

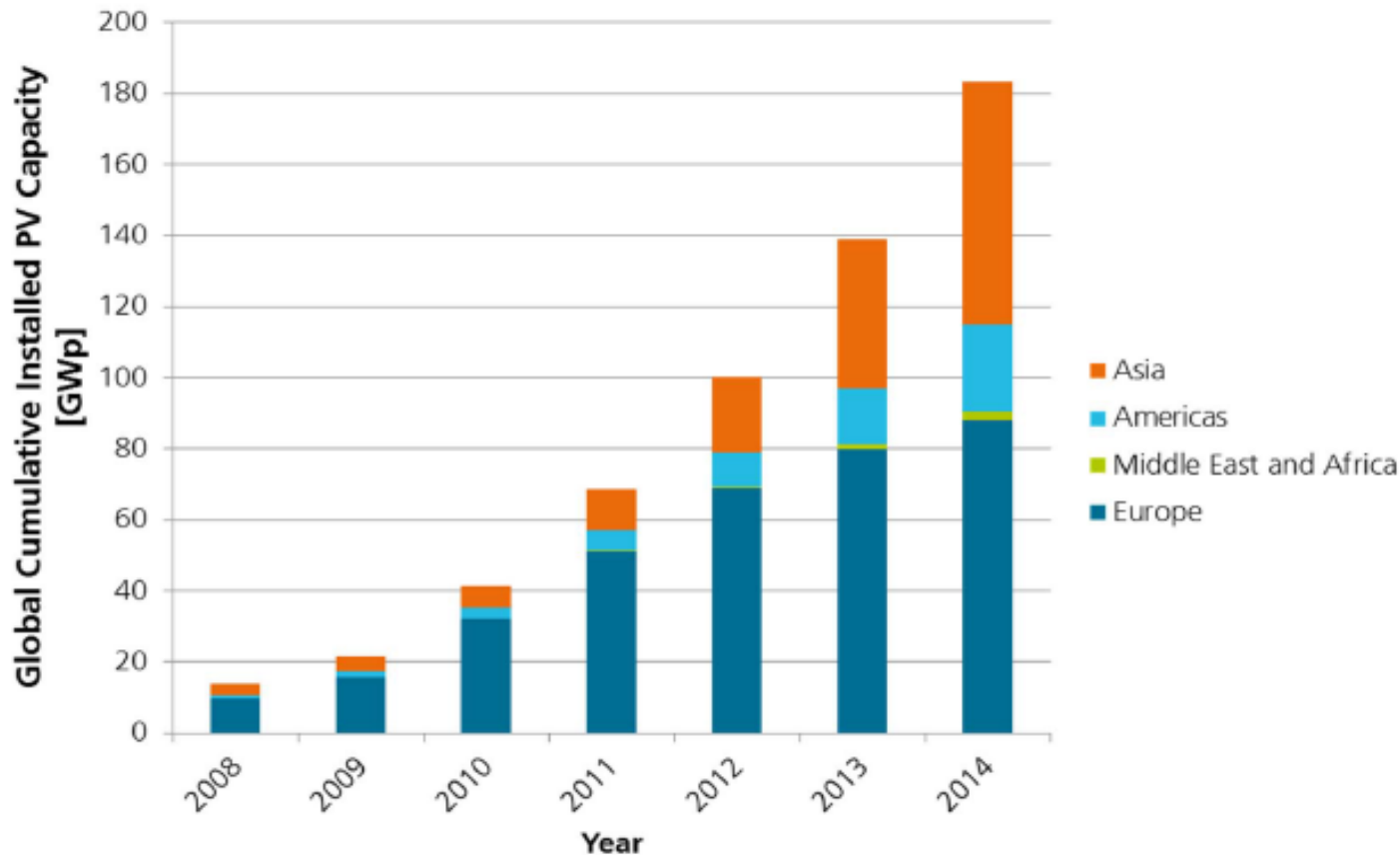


# **India's Emergence as a Dominating Global PV Market**

**SHIFTING GEAR FROM MW TO GW –  
INDIA'S EMERGENCE AS A PROMINENT GLOBAL PV MARKET**

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SunEdison**

# Global Cumulative PV Installation until 2014



Data: IHS. Graph: PSE AG 2015

**Photovoltaics is a fast growing market: The Compound Annual Growth Rate (CAGR) of PV installations was 44 % between 2000 to 2014**

