water flow.
- 10 MW SPV Plant on Vadodara Branch Canal and 15 MW on canal bank on Vadodara Branch is under consideration (MNRE Approved)
- This has been replicated in the sponsoring country and similarly can be replicated across the Commonwealth also.



1 MW Canal-top PV, Krishna River, Karnataka



**10 MW Canal-Solar Project at Vadodara City.
(3,25 km Length, canal top-width 22.1m)**

Final Conclusion

- Degradation effect on solar PV modules installed and under operation at world's first pilot demonstration project of canal top near Sanand, Gujarat were studied by GERMI and tested as per IEC 61215 at NABL accredited laboratory. In order to reconfirm results, additional 49 no. of modules were tested. Results of the tests showed very negligible degradation even after 34 months of operation in field. This is in disagreement to established annual degradation rates prevailing in solar industry. Also, annual Performance ratio (PR) of the plant reaffirmed the laboratory results. Based on global experiences, authors attribute slow degradation rates to cooling effect of modules as a result of evaporation of water from canal. It is concluded that canal top solar PV plant can offer a long service life of 40 years unlike global market standard service life of 25 years.



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