



Department of Industrial and Management Engineering

Indian Institute of Technology Kanpur



5th Capacity Building Programme for
Officers of Electricity Regulatory Commissions
18 – 23 Oct., 2012

Forum of Regulators

Experience with Implementing Jawaharlal Nehru National Solar Mission and the Road Ahead


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Government of India
Ministry of New and Renewable Energy

Renewable Energy is Green, Clean and
Sustainable Energy

Background



- Launched by Hon'ble Prime Minister on 11 January 2010 as a part of NAPCC
- 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




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

JNNSM: Phase-I, Batch-I



Scheme	Projects allotted		Projects Commissioned		Min ^m / Max ^m / Weighted Avg. bid tariff	% Reduction in tariff	
	No.	MW	No.	MW			
Large PV projects through NVVN	30	150	26	130	10.95/12.76/12.16 Rs. / Unit	32 %	
			2 Projects Cancelled				
Migration Scheme	SPV	13	54	11	48	CERC applicable tariff	
	ST	3	30	1	2.5		
RPSSGP Scheme (PV)		78	98.05	68	87.80	CERC linked tariff	
Solar Thermal projects through NVVN		7	470	Scheduled for commissioning by May 2013		10.49/12.24/11.48 Rs. / Unit	25 %



सत्यमेव जयते

Commissioning Status of Solar PV Projects under Batch – I, Phase -I of JNNSM

A) Rooftop PV and Small Solar Power Generation Programme (RPSSGP)

State Wise:

S. no	State	Solar PV capacity to be commissioned as per PPA (MW)	Solar PV capacity actually commissioned (MW)	Capacity not commissioned (MW)
1	Andhra Pradesh	10.5	9.75	0.75
2	Chhattisgarh	4	4	0
3	Haryana	8.8	7.8	1
4	Maharashtra	5	5	0
5	Odisha	8	7	1
6	Punjab	8.5	6	2.5
7	Rajasthan	12	10	2
8	Tamil Nadu	7	5	2
9	Uttarakhand	5	5	0
10	Uttar Pradesh	8	7	1
11	Jharkhand	16	16	0
12	Madhya Pradesh	5.25	5.25	0
Total		98.05	87.80	10.25


सत्यमेव जयते

B) i. Grid Solar PV Projects under Migration Scheme

S. No.	Name of project commissioned	State	Solar PV capacity allocated as per PPA (MW)	Solar PV capacity actually commissioned (MW)
1	Clover Solar Pvt. Ltd., Mumbai	Maharashtra	2	2
2	Maharashtra State Power Generation Co. Limited, Mumbai	Maharashtra	4	4
3	Videcon Industries Ltd, Mumbai	Maharashtra	5	5
4	Azure Power (Punjab) Pvt. Ltd., Amritsar Pvt. Ltd., Gurgaon, Haryana	Punjab	2	2
5	AES Solar Energy	Rajasthan	5	5
6	Aston Field Solar (Rajasthan) Pvt. Ltd.	Rajasthan	5	5
7	Comet Power Pvt. Ltd., Mumbai	Rajasthan	5	5
8	Moser Baer Photo Voltaic Ltd., New Delhi	Rajasthan	5	5
9	OPG Energy Pvt. Ltd., Chennai, Tamil Nadu	Rajasthan	5	5
10	Refex Refrigerants Limited, Chennai	Rajasthan	5	5
11	Swiss Park Vanijya Pvt. Ltd.	Rajasthan	5	5
12	Enterprise Business Solutions	Rajasthan	5	-
13	Entegra Ltd	Rajasthan	1	-
Total			54	48

B) ii. Grid Solar Thermal Projects under Migration Scheme




S. No.	Name of project commissioned	State	Solar PV capacity allocated as per PPA (MW)	Solar PV capacity actually commissioned (MW)
1.	Acme Tele Power Limited, Gurgaon	Rajasthan	10	2.5
2.	Dalmia Solar Power Limited	Rajasthan	10	-
3.	Entegra Ltd.	Rajasthan	10	-
	Total		30	2.5

The commissioning target is May, 2013.


B) iii. Grid Solar PV Projects under Phase-I, Batch-I.