# Solar potential in the country

- Solar Power Potential: 750 GW

(use of 3% wasteland area assumed) - [National Institute of Solar Energy in India](#)

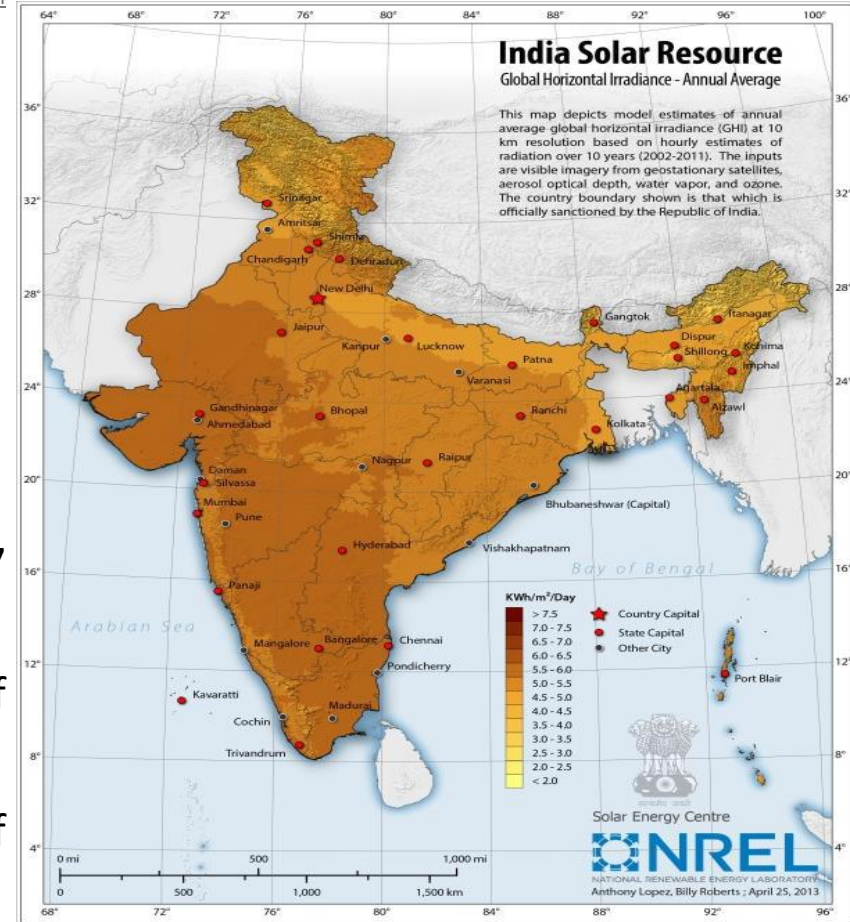
• Estimated Potential in GW:		GW
(i) Rajasthan	–	142
(ii) Jammu & Kashmir	–	110
(iii) Madhya Pradesh	–	60
(iv) Maharashtra	–	60
(v) Gujarat	–	36
(vi) Others	–	340

- India's current solar power installed capacity: 4657 MW (0.6% of the estimated potential)

