THE STATE OF SOLAR THERMAL IN INDIA

A roadmap to developing solar thermal technologies

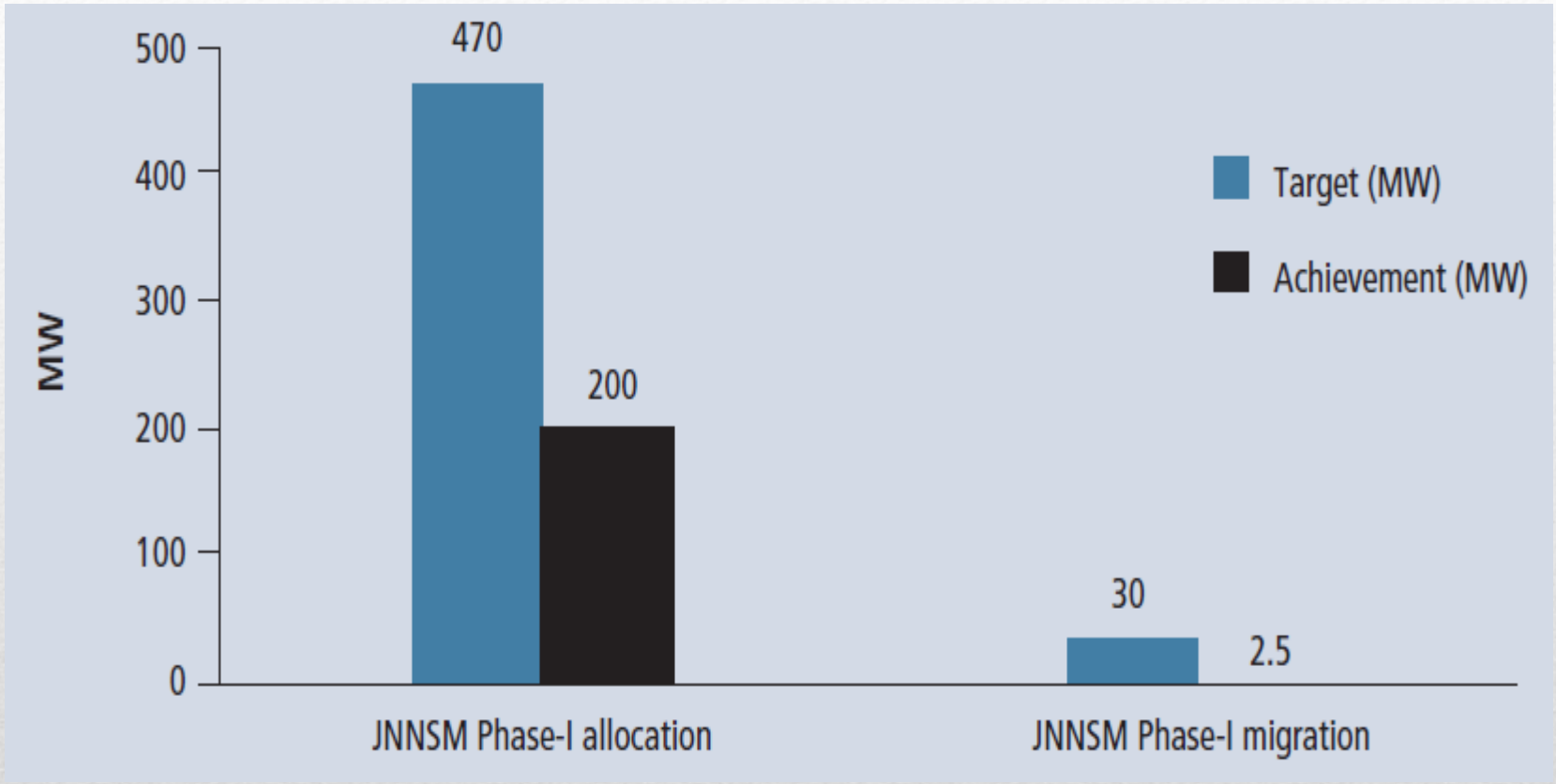
CONCENTRATED SOLAR POWER

WHY CSP?