S. No.	Name of project commissioned	State	Solar PV capacity allocated as per PPA (MW)	Solar PV capacity actually commissioned (MW)	Date of commissioning
1.	Aftaab Solar Pvt. Limited	Odisha	5	5	07/02/2012
2.	Alex Spectrum Radiation Private Limited	Rajasthan	5	5	21/02/2012
3.	Amrit Energy Pvt. Limited	Rajasthan	5	5	02/02/2012
4.	Azure Power (Rajasthan) Pvt Ltd	Rajasthan	5	5	01/01/2012
5.	CCCL Infrastructure Limited	Tamil Nadu	5	5	29/03/2012
6.	DDE Renewable Energy Private Limited	Rajasthan	5	5	14/02/2012
7.	Electromech Maritech Pvt Ltd	Rajasthan	5	5	01/02/2012
8.	EMC Limited	Uttar Pradesh	5	5	04/03/2012



9.	Finehope Allied Engineering Private Limited	Rajasthan	5	5	07/02/2012
10.	Greentech Power Private Limited	Rajasthan	5	5	08/02/2012
11.	Indian Oil Corporation Limited	Rajasthan	5	5	02/02/2012
12.	Karnataka Power Corporation Limited	Karnataka	5	5	25/06/2012
13.	Khaya Solar Projects Private Limited	Rajasthan	5	5	28/01/2012
14.	Maharashtra Seamless Limited	Rajasthan	5	5	07/01/2012
15.	Mahindra Solar One Private Limited	Rajasthan	5	5	03/01/2012
16.	Newton Solar Private Limited	Rajasthan	5	5	09/02/2012



17.	Northwest Energy Private Limited	Rajasthan	5	5	07/01/2012
18.	Oswal Woollen Mills Limited	Rajasthan	5	5	10/01/2012
19.	Precision Technik Private Limited	Rajasthan	5	5	22/03/2012
20.	Punjilloyd Solar Power Limited	Rajasthan	5	5	08/01/2012
21.	Saidham Overseas Private Limited	Rajasthan	5	5	30/01/2012
22.	Saisudhir Energy Limited	Andhra Pradesh	5	5	05/01/2012
23.	SEI Solar Energy Private Limited	Rajasthan	5	5	01/01/2012
24.	Vasavi Solar Power Pvt. Limited	Rajasthan	5	5	02/02/2012



25.	Viraj Renewables Energy Private Limited	Rajasthan	5	5	05/01/2012
26.	Welspun Solar AP Private limited	Andhra Pradesh	5	5	01/01/2012
27.	Rithwik Projects Private Limited	Andhra Pradesh	5	-	-
28.	FireStone Trading Private Limited	Maharashtra	5	-	-
		Total	140	130	-

Grid Connected Projects under Batch-I, Phase-I



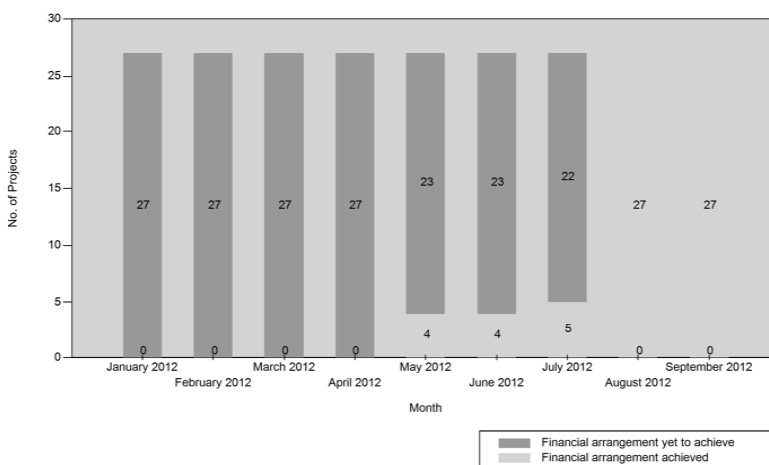
State	Solar PV capacity to be commissioned as per PPA (MW)	Solar PV capacity actually commissioned (MW)	Balance capacity to be commissioned (MW)
Rajasthan	100	100	0
Maharashtra	5	-	5
Andhra Pradesh	15	10	5
Karnataka	5	5	0
Orissa	5	5	0
Tamil Nadu	5	5	0
Uttar Pradesh	5	5	0
Total	140	130	10

JNNSM: Phase-I, Batch-II



Scheme	Projects allotted		Projects Commissioned		Minimum bid tariff	Maximum bid tariff	Weighted Average bid tariff	% Reduction in tariff
	No.	MW	No.	MW				
Large PV projects through NVVN	28	350	Scheduled for commissioning by Feb. 2013		7.49 Rs. / Unit	9.44 Rs. / Unit	8.77 Rs. / Unit	43 %

Financial Arrangement Total No. of Projects - 27



Solar Power Installation



▪ Under the national programme, over 280 MW capacity projects connected to the grid

- Large projects = 130.0 MW (Out of 140 MW)
- Small Plants = 87.80 MW (Out of 98 MW)
- Migration = 50.5 MW (Out of 84 MW)
- Other Schemes = 21.5 MW

▪ Through the encouragement provided by the JNNSM, the states have taken initiatives to install over 755 MW capacity projects.