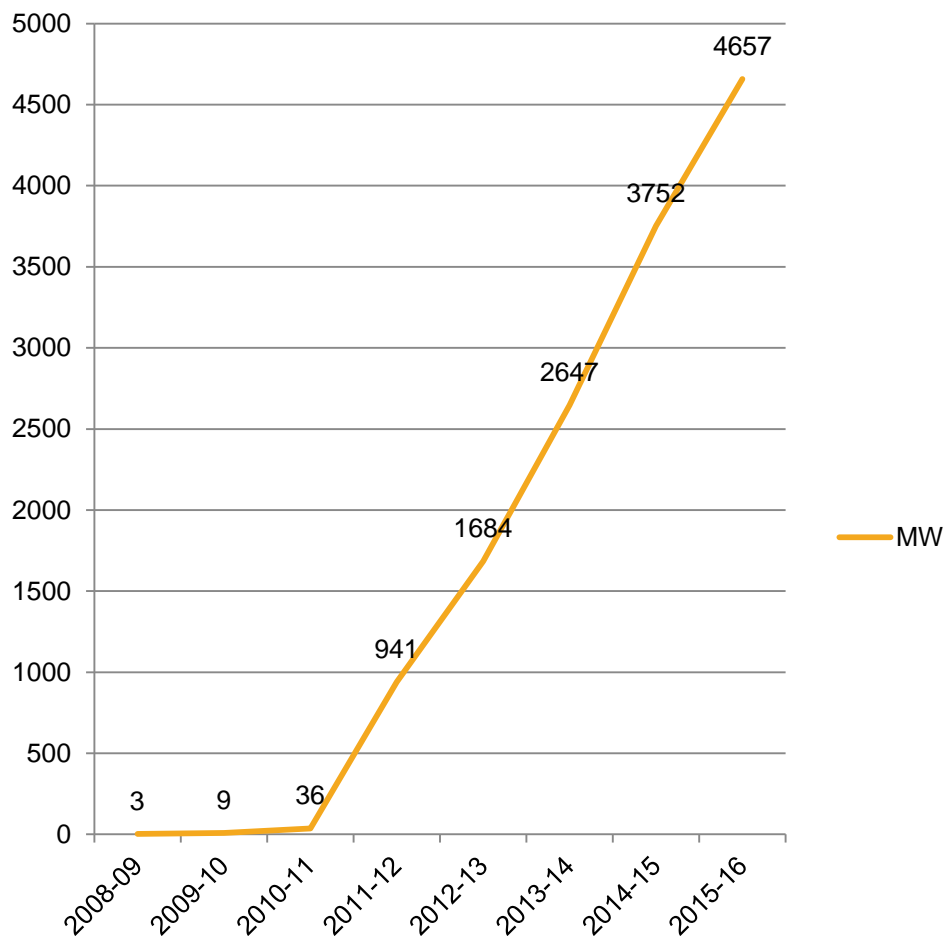
- Solar radiation is high 4.5-5.5 kWh/m<sup>2</sup> in most of the regions (>300 days of Sunshine)

