



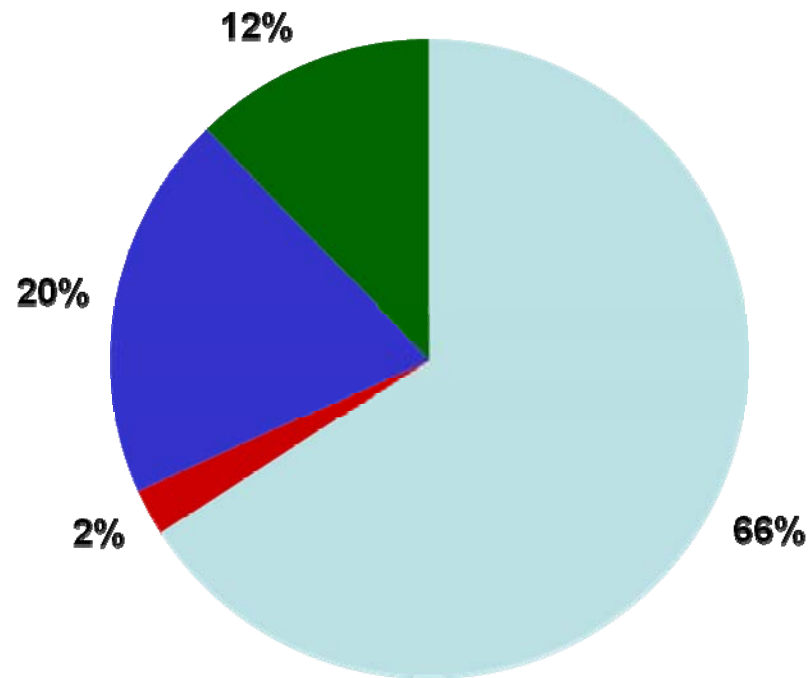
# **Grid Connected Solar Power in India**

**Tarun Kapoor**  
**Joint Secretary**  
**Ministry of New and Renewable Energy**  
**Government of India**

# Indian Power Sector (31 March 2012)

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**Power Installed Capacity ( ~200 GW)**

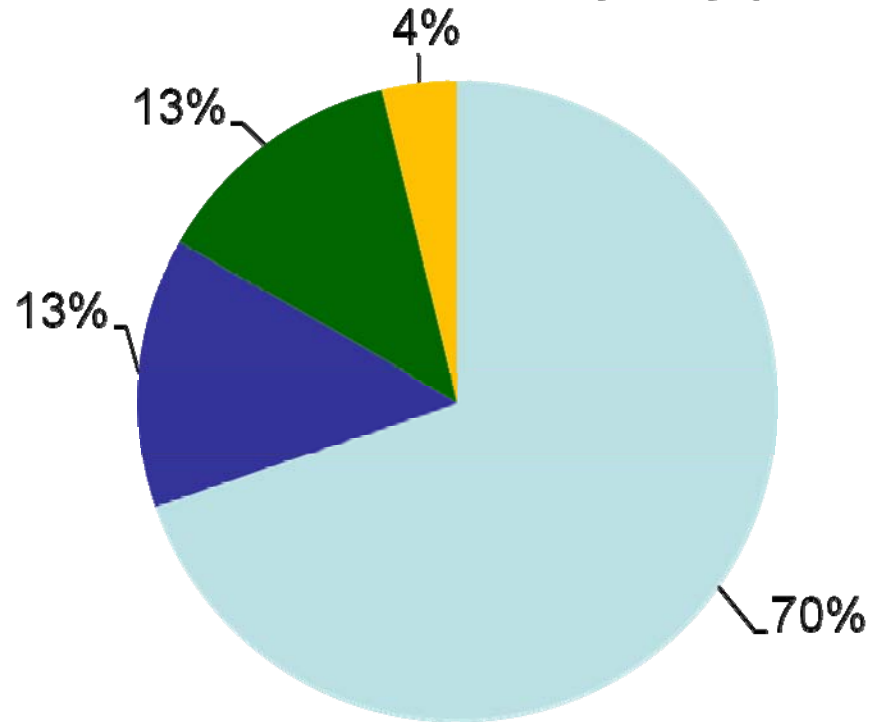


Thermal 1,31,353 MW	Hydro 38,990 MW	Nuclear 4,780 MW	Renewable 24,915 MW
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# Renewable Power Capacity (31 March 2012)