Overall achievement is already over 1046 MW.

State wise Capacity



State/UT	MW	State/UT	MW
Andhra Pradesh	21.8	Punjab	9.3
Chhattisgarh	4.0	Rajasthan	198.7
Gujarat	690.0	Tamil Nadu	15.1
Haryana	7.8	Uttar Pradesh	12.4
Jharkhand	16.0	Uttarakhand	5.1
Karnataka	14.0	West Bengal	2.1
Madhya Pradesh	7.4	Andaman & Nicobar	0.1
Maharashtra	20.0	Delhi	2.5
Orissa	13.0	Lakshadweep	0.8
TOTAL		1046.66	

State Initiative



S. No	State	Solar Specific Programme
1.	Gujarat	Announced – 968.5 MW Commissioned – 680 MW
2.	Maharashtra	Announced – 205 MW Commissioned – 40 MW (Setup in Rajasthan)
3.	Karnataka	Commissioned – 8 MW Bids invited – 80 MW, Minimum tariff – Rs. 7.94/unit
4.	Rajasthan	Announced – 200 MW
5.	Odisha	Awarded – 25 MW, Minimum tariff – Rs. 7/unit
6.	Madhya Pradesh	Announced – 200 MW Minimum tariff – Rs. 7.90/unit
7.	Tamil Nadu	Announced – 50 MW
	Total	Announced – 1736.50 MW

Off Grid SPV : Physical Targets and Achievements (Target: 200 MW in Phase-I)



Year	Target in MW	Project Sanctioned (MW)
Till March 2010	-	-
2010-11	32	40.65
2011-12	68	77.40
2012-13	100	20

Solar Thermal : Achievements

5.83 million square meter of solar thermal collector area installed so far cumulatively against target of 7.0 million square meter in Phase-I.

JNNSM – Phase 2 : Goals



- 3000 MW capacity to be supported by the Government of India
- Additional 6000 MW is envisaged through Solar RPO requirement
 - Requirement of solar power capacity by 2017 is estimated to be about 10000 MW.
- A demand of about 10 GW of solar power is expected to be generated by 2017 assuming an yearly increase of solar RPO by 0.25 % and increase in conventional power capacity by 3%
- 1000 MW off grid solar applications by 2017
- 15 million square meters solar thermal collector area by 2017

JNNSM : Phase 2 Strategy (Grid Connected)



Options

- Bundling with Thermal Power
 - Bundling in the ratio of 1.6 MW of solar power with 1 MW capacity of thermal power
 - 1900 MW thermal power would be required to achieve 3000 MW capacity
- Generation Based Incentive
 - In view of the declining cost of generation of solar PV power, GBI of around Rs 2.5 per unit may be required.
- Viability Gap Funding Mechanism
 - VGF through open tender on deferred payment basis is one of the alternatives

Proposals for Supporting 3000 MW Capacity




- 1500 MW capacity of PV Power in two lots of 750 MW each through VGF mechanism
- 500 MW Capacity of Solar Thermal Power with VGF Funding mechanism
- 250 MW capacity through a Special Project in Ladakh through VGF
- 750 MW capacity through bundling with thermal power through NRVN; 500 MW of thermal power may be required for this purpose.

Estimated requirement of Solar Power Capacities to meet Solar RPOs



S.No	State	Solar RPO Year wise	Installed Capacity* (MW)	Solar Power Required (MW)					
				2011-12	as on 31.05.11	2011-12	2012-13	2013-14	2014-15
1	Andhra Pradesh	0.25%	14268	143	294	454	622	799	984
2	Arunachal Pradesh	0.25%	135	1	3	4	6	8	9
3	Assam	0.25%	951	10	20	30	41	53	66
4	Bihar	0.25%	1854	19	38	59	81	104	128
5	Chhattisgarh	0.25%	4632	46	95	147	202	259	320
6	Delhi	0.25%	5800	58	119	184	253	325	400
7	Goa & UT	0.25%	822	8	17	26	36	46	57
8	Gujarat	0.25%	13722	137	283	436	598	768	947
9	Haryana	0.25%	5880	59	121	187	256	329	406
10	Himachal Pradesh	0.25%	2201	22	45	70	96	123	152
11	Jammu & Kashmir	0.25%	2167	22	45	69	94	121	150
12	Jharkhand	0.25%	1979	20	41	63	86	111	137
13	Karnataka	0.25%	9530	95	196	303	416	534	658
14	Kerala	0.25%	3573	36	74	114	156	200	247
15	Madhya Pradesh	0.25%	8114	81	167	258	354	454	560