- **Potential for India** – The Thar Desert, in Rajasthan, receives more than 2,000 kWh of DNI per square metre per annum, estimated to be sufficient to generate 700-2100 gigawatts (GW) of energy
- **Capacity utilization factor** – CSP claims to have better generation as compared to PV, and can be further enhanced by thermal storage and hybridization.
- CSP with **thermal storage and hybridization** offers higher grid flexibility

CURRENT STATE OF CSP

- Out of the 470 MW allotted to CSP plants in JNNSM Phase I, only 200 MW is operational.
  - Godawari Green's 50 MW parabolic trough-based plant in Jaisalmer, Rajasthan
  - Reliance Power's (Rajasthan Sun Technique) 100-MW linear Fresnel plant in Jaisalmer, Rajasthan
  - Megha Engineering and Infrastructure's 50 MW parabolic trough-based plant in Ananthapur district, Andhra Pradesh
- Out of the three projects that were transferred in the Migration Scheme, only 2.5 MW was commissioned



CSP IN JNNSM PHASE-I

CHANGINING DIRECTIONS

Back in 2012, share of the allocation to CSP was changed to 30 per cent in Phase II from 50 per cent in JNNSM Phase I.

Technology	Total		Centre		State	
	Ratio	MW	Ratio	MW	Ratio	MW
Solar PV	70 %	6,300	40 %	2,520	60 %	3,780
Solar Thermal	30 %	2,700	40 %	1,080	60 %	1,620

After the announcement of 100 GW of solar and 40 GW being dedicated to rooftop {clearly reserved for Photovoltaic (PV)}, there is no clarity on how much of the remaining 60 GW would be available for CSP.

CHALLENGES: TECHNICAL

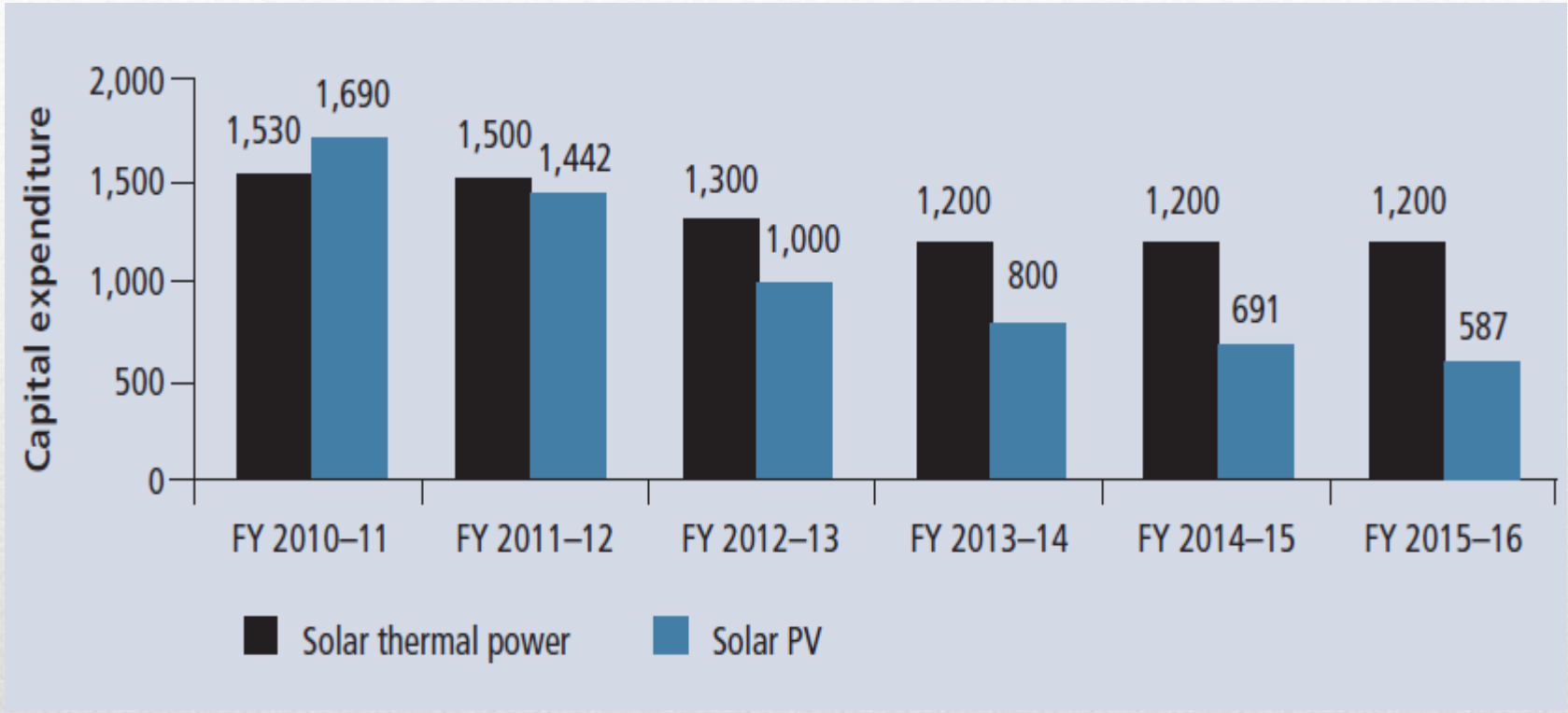
- **No reliable DNI data** – Actual DNI measured on the ground was quite different than what was estimated at the time of quoting. NASA data that was used was incorrect and that caused delays in the project
- **No successful demonstration project** – India lacked any successful demonstration projects based on CSP technology to prove the techno-commercial feasibility of the technology at the timing of bidding in JNNSM.