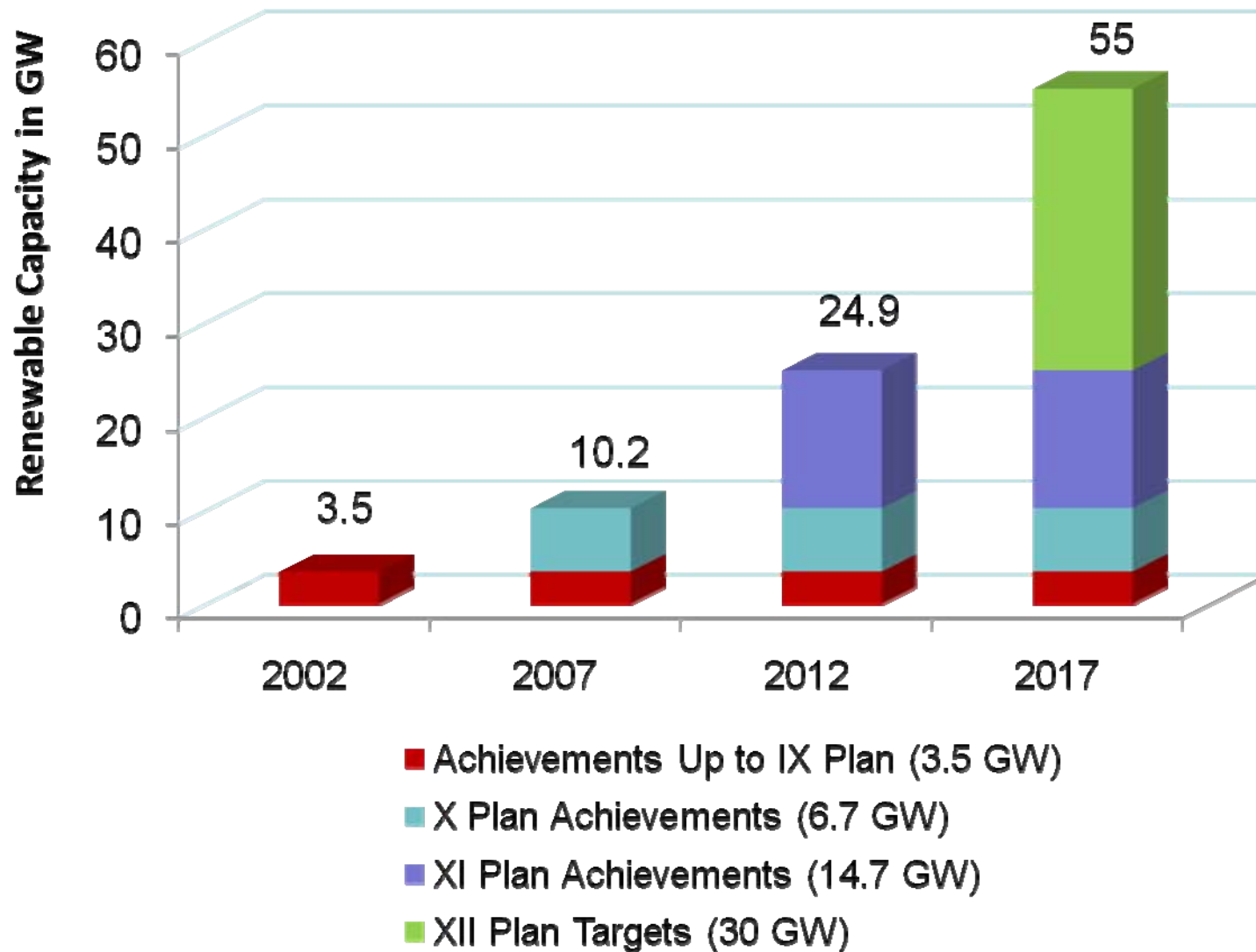
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**Installed Renewable Power Capacity (~ 25 GW)**



Wind 17,353 MW	Small Hydro 3,396 MW	Solar 905 MW	Biomass 3,225 MW
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# Plan-wise Renewable Capacity Addition



# Jawaharlal Nehru National Solar Mission (JNNSM)

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- One of the eight Missions under National Action Plan on Climate Change
- Launched by the Government of India in January 2010.
- JNNSM is one of the major global initiatives in promotion of solar energy technologies.
- Mission aims to achieve grid tariff parity by 2022 through
  - Large scale utilization, rapid diffusion and deployment at a scale which leads to cost reduction
  - R&D, Pilot Projects and Technology Demonstration
  - Local manufacturing and support infrastructure

# Mission Road Map

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<b>Application Segment</b>	<b>Target for Phase I (2010-13)</b>	<b>Cumulative Target for Phase 2 (2013-17)</b>	<b>Cumulative Target for Phase 3 (2017-22)</b>
<b>Grid solar power</b> (large plants, roof top & distribution grid plants)	1,100 MW	4,000 - 10,000 MW	20,000 MW
<b>Off-grid solar applications</b>	200 MW	1,000 MW	2,000 MW
<b>Solar Thermal Collectors</b> (SWHs, solar cooking/cooling, Industrial process heat applications etc.)	7 million sq meters	15 million sq meters	20 million sq meters
<b>Solar Lighting System</b>	5 million	10 million	20 million

# National Solar Mission: Strategy

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- Enabling policy and regulatory frame work
- Supporting Utility scale power generation
- Emphasis equally on grid & off-grid applications
- Accelerating Research and Development
- Enhancing Domestic manufacturing base

# Policy and Regulatory Framework

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- Amendment of National Tariff Policy for solar specific RPOs
- Solar specific RPO - 0.25% in Phase 1 (2013) to increase to 3% by 2022;
- REC Mechanism
- Encourage state specific solar policies
- State-wise RPO Orders by Regulators
- Exemption from environmental clearance for solar power projects



# JNNSM (Phase 1) - Key Deliverables

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- 1,100 MW Grid Solar Power Projects
- 200 MW Off-grid Solar Applications
- 7 million Sq. m solar thermal collector area
- R&D and HRD; Centers of Excellence
- Domestic Manufacturing
- Institutional arrangements for implementation of activities under the Mission

# JNNSM (Phase 1) - Guidelines Features

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- **Capacity allocation between technologies**
  - Capacity allocation between SPV and Solar Thermal was decided to be 50:50.
- **Phasing of Allocation**
  - **Solar PV:** Selection of PV projects done in two batches of 150 MW and 350 MW over two financial years of Phase 1 i.e., 2010-2011 and 2011-2012.
  - **Solar Thermal:** Given the longer gestation period of Solar Thermal Projects, entire capacity was selected in batch 1.

# JNNSM (Phase 1) - Guidelines Features

Cont...

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- **Maximum and Minimum Capacity (Batch 1)**
  - For SPV- 5 MW as both maximum and minimum
  - For Solar Thermal - 100 MW as maximum and 20 MW minimum
- **Maximum and Minimum Capacity (Batch 2)**
  - For SPV- 20 MW as maximum and 5 MW as minimum;
- **Applications per Company (Batch 1)**
  - For SPV: Only one application per Company
  - For Solar Thermal: Company was allowed to set up the proposed capacity through one application in multiple locations.
- **Applications per Company (Batch 2)**
  - For SPV: Capacity was limited to 50 MW; maximum 3 projects through single applications

# JNNSM (Phase 1) - Guidelines Features

Cont...