16	Maharashtra	0.25%	20271	203	418	645	884	1135	1399
17	Manipur	0.25%	152	2	3	5	7	9	10
18	Meghalaya	0.25%	258	3	5	8	11	14	18
19	Mizoram	0.25%	102	1	2	3	4	6	7
20	Nagaland	0.25%	75	1	2	2	3	4	5
21	Orissa	0.25%	5299	53	109	169	231	297	366
22	Punjab	0.25%	6690	67	138	213	292	375	462
23	Rajasthan	0.25%	7508	75	155	239	327	420	518
24	Sikkim	0.25%	154	2	3	5	7	9	11
25	Tamil Nadu	0.25%	9803	98	202	312	427	549	676
26	Tripura	0.25%	249	2	5	8	11	14	17
27	Uttar Pradesh	0.25%	9848	98	203	313	429	551	680
28	Uttarakhand	0.25%	2309	23	48	73	101	129	159
29	West Bengal	0.25%	8155	82	168	259	356	457	563
	Total		146501	1465	3018	4659	6387	8204	10109

Off Grid SPV : For 12th Plan (1)



Off-grid Solar Power Application:

Target – 800 MW

At current rate of subsidy, the requirement of funds would be roughly 6,000 Crore i.e. annually 1200 Crore.

Solar Thermal Heating:

Target – 8 million sq. meters of collector area

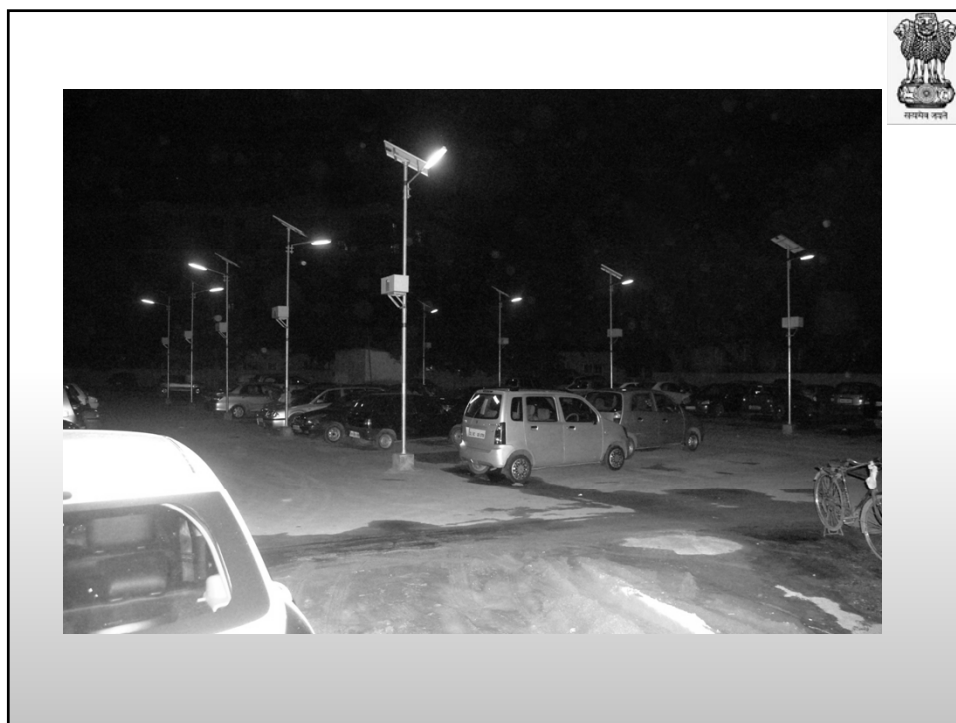
The requirement of subsidy shall be Rs. 1075 Crore.