CHALLENGES: MARKET

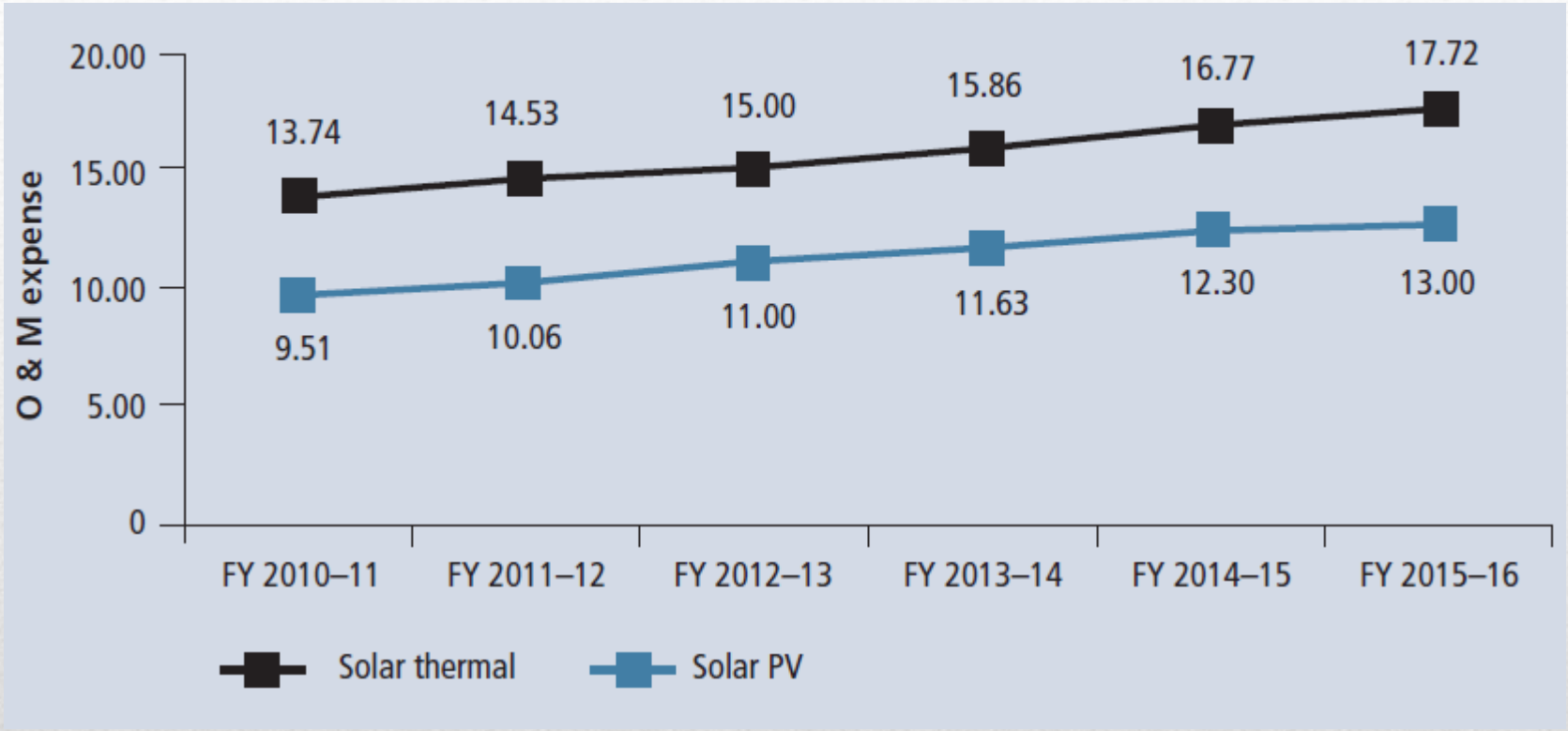
- **No non-recourse finance** –
  - India skipped two important stages of technology development – R&D and demonstration project.
  - Since there was no successful demonstration project on the ground, there had to be a guarantee of performance of various components and sub-components to gain confidence and no project got non-recourse finance
- **No local manufacturing** – Lack of local manufacturing facilities for some critical components. Depending on imports also caused delays for the projects
- **No skilled manpower** – Many of the components required could be produced locally, but without prior experience and a lack of in-house skills, this was a challenge which hindered CSP take off.