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## Domestic Content

- Solar PV: Batch 1
  - **Crystalline Technology**: Use of modules manufactured in India was mandatory
  - **Thin film/ CPV** : Was allowed to be sourced from other countries
- Solar PV: Batch 2
  - **Crystalline Technology**: Use of cells and modules manufactured in India was mandatory
  - **Thin film/ CPV** : Was allowed to be sourced from other countries
- Solar Thermal
  - 30% of the Project Cost

# JNNSM (Phase 1) - Guidelines Features

Cont...

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## **Selection Procedure**

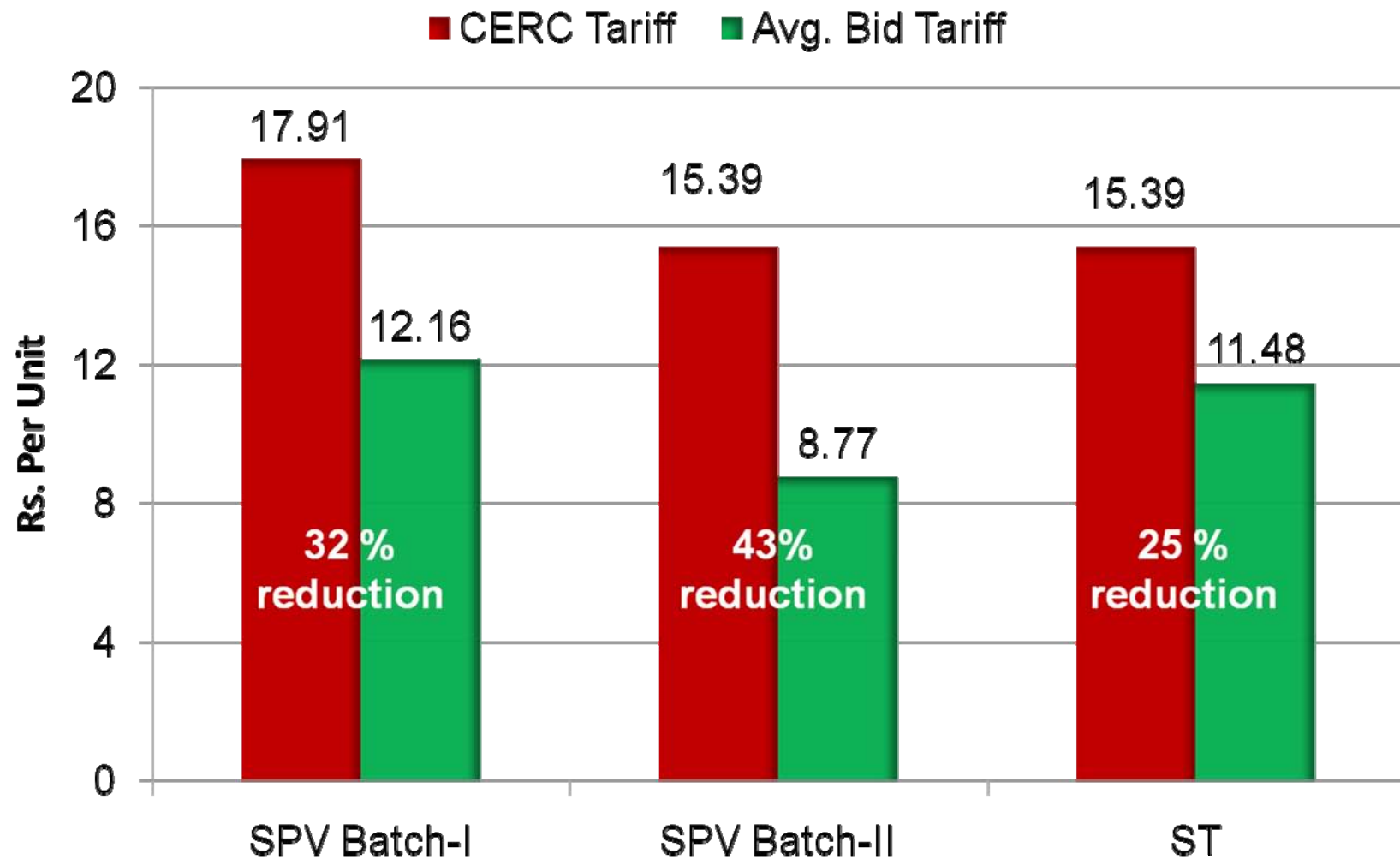
Projects were selected on the basis of discount offered by the Project Developers on CERC Approved Applicable Tariff

# Grid Solar Power – Phase-I Status

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- **Solar Thermal:** 7 projects for 470 MW selected in December, 2010. Average Tariff Rs. 11.48 per unit (25% reduction on CERC Tariff)
  - CSP Projects to be synchronized in early 2013
- **Solar PV :** 30 projects for 150 MW selected in December, 2010. Average Tariff - Rs. 12.16 per unit (32% reduction on CERC Tariff)
  - 25 Projects completed; 2 Projects cancelled;
  - Reports on balance three projects awaited.
- **Batch II Projects:** Total 350 MW capacity in 28 projects
  - The minimum and maximum tariff is Rs 7.49 and Rs. 9.44 per unit.
  - The weighted average tariff Rs. 8.77 per unit (43% reduction on CERC Tariff)
  - Likely to be commissioned by February 2013.