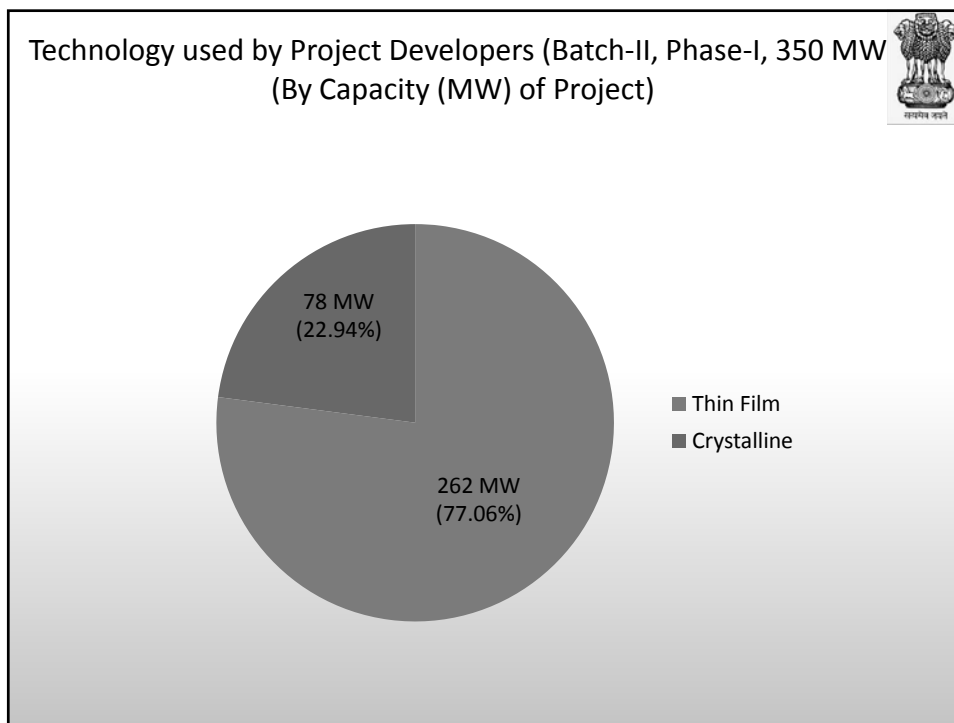
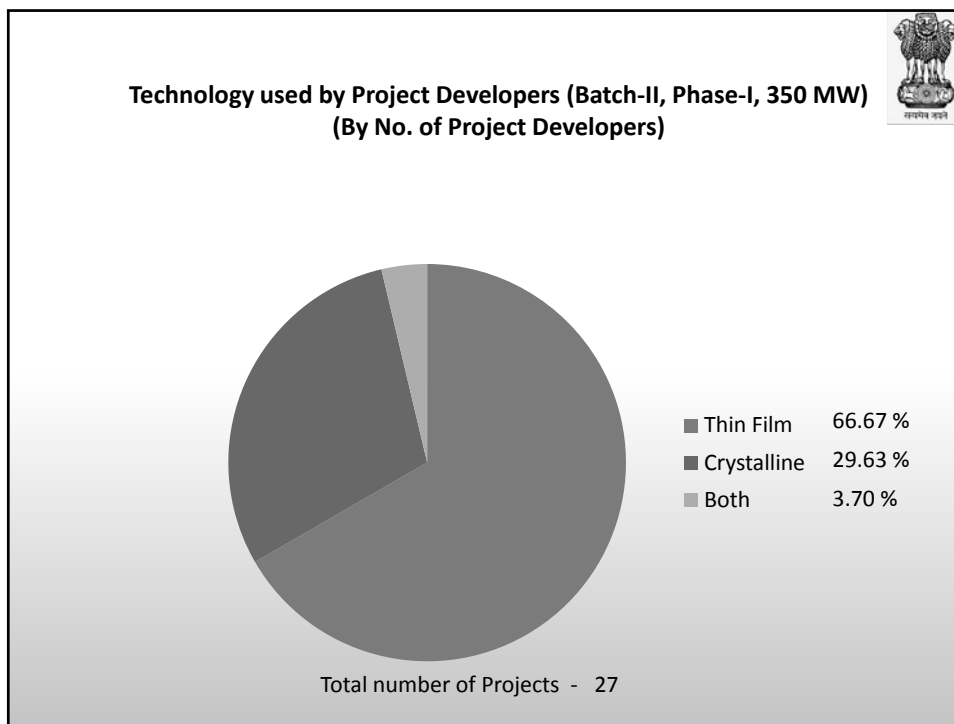
New Schemes