- High radiation areas are having large tract of wasteland

- 10% of Solar in Energy Mix requires 100 GW solar capacity



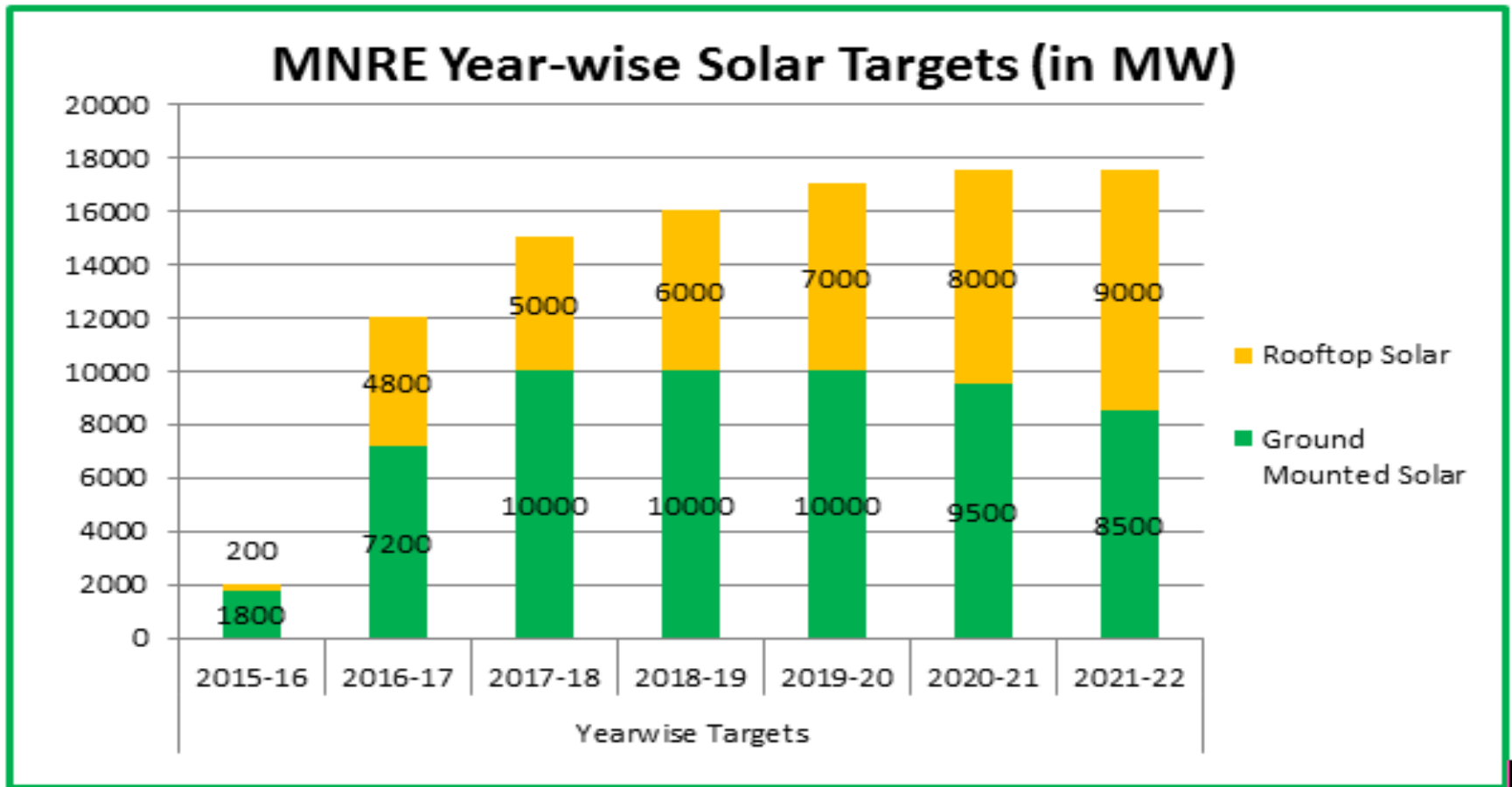
# Growth of Solar Capacity addition so far



Commissioning Status of Grid Connected Solar Power Projects		
Sr. No.	State/UT	Total commissioned capacity till 09-11-15 (MW)
1	Andhra Pradesh	283.74
2	Arunachal Pradesh	0.263
3	Chhattisgarh	73.18
4	Gujarat	1024.15
5	Haryana	12.8
6	Jharkhand	16
7	Karnataka	104.22
8	Kerala	12.023
9	Madhya Pradesh	673.58
10	Maharashtra	378.7
11	Orissa	56.92
12	Punjab	200.32
13	Rajasthan	1256.7
14	Tamil Nadu	375.87
15	Telangana	77.23
16	Tripura	5
17	Uttar Pradesh	71.26
18	Uttarakhand	5
19	West Bengal	7.21
20	Andaman & Nicobar	5.1
21	Delhi	6.712
22	Lakshadweep	0.75
23	Puducherry	0.023
24	Chandigarh	5.041
25	Daman & Diu	4
26	Others	0.79
<b>TOTAL</b>		<b>4656.608</b>