# CERC Tariff Vs Bid Tariff



## **Grid Solar Power**

### **(Small Plants - connected to below 33 KV grid)**

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- Total targeted capacity - 100 MW
- Generation Based Incentive (GBI) to utilities on reimbursement basis
- GBI rate Rs. 12.41/ Unit based on the difference of CERC tariff of Rs. 17.91 / Unit and notional tariff of Rs. 5.5 / Unit
- SERCs were to declare tariff. Lower of CERC and SERC tariff to be considered for GBI.
- 78 projects for 98 MW capacity from 12 States were allocated in September and December, 2010.
- 62 Plants (76.55 MW capacity) commissioned so far



# Grid Solar Power – Phase-I Status

So far, 99 projects with a cumulative capacity of 252 MW have been installed under JNNSM. The state-wise break-up of the number of projects and capacity installed as under:

Sl. No.	State	New NVVN Phase-I, Batch-I		Migration Scheme		RPSSGP through IREDA		Total	
		(a)		(b)		(c)		d=(a+b+c)	
		No.	MW	No.	MW	No.	MW	No.	MW
1	Andhra Pradesh	2	10			10	9.75	12	19.75
2	Chhattisgarh					2	4	2	4
3	Haryana					8	7.8	8	7.8
4	Jharkhand					6	12	6	12
5	Maharashtra			3	11	3	5	6	16
6	Orissa	1	5			7	7	8	12
7	Punjab			1	2	5	6	6	8
8	Rajasthan	20	100	8	37.5	10	10	38	147.5
9	Tamil Nadu	1	5			5	5	6	10
10	Uttra Pradesh	1	5			3	5	4	10
11	Uttrakhand					3	5	3	5
	Total	25	125	12	50.5	62	76.55	99	252

## Other Programmes

Additionally, 21.5 MW capacity projects have been installed under other schemes of the Ministry.

# State Initiatives

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The following States have announced Solar specific programmes:

- Gujarat – 968.5 MW
  - Around 690 MW already Commissioned
- Maharashtra – 125 MW + 80 MW
- Karnataka – 8 MW commissioned;
  - 80 MW Bids have been invited. Minimum tariff bid received is Rs 7.94 per unit.
- Rajasthan-100 MW ST + 100 MW PV
  - Bids have been invited
  - A 40 MW project commissioned to meet solar RPO
- Orissa – 25 MW
  - Bidding has been concluded with lowest tariff of Rs 7.00 per unit
- Madhya Pradesh – 200 MW
  - Minimum bid – Rs 7.90 per unit
- Tamil Nadu – Planning to invite bids for 50 MW

# Grid Solar Power Installations

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- *Under the national programme, over 270 MW capacity projects connected to the grid*
  - *Large projects = 125.0 MW*
  - *Small Plants = 76.6 MW*
  - *Migration = 50.5 MW*
  - *Other Schemes= 21.5 MW*
- *Through the encouragement provided by the JNNSM, the states have taken initiatives to install over 760 MW capacity projects.*

***Overall achievement is already over 1030 MW.***

# Large Solar PV projects commissioned

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## 40 MW Capacity Plants

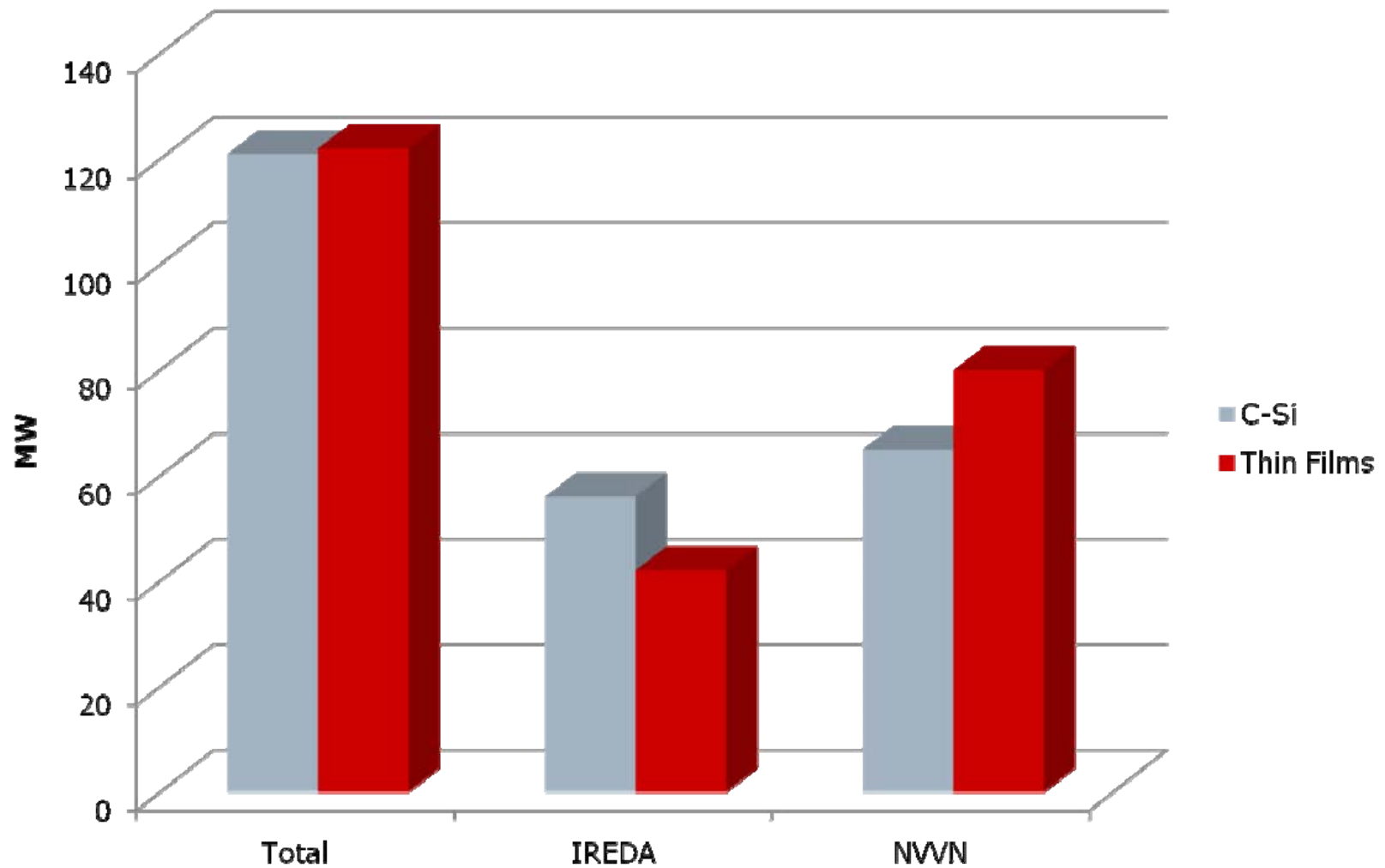
- Reliance Power, Pokaran, Rajasthan
- Adani Enterprises Ltd., Kutch Gujarat