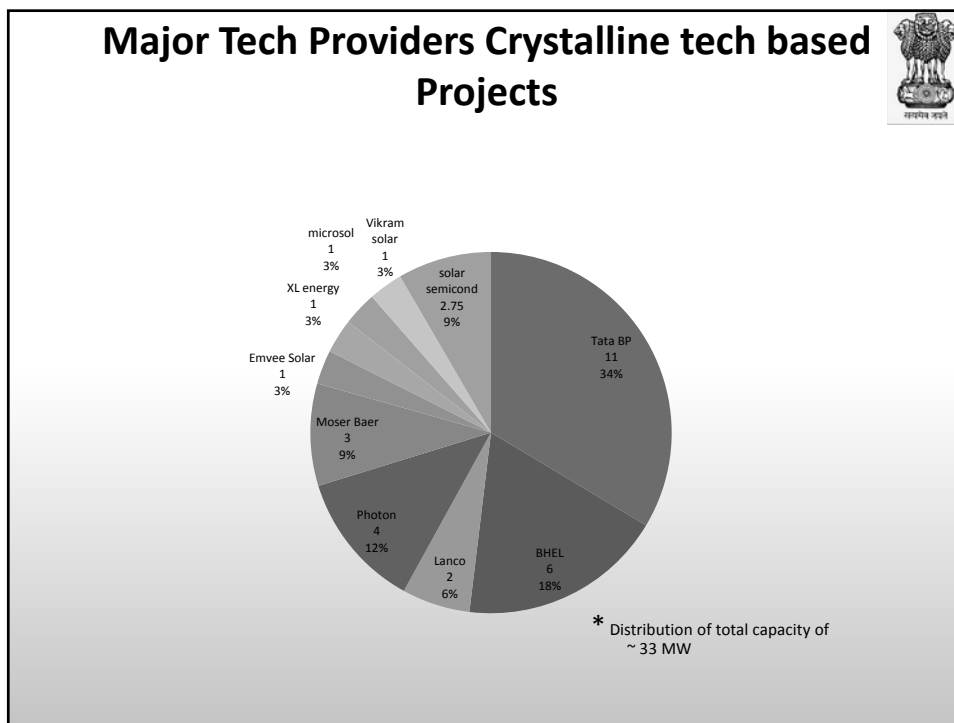
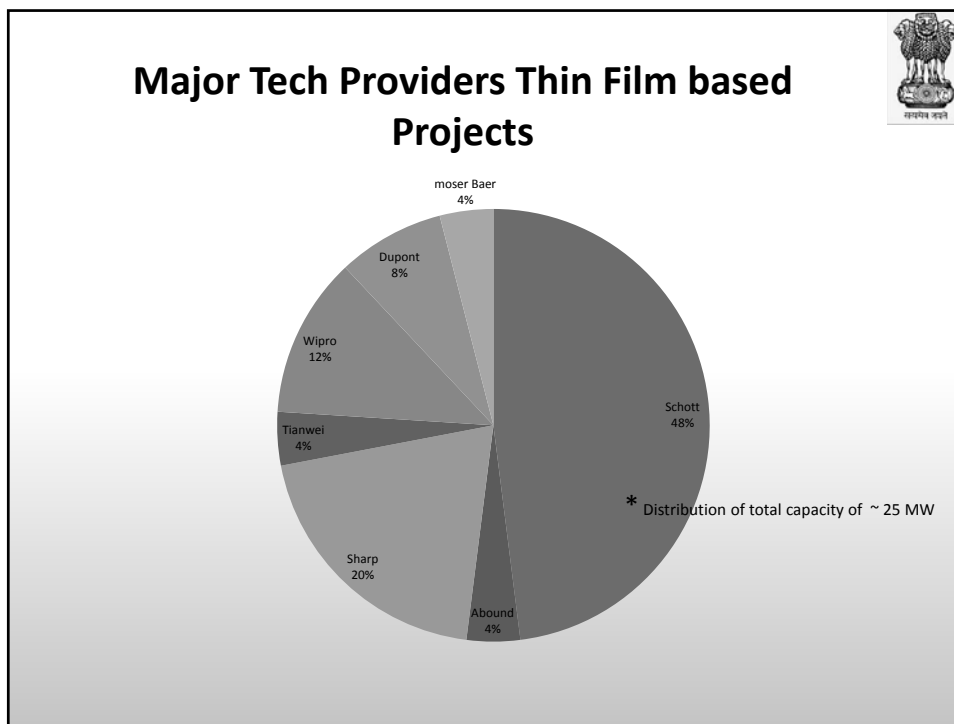