Source: MNRE, As on 09/11/2015

# Enablers: MNRE Year-wise targets to achieve the 100GW solar Capacity in next 7 years (I.e. by FY 2021-22)

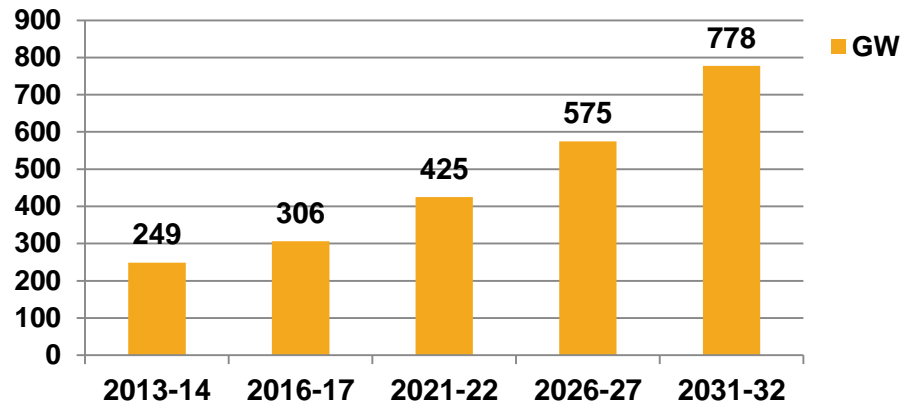


Out of total 100GW target, 40GW capacity will be achieved through Rooftop system  
Remaining 60GW will come through medium and large scale grid connected solar power projects including projects in the solar parks.

# Future India's Power Scenario

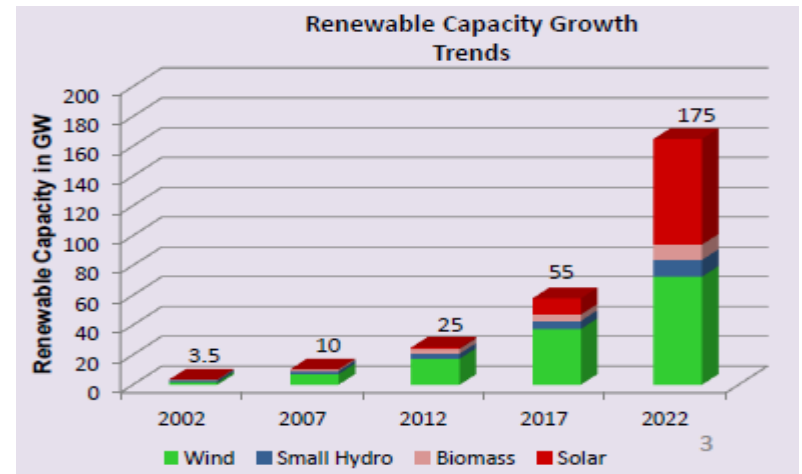
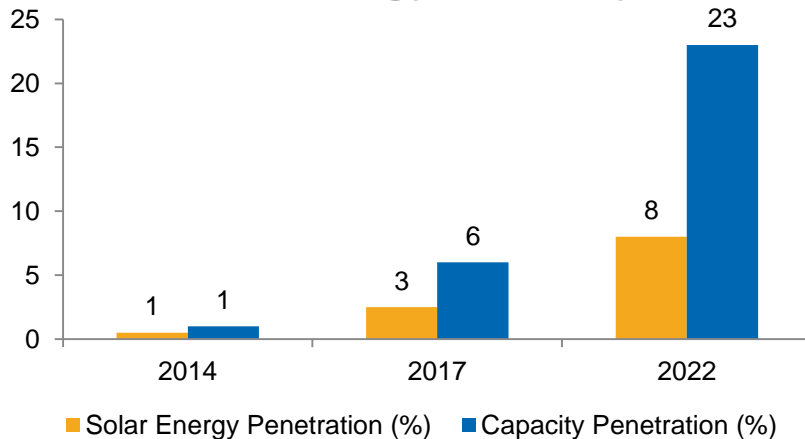
## 100 GW target by 2022 is achievable