## 25 MW Capacity Plants

- Alex Asatral Power Pvt. Ltd. Patan, Gujarat
- GMR Gujarat Solar Power Pvt. Ltd., Patan, Gujarat
- Louroux Bio Energies Ltd., Surendranagar, Gujarat
- Roha Dyechem Pvt. Ltd., Patan, Gujarat
- Sandland real estate Pvt. Ltd., Banaskantha, Gujarat
- Sun Edison Energy India Pvt. Ltd., Patan, Gujarat
- Tata Power Company Ltd., Jamnagar, Gujarat
- Visual Percept Solar Projects P. Ltd., Surendranagar, Gujarat

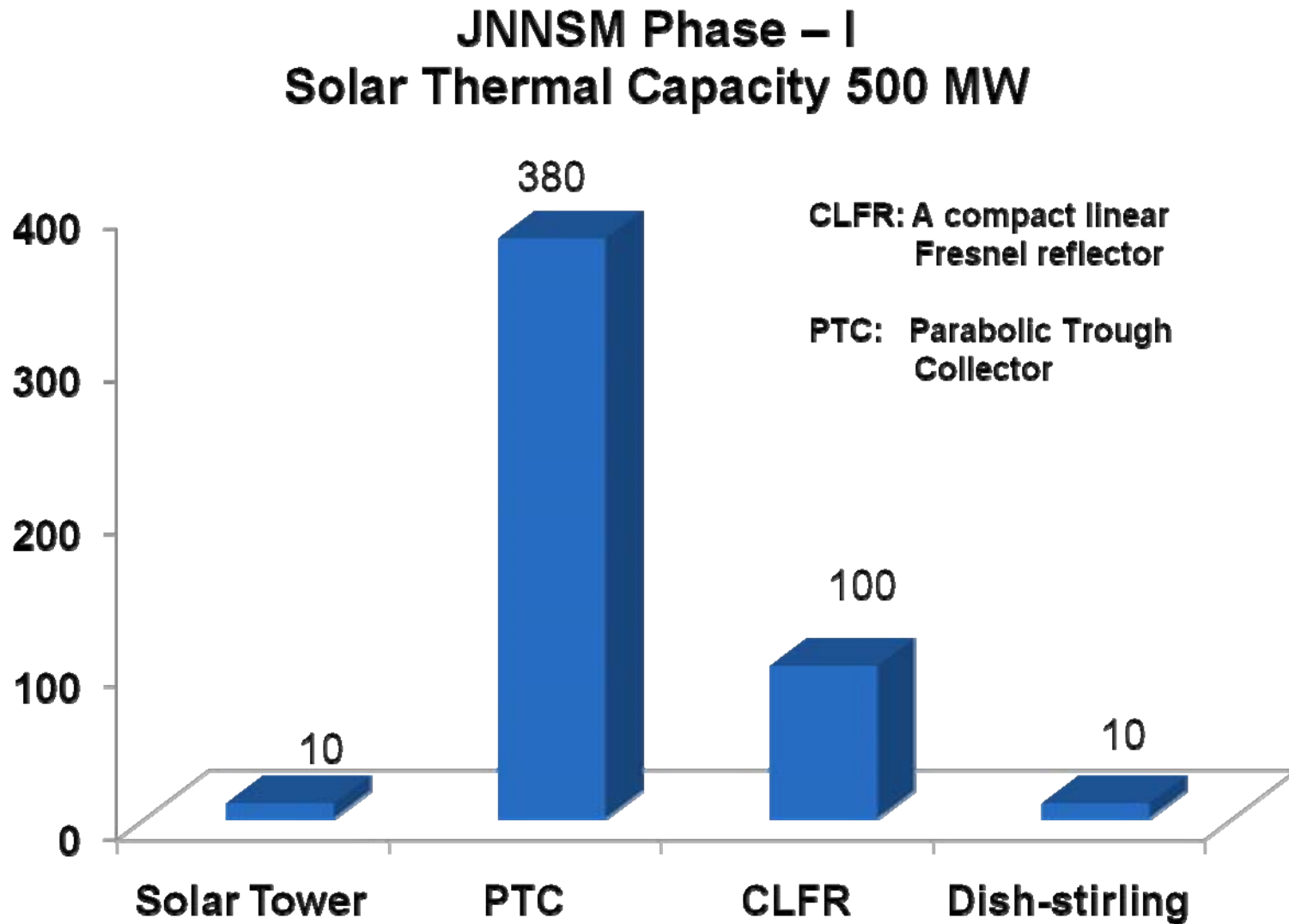
# Technology Choice in Grid PV Power

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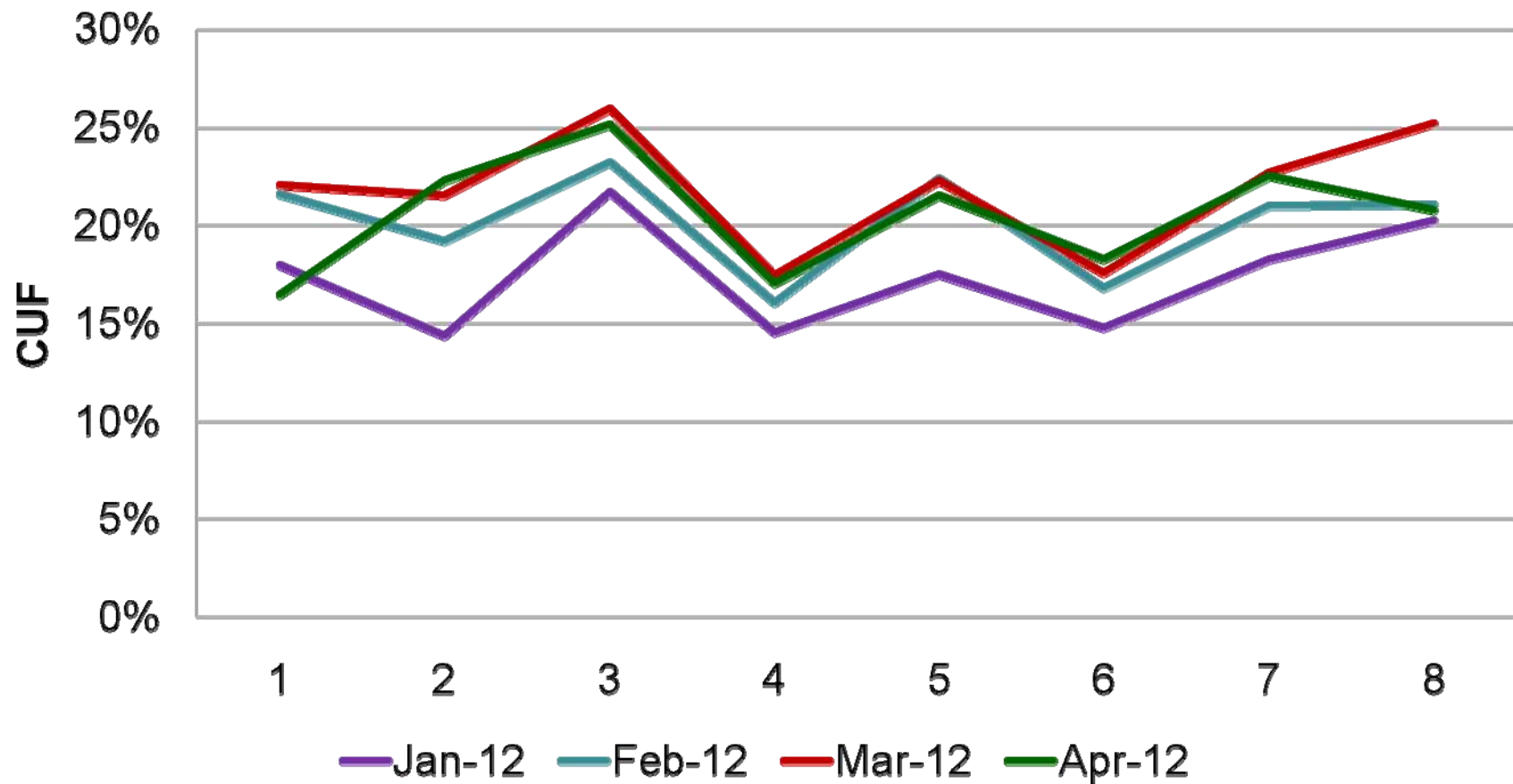


# Technology Choice Grid Solar Thermal

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# Typical performance of 5 MW Solar PV Plants in Rajasthan