- Mini / micro grid for energy access
- Solar parks
- Small capacity grid connected solar PV plants for left over States
- Making available low cost solar lantern
- Roof top systems – grid tied
- Focus on industrial process heat systems










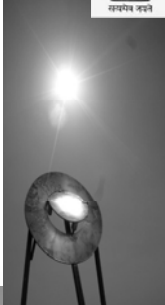





Solar PV outdoor test bed at SEC



1 MW with 16 hour thermal storage Project at Mount Abu By WRST with co-funding from German Ministry and Indian industry.

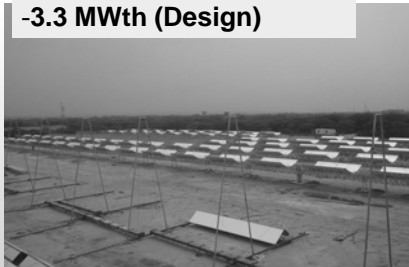


National Solar Thermal Power Testing, Simulation and Research Facility

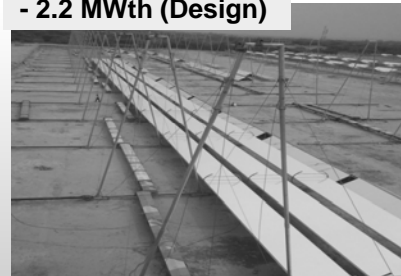


- **1MWe Solar Thermal Power Plant**
 - Research and Demonstration plant
 - Combination of different collector fields (Direct and Indirect Steam Generation)

Parabolic Trough Field
- 8700 sq. m
- 3.3 MWth (Design)





Linear Fresnel Field
- 7200 sq. m
- 2.2 MWth (Design)





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



(1 MW capacity PV Plant at Hissar in Haryana



**2.5 MW
Solar Thermal
Tower
Grid Power Plant
at
Bikaner, Rajasthan
(Migration)**



**1 MW PV (Crystalline Silicon) Grid Power Plant at New Delhi
(Solar RPO arrangement)**

Indian PV Industry



- More than 60 companies, with installed capacity of over 1.7 GW, make PV modules
 - 15 companies manufacture solar cells (> 700 MW installed capacity)
- Manufacturing of various raw materials, components, devices and systems is coming up/expanding (Poly silicon, wafers, glass, EVA, back sheet, grid inverters etc.)
- Turn over of Indian solar industry in 2010-11 estimated around Rs. 10,000 crore
- One of the Mission objectives is to take a global leadership role in solar manufacturing (across the value chain) of leading edge solar technologies and target a 4-5 GW equivalent of installed capacity by 2020

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What are the constraining factors to developers?



- Land acquisition
- Multiple clearances
- Transmission to nearest grid s/s
- High cost of Indian debt with short tenures
- Radiation data uncertainty
- With recourse debt. Non-availability of Project Finance.
- Human resources

Land acquisition issues



- Due to aggressive bidding, projects opt for inexpensive land/ Govt. land
 - At times, it get significantly expensive to bring the land to a state suitable for installation and requires levelling, terracing etc.
- MW scale PV plants require considerable land area. Usually not available with a single owner
 - Consolidation of contiguous land from multiple owners and families, title search, legal due diligence, negotiations takes considerable time and expense. In turn leading to cost/ time overruns.

Multiple Clearances



- Under JNNSM, Acquisition of clearances for water, construction power, pollution provided at the state level
 - Adds a layer of process which lead to delays & poses risk to timely completion of projects
 - Pollution related clearances should be done away with for solar PV projects
 - Water required for construction as well as panel cleaning during O&M phase, domestic purposes for staff.
 - ✓ In far flung areas with no access of piped water, borewell is the only viable option.
 - ✓ It typically takes considerably long to get requisite approvals for this permit
 - Inability of the state governments to provide a single-window clearance

Evacuation Infrastructure



- Under JNNSM, the developer responsible for laying evacuation infrastructure upto the interconnection point/ GSS
 - As per state solar policies of Gujarat and Rajasthan, state transmission utilities are responsible for building the power evacuation infrastructure
- Considerable challenges for developer in power evacuation infrastructure:
 - Cheaper and suitable land available mostly in remote areas at a considerable distance from grid substations. Involves substantial transmission infrastructure building costs
 - Right of Way (ROW) issue is more often under-estimated in time and cost by developers. Takes considerable time/ expense in negotiating individually with each land owner.
 - State support essential in resolving the ROW issues
 - State providing connectivity to project would considerably de-risk timely evacuation challenge