Capacity requirement to be doubled by next decade and quadrupled in next two(2) decades

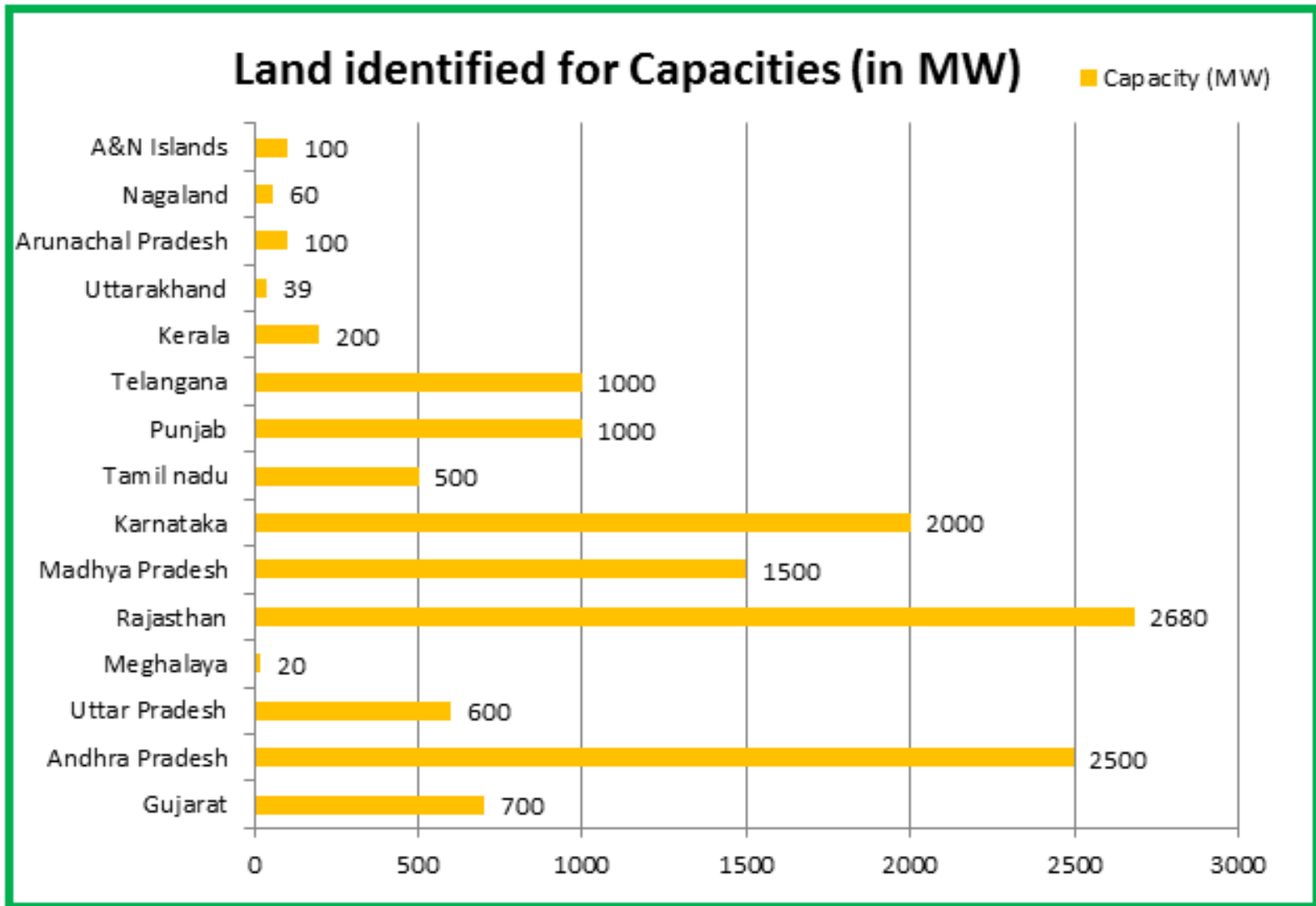


Source : Integrated Energy Report,

### • Solar Energy/capacity Penetration



# Enablers for achieving 100 GW targets: MNRE Solar Parks Scheme



25 Solar Parks to be set up in various states (Target capacity:20,000 MW)

# Enablers: Tariffs discovered in Bidding

Previous bid results					
	Year	Capacity on Offer (MW)	Highest Bid (Rs./KWh)	Lowest (Rs./KWh)	Weighted Avg. Price (Rs./KWh)
NSM Batch 1	Dec'10	150	12.76	10.95	12.16
NSM Batch2	Dec'11	350	9.39	7.49	8.79
Orissa Phase 1	Mar'12	25	8.98	7.0	8.36
Orissa Phase 2	Dec'12	25	9.50	7.28	8.73
Karnataka	Apr'12	60	8.5	7.94	8.34
Madhya Pradesh	Jun'12	125	12.45	7.9	8.05
Tamil Nadu	Mar'13	150	14.5	5.97	6.48*
Rajasthan	Mar'13	75	8.25	6.45	6.45 (L1)
Andhra Pradesh	Apr'13	226	15.99	6.49	6.49 (L1)
Punjab Phase 1	June'13	270	8.75	7.2	8.41
Uttar Pradesh Phase 1	Aug'13	130	9.33	8.01	8.9