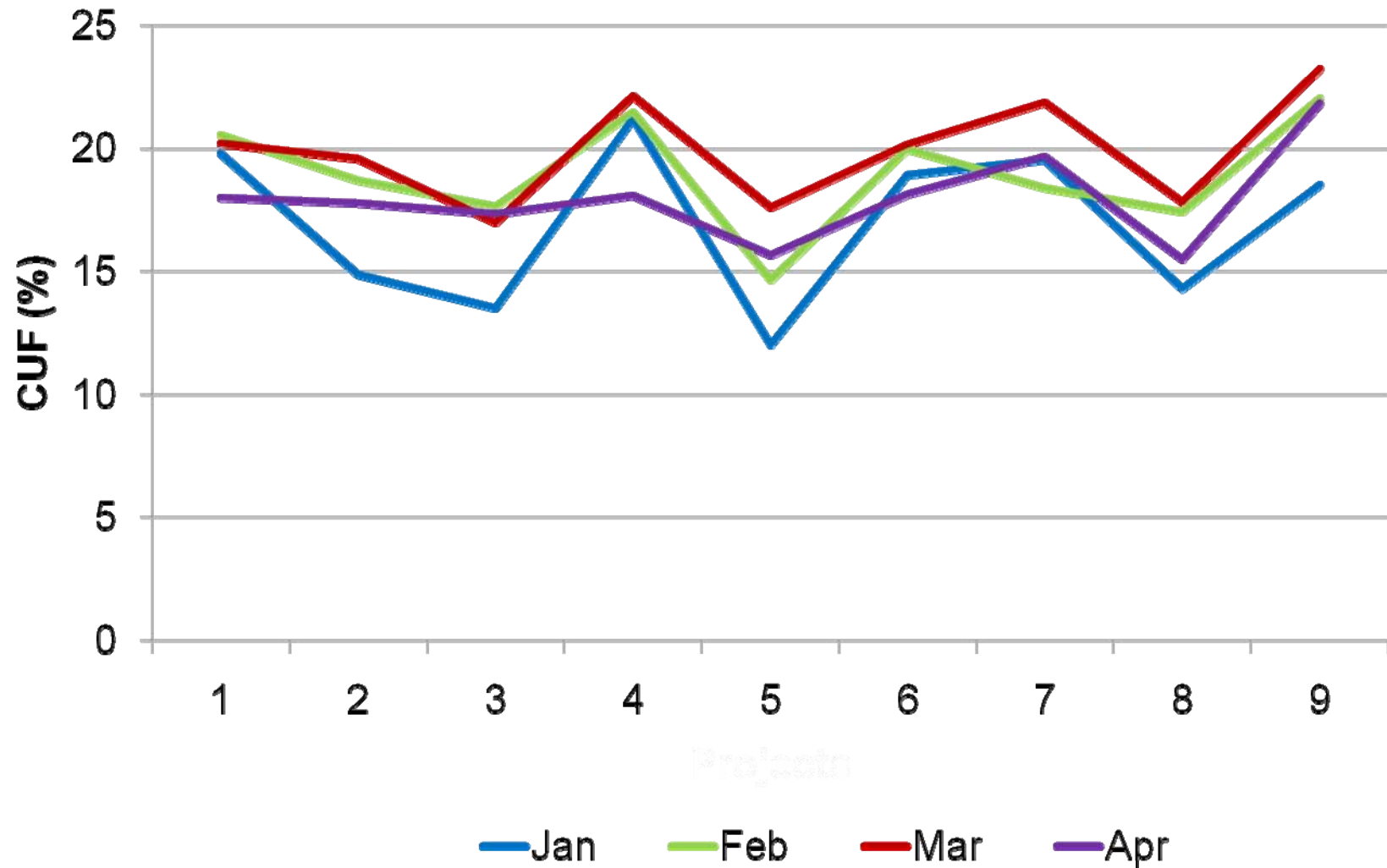


**Average CUF in Rajasthan is likely to be over 20%**

**Typical CUF in Germany is 13%**

# Typical performance of some small Solar PV Plants

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# 1 MW PV Plant at Osamabad

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# 5 MWp SPV Plant at Khimsar, Rajasthan

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# JNNSM – Phase 2

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- 3000 MW capacity to be supported by the Government of India
  - Bundling with thermal power to the extent the latter is available
  - Generation Based Incentive
  - Use of viability gap funding mechanism
- Additional 6000 MW is envisaged through Solar RPO requirement
  - Requirement of solar power capacity by 2017 is estimated to be about 10000 MW.

# Mandatory Solar RPO Mechanism

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- State Electricity Regulators to fix a percentage of energy purchased from Solar Power under RPO.
- The Solar RPO has to begin with .25 % of the energy procured reaching 3% by 2022.

Solar Power required to meet Solar RPOs (MW)					
2011-12	2012-13	2013-14	2014-15	2015-16	2016-17
1465	3018	4659	6387	8204	10109

- This requirement likely to go up to 30,000 MW by 2022.

# Mandatory Solar RPO Mechanism

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State	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17
Andhra Pradesh	0.25%	0.25%	0.25%	0.25%	0.25%	0.25%
Assam	0.10%	0.15%	0.20%	0.25%		
Bihar	0.50%	0.75%	1.00%	1.25%		
Chhattisgarh	0.25%	0.50%				
Delhi	0.10%	0.15%	0.20%	0.25%	0.30%	0.35%
JERC (Goa & UT)	0.30%	0.40%				
Gujarat	0.50%	1.00%				
Haryana	0.00%	0.05%	0.10%			
Himachal Pradesh	0.01%	0.25%	0.25%	0.25%	0.25%	0.25%
Jammu and Kashmir	0.10%	0.25%				
Jharkhand	0.50%	1.00%				
Kerala	0.25%	0.25%	0.25%	0.25%	0.25%	0.25%

# SERCs Declared Solar RPO

State	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17
Andhra Pradesh	0.25%	0.25%	0.25%	0.25%	0.25%	0.25%
Assam	0.10%	0.15%	0.20%	0.25%		
Bihar	0.50%	0.75%	1.00%	1.25%		
Chhattisgarh	0.25%	0.50%				
Delhi	0.10%	0.15%	0.20%	0.25%	0.30%	0.35%
JERC (Goa & UT)	0.30%	0.40%				
Gujarat	0.50%	1.00%				
Haryana	0.00%	0.05%	0.10%			
Himachal Pradesh	0.01%	0.25%	0.25%	0.25%	0.25%	0.25%
Jammu and Kashmir	0.10%	0.25%				
Jharkhand	0.50%	1.00%				
Kerala	0.25%	0.25%	0.25%	0.25%	0.25%	0.25%