Solar Park development



- Problems in Land acquisition/ Consolidation/ clearances/ evacuation may be resolved by:
 - Developing the solar park on lines of Gujarat whereby land could be leased out to solar developers
 - Solar Park may provide necessary evacuation infrastructure, water and clearances
 - Sharing of cost of infrastructure lowers project cost. Win-win for State as well as developers.
 - Also serves as a showcase site for State to encourage developers/ investors
- Development of State specific database on waste-lands suitable for solar project development would also be helpful

Project Financing



- Most lenders in India still uncomfortable in financing solar PV projects on a non-recourse basis. Perceives high levels of projects construction and operating risks:
 - Payment security considering financial health of SEBs and Discoms
 - Not enough operating history for the technologies proposed by developer
 - Uncertainty surrounding the generation potential at site. Different solar radiation database yield varying estimates.
 - Lack of adequate ground-mounted monitoring stations to validate satellite based estimates
 - Radiation variability could significantly affect projected cash flows
 - Low confidence on developers to deliver projects at costs to sustain cash-flows within the very competitive tariffs quoted under reverse bidding mechanism of JNNSM

Cost of financing



- Prohibitive cost of financing in India in terms of prevailing interest rates.
- Not amenable to funding infrastructure projects.
- Long-tenure loans not available (15 years and more) with Indian banks. Stretches cash-flows during debt service period.
- ECBs not readily available to small developers

Reliable radiation measurement



- Project developers have to rely on satellite information from sources like NASA, NREL, etc.
- Uncertainty surrounding the generation potential at site. Different solar radiation database yield varying estimates.
- Lack of adequate ground-mounted monitoring stations to validate satellite based estimates.
- Radiation variability could significantly affect projected cash flows

Some of the Other Experiences



- Net-worth of Rs. 3 Crores/MW as qualification criteria and Solar PV Project capacity being fixed at 5 MW, any newly born company with a net-worth of Rs. 15 Crores has become eligible to bid for a Solar PV Project without past experience in developing any project. This has resulted in huge competition and resulting in 300 companies vying for 30 projects. Though competition is good for any industry, just opening the doors for everyone resulted in a mad rush from developers without proper due diligence. Out of the selected bidders, some of them were diamond traders and some were pure chartered accountant companies having no knowledge of any project whatsoever.
- The guidelines for Batch-1 also mandate that the promoter infuse an equity of Rs. 15 Crores (Rs. 3 Cr/MW) upfront in to the company, which isn't a financially prudent practice. Once the PPA is signed it would at least take 6 to 7 months for the Project construction to start when the equity is actually required to be spent on the Projects, but due to the stipulation in the guidelines the Companies had to block the amount from Day One in their accounts.



- As per the guidelines the Transmission system for these 5 MW Solar Projects have to be arranged by the Developers themselves at their own cost. However confusion reigned in many states because the State Transmission Utilities were never exposed anything related to Solar. Since the Projects were to be connected to STU grid sub-station with voltage level of 33 kV or above, the Developers had to connect it at 33 kV invariably as grid connection higher voltage levels would have been uneconomical. This has complicated the issue because 33 kV is dealt by DISCOMs and not STUs in all the states.
- Solar Projects can avail certain benefits through Customs Duty and Excise Duty exemption. The Process for availing such benefits is very complex and resulted in too much running around for the Developers to get the signatures of manufacturers, EPC contractors, nodal agencies, chartered engineers and MNRE. First time many state government agencies had no clue of the process and initially it took too much time for issuing the documents.



- JNNSM guidelines also require the developers to have modules tagged with RFID Tags, containing information like Name of the manufacturer of cell and module, month and year of manufacture, country of origin, i-v curve wattage, serial no. etc. While the purpose of this was supposed to have a track of the source and type of modules it became a practical headache for developers and module vendors. None of the module manufacturers were having such facility in their assembly lines to fix RFID tags directly on to the modules. Further the quantum of business was small compared to their overall portfolio, thus making it unattractive to alter their business lines for attaching a RFID Tag.



Thank You



Government of India
Ministry of New and Renewable Energy

Renewable Energy is Green, Clean and Sustainable Energy