Karnataka Phase 2	Aug'13	130	8.05	5.5	6.87
Madhya Pradesh Phase 2	Jan'14	100	6.97	6.47	6.86
Andhra Pradesh Phase 2	Oct'14	500	5.99**(7.03 Levelized)	5.25** (6.17 Level.)	5.75** (6.75 Level.)
Karnataka	Nov'14	500	7.12	6.71	6.94
Telangana	Nov'14	500	6.9	6.46	6.72
Punjab (Capacity 5-24 MW)	Feb'15	100	7.45	6.88	7.17
Punjab (Capacity 25-100 MW)	Feb'15	100	7.56	6.88	7.16
NTPC Anantapur	May'15	250	-	-	6.16*** (L1)
Uttar Pradesh Phase 2	June'15	215	8.6	7.02	8.04
Madhya Pradesh	June'15	300	5.641	5.051	5.36
Telangana Group 1****	August'15	500	5.8727	5.4991	5.73
Telangana Group 2****	August'15	1500	5.8877	5.1729	5.62
Punjab	Sept'15	500	5.98	5.09	5.65

With such a low tariff Discoms will replace future their power requirement with solar and hedge power purchase cost

Telangana and Andhra Pradesh's bid size of 1000 MW each, convey that with reduction in cost of generation of solar PV legislative support in the form of RPO/SPO would not be required