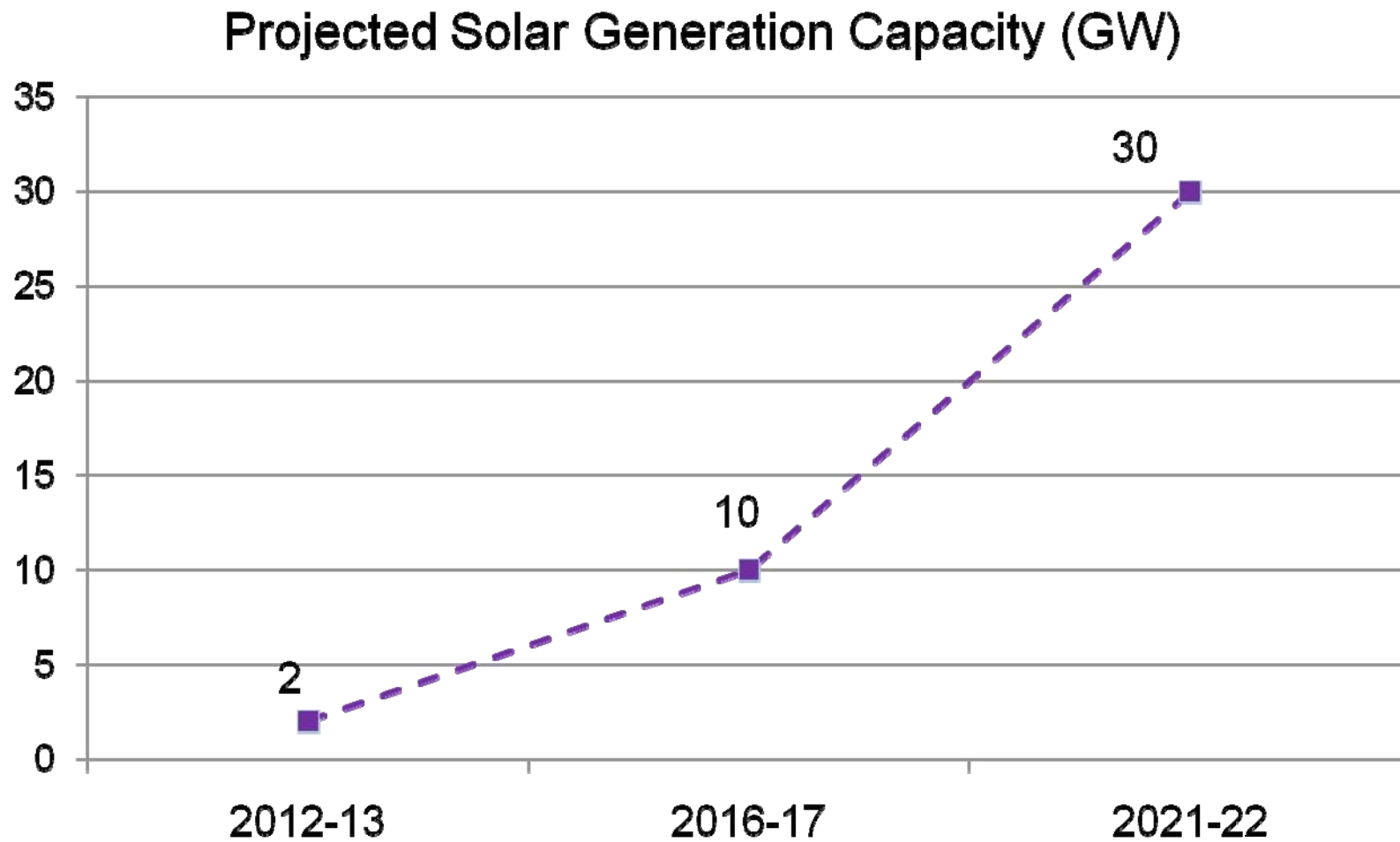
# SERCs Declared Solar RPO

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State	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17
Madhya Pradesh	0.40%	0.60%	0.80%	1.00%		
Maharashtra	0.25%	0.25%	0.50%	0.50%	0.50%	
Manipur	0.25%	0.25%				
Mizoram	0.25%	0.25%				
Meghalaya	0.30%	0.40%				
Nagaland	0.25%	0.25%				
Orissa	0.10%	0.15%	0.20%	0.25%	0.30%	
Punjab	0.03%	0.07%	0.13%	0.19%		
Rajasthan	0.50%	0.75%	1.00%			
Tripura	0.10%	0.10%				
Uttarakhand	0.03%	0.05%				
Uttar Pradesh	0.50%	1.00%				

# Projected Growth

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# Roof-Top Grid Connected Solar Power

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- One of the major potential area in cities like Delhi where land is not available for large grid connected solar projects.
- With subsidy and soft loan, a viable option even for domestic use.
- Action already initiated
  - Draft Grid connectivity standards notified by CEA
  - FOR in the process of framing regulations for tariff determination
  - MNRE in the process of evolving new scheme

# Exemption from Taxes

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- Vide Custom Notification No. 25/1999 dated 28<sup>th</sup> February, 1999 there was no customs & Excise duty on cells and modules but some raw materials required to manufacture cells and modules attract 5% customs duty and CVD.
- Vide Custom Notification No. 32/2012 dated 8<sup>th</sup> May, 2012 importation of Plant & Machinery for initial setting up of solar power projects is exempted from Additional Custom Duty and the total custom duty leviable has come down from 9.35% to 5.15%.
- Vide Notification No. 31/2012 dated 8<sup>th</sup> May, 2012 goods required for manufacturing of solar cells and modules have been exempted from Additional Custom Duty and the total custom duty leviable has come down to 9.35%.

# Ground Measurements of Solar Radiation

Andhra Pradesh	6
Gujarat	11
Haryana	1
Madhya Pradesh	3
Karnataka	5
Rajasthan	12
Chhattisgarh	1
Ladakh	1
Maharashtra	3
Pudducherry	1
Tamil Nadu	6

- C-WET is implementing the project for setting up 51 ground monitoring stations
- Centralized data collection, analysis and calibration of measuring sensors



# National Solar Thermal Power Testing, Simulation and Research Facility

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- **1MWe Solar Thermal Power Plant**
  - Research and Demonstration plant
  - Combination of different collector fields  
(Direct and Indirect Steam Generation)

## Parabolic Trough Field

-8700 sq. m  
-3.3 MW<sub>th</sub> (Design)



## Linear Fresnel Field

- 7200 sq. m  
- 2.2 MW<sub>th</sub> (Design)



Turbine operating conditions: saturated steam at 350° C and 40 bar

# Institutional Arrangements

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- Solar Energy Corporation of India (SECI) has been set up as a Company Not for Profit under Section 25 of Company Act for implementation of activities under the Mission
- Solar Energy Research Advisory Council, Chaired by Dr. Anil Kakodkar has been set up to advise on research policy with a view to achieve Mission targets.
- Solar Energy Industry Advisory Council, Chaired by Shri Anand Mahindra set up.

# Solar Energy Centre

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- Solar Energy Centre (SEC) near New Delhi under the Ministry is the lead Centre for testing and training in solar energy in the country
- SEC has NABL accredited testing facilities for PV module qualification as per Indian and International standards
- SEC is imparting training in solar energy at various levels
- SEC is regularly conducting international training programmes in solar energy with MEA
- Several research and technology validation projects are being set up at SEC.

**Thank You**  
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