COMPETITION FROM PV

- **High capital and operating expenditure** – The cost curve of CSP technology has been unable to compete with that of PV. The tremendous drop in PV prices has adversely affected CSP.
- **Technological knowhow** and skill availability is more in the case of PV
- Investors have **experience** in working with the technology globally and are aware of associated financial risk.
- PV has a **lower gestation** period than CSP



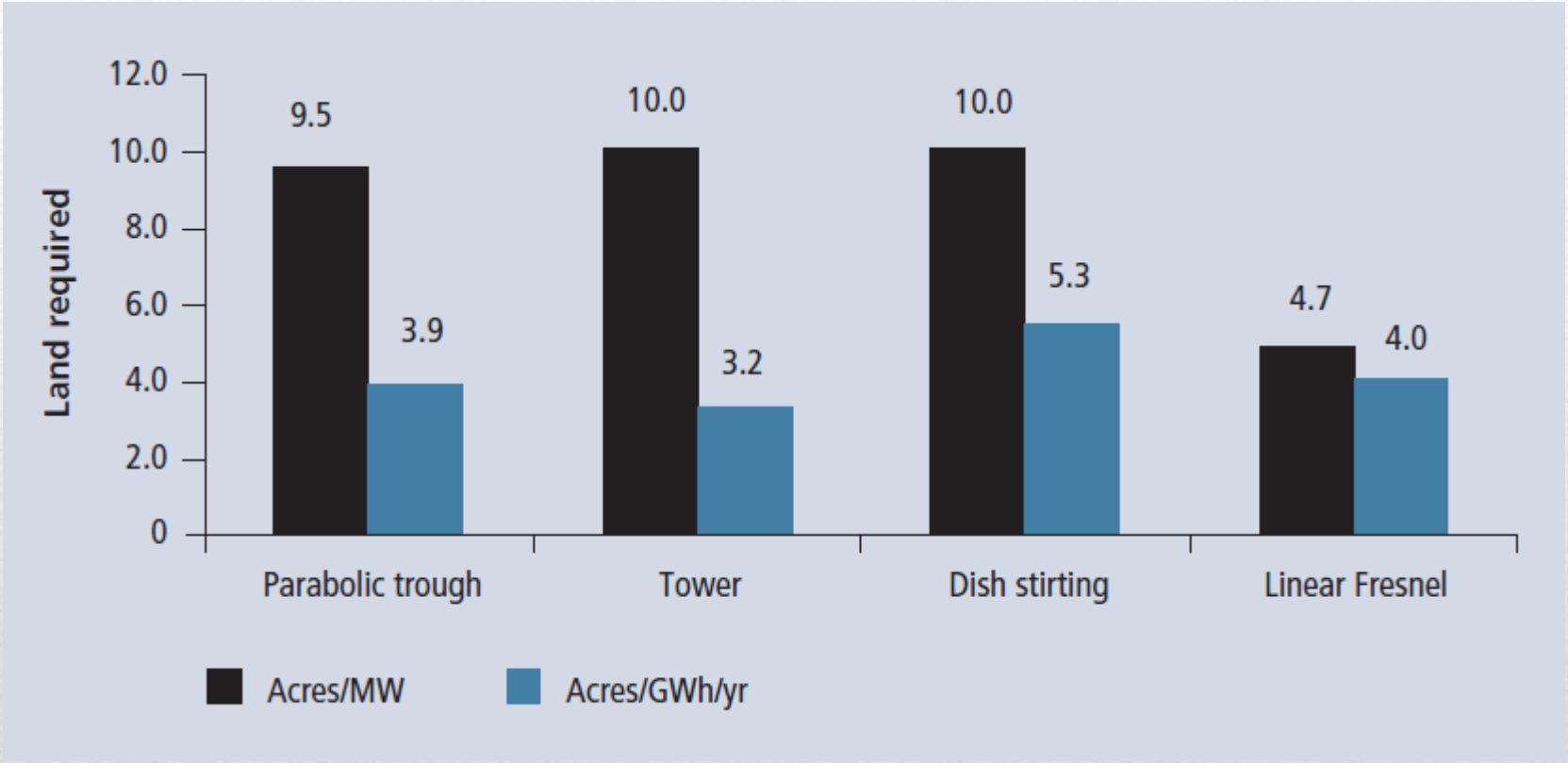
COMPETITION FROM PV



COMPETITION FROM PV

CHALLENGES: ENVIRONMENTAL

- **Water requirement** – Water is required mainly for the regular cleaning of mirrors and production of steam to run the turbine.
- **Land allocation** – CERC benchmarked 5 acres per MW for solar PV technology in 2010, but no such benchmark has been decided for CSP so far

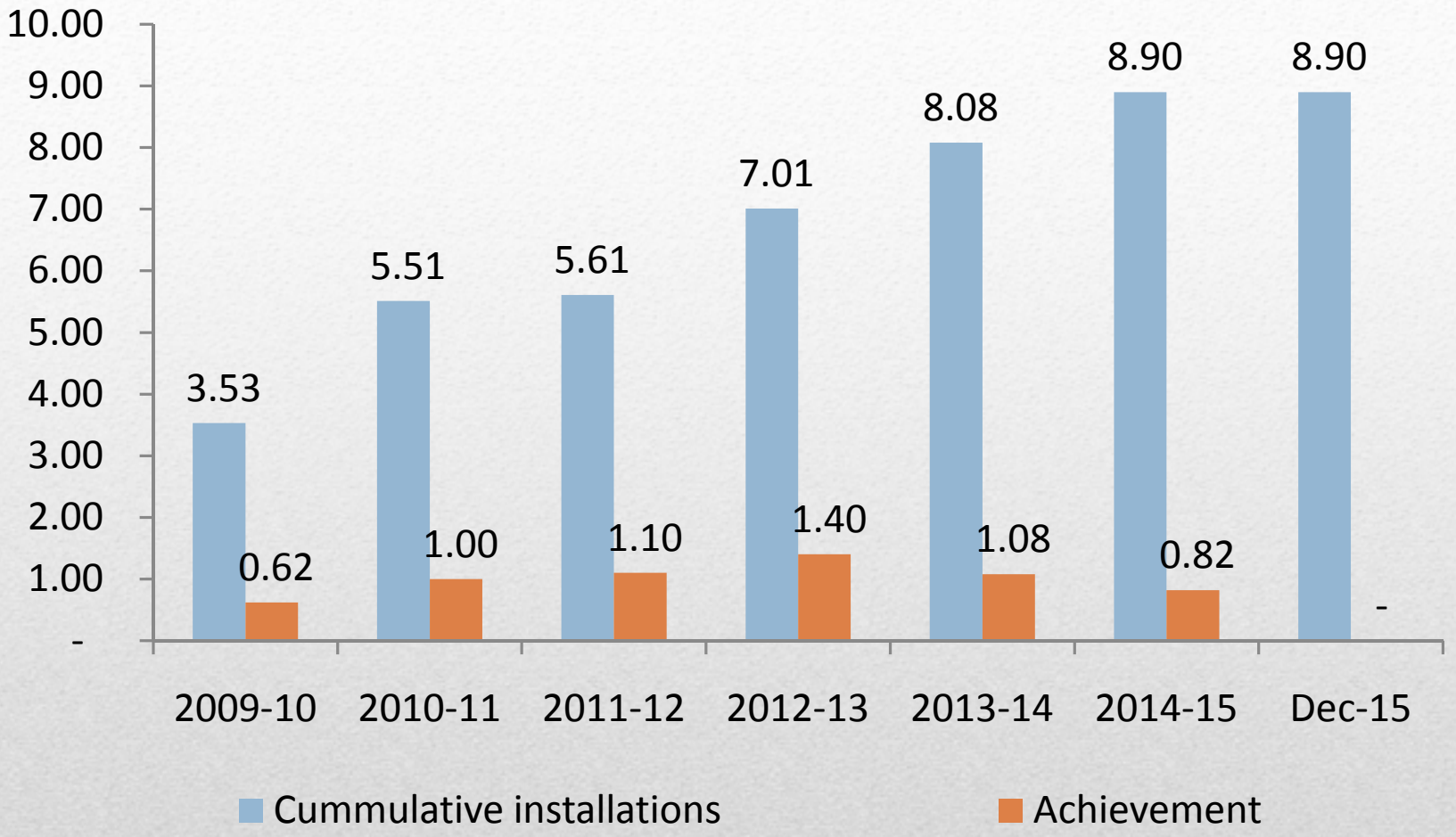


LAND REQUIREMENT: USA

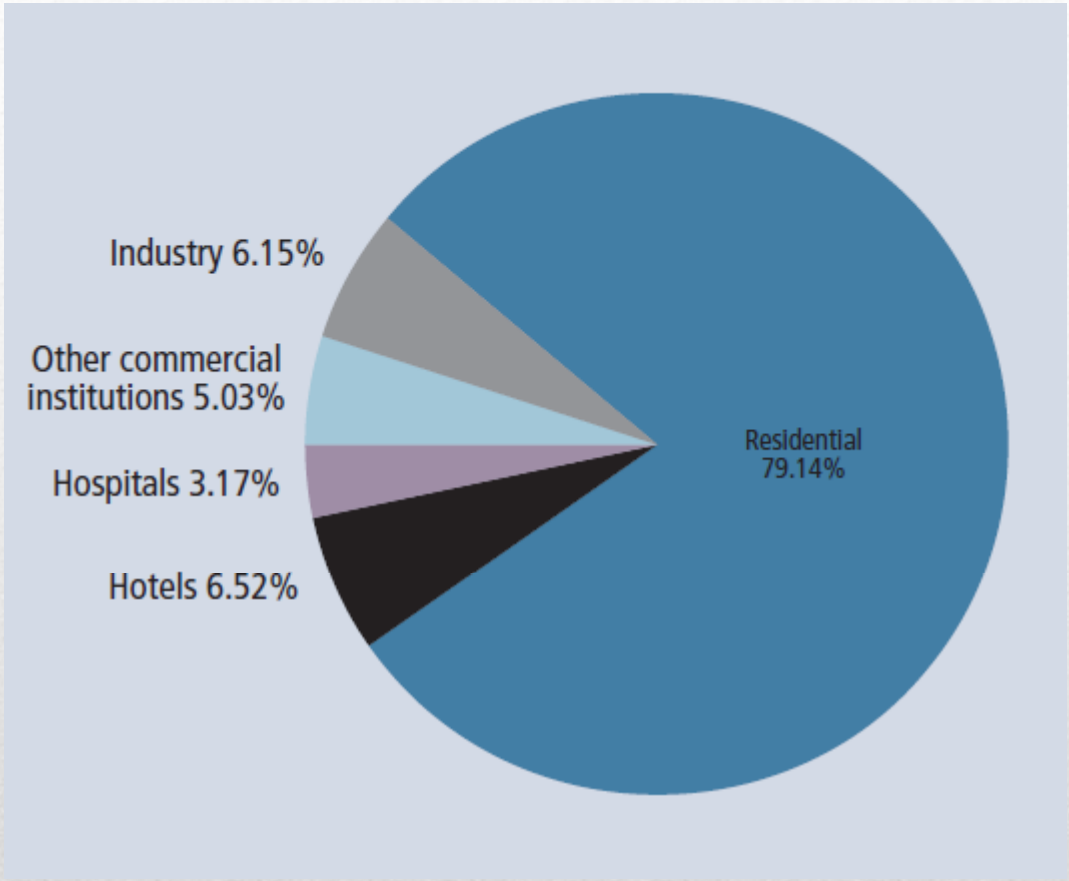
SOLAR THERMAL APPLICATIONS

CURRENT STATE

- Solar thermal applications have been used in India since the 1980s, most common one being *solar water heaters*. They can be installed in any rooftop.
- As of December 2015, there were *8.90 million square meters of solar water- heating collector areas*
- 2008 scheme of *"Accelerated Development and Deployment of Solar Water Heating System in Domestic, Industrial and Commercial Sectors"* was the most important contributor to this development.
  - IREDA provided finance at discounted rate of 6.5 per cent
  - This programme has been put on hold and according to MNRE officials, the priority at this moment is to clear the large backlog



WATER HEATING COLLECTOR AREAS



WATER HEATER MARKET

SOLAR COLLECTORS

	2017	2022
Residential	7.68	15.74
Hotels	0.61	0.97
Hospitals	0.27	0.43
Other commercial/institutional	0.39	0.52
Industry	0.57	1.57
Total	**9.52**	**19.23**

The target assigned for Phase II of JNNSM (2013-17) for solar collectors is 15 million square meters.

- This is not limited to water heaters, but includes all collectors since the potential for water heaters is only 9.52 by 2017.
- But there is no available data for the achievement of this target

INDUSTRIAL APPLICATIONS

- Examples of industrial applications of solar thermal can be found in industries in iron and steel, paper and pulp, ceramic and tile, food processing and dairy (for pasteurisation)
- Study shows that solar thermal has the potential of fuel replacement up to 100 per cent in case of pulping, paper drying and pulp bleaching in the textile industry
- The ministry has allotted funds from the National Clean Energy Fund (NCEF) for the implementation of CST-based systems in institutional and commercial establishments for process heat, community cooking and cooling applications under the Off-Grid Solar Thermal Programme

UNTAPPED POTENTIAL

- Over 15 million tonnes of fuel oil is consumed annually in industries for process heat applications below 250°C
- Over 35 million tonnes of fuel oil is consumed annually for industrial applications above 250°C
- Solar cooling/refrigeration is the most pertinent application for India in the industrial space. It is estimated that cooling consumes about 35,000 MW of electricity for various end-uses.

CHALLENGES

- Technology is still evolving and there are frequent upgrades and improvements available in the systems installed.
- Very few subsidies available and their disbursal is very slow.
- Some scattered projects on the ground, particularly for the industrial sector.
- Awareness and knowledge of these applications are limited.
- The government has no plans of developing any new policies for the promotion of solar thermal applications

RECOMMENDATIONS

Measure DNI data on the ground:

- NIWE should measure the DNI for two years for each SRRA stations and compare it with five years of satellite data to evaluate DNI for a particular location.
- NIWE should declare these evaluated DNI data for each location where the SRRA stations were commissioned which becomes the basis for project design and financial-viability calculations.

BUILD DATA, CAPACITY AND CONFIDENCE

Development of solar thermal applications:

- In the interim, where solar thermal power generation is not financially feasible, solar thermal applications for industries should be promoted by MNRE.
- This will encourage the manufacturing sector to develop since there would be a constant demand for them to supply and thereby costs reduce over time as a result of economies of scale.

BUILD IN STAGES

Promote local manufacturing:

- The government encourage local manufacturing of CSP and solar thermal applications components in India through a domestic content requirement clause and a host of incentives to set up manufacturing facilities.
- This will not only reduce the price of these components significantly, but will also transform India into a manufacturing hub for CSP with ample job opportunities. It also buys into the government's idea of "Make in India".

BUILD IN STAGES

Implement demonstration project before scaling up:

- MNRE should announce pilot projects with technological innovations, especially with thermal storage.
- It is important that there are projects on the ground which would illustrate that the technology is performing as per expectations. These projects are also important for testing components and sub-components of the solar thermal.
- It is the first step in the development of any technology.

BUILD IN STAGES

Use advantages of hybridization:

- Hybridization be given first preference wherever possible - with coal-, gas- or biomass-based power plants already exist with sufficient land for commissioning CSP plants.
- Such possibilities should be identified, particularly in Rajasthan and Gujarat