**All time low tariff discovered in November 15 :  
Andhra Pradesh : 500 MW: Rs. 4.63/kWh**



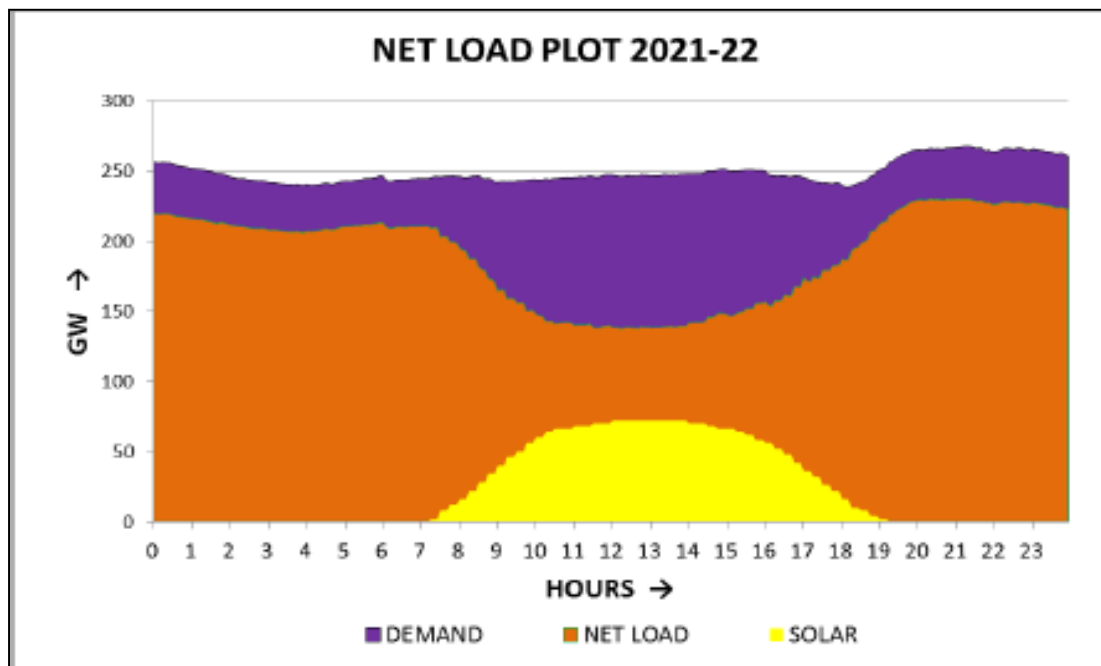
# Enablers: Green Energy Corridor

**Low Gestation period of Solar PV Generation (9-12 Months) than development of Transmission Strengthening (24-36 Months)**

- Green Energy Corridor already planned with strong grid interconnection to enlarge balancing areas
- Green Energy Corridors would comprise transmission scheme required for integration of solar (100GW) & wind capacity (65 GW) envisaged in 13th Plan by 2021-22
- About 22,000 MW Solar capacity proposed to be evacuated from Ultra Mega Solar Power (12) states
  - Inter State Transmission System (ISTS):  
17,600 MW including 7500MW in Leh/Kargil (J & K)
  - Intra state network : 4500 MW
  - Transmission scheme for NP Kunta solar park (1500MW) under implementation by POWERGRID



# Balancing Scenario in accelerated case of 100 GW by 2022



- With the given flexible resource composition through hydro (including PSP and reservoir type), gas and super critical thermal generation, we should be able to match the ramping requirements .
- Suitable market mechanism should be developed to encourage participation of flexible reserves to meet short and medium term volatility
- Existing hydro generation capacity especially Reservoir type as well as Pumped Storage Hydro must be solely allocated for balancing of variable Renewable Generation

# Challenges for RE Integration and Mitigating Measures

- **Intermittency – Problem of scheduling:** CERC notified Forecasting and Scheduling Regulations for inter-State, SERCs to adopt the same for intra-State transaction;
- **Need flexible power for balancing :** CERC notified Ancillary Services Regulations, Need to expand the scope of it for DSM, DR, Energy Storage, and market based AS;
- **Grid Stability – High penetration of a large number of distributed RE generators :** Development of REMC at RLDCs and SLDCs level;
- **Low Gestation period of Generation (9-12 Months) than development of Transmission Strengthening (24-36 Months) :** Green Energy Corridor already planned with strong grid interconnection to enlarge balancing areas

# Other Challenges

- **Capital requirement**
  - Need to develop the Corporate bond market in the country
  - Need to provide long term currency hedges
- **Land requirement and other approvals**
  - Need simple land acquisition process
  - Single Window Clearance
- **Developing domestic manufacturing capability**
  - Need enabling policies to encourage indigenous manufacturing
- **Uniformity in Policies, Regulations & Bidding Guidelines**
- **Discoms Financial health**
  - Discoms debt restructuring
  - Convert Ag pumps into solar pumps
  - Leveraging solar mini/micro grid for rural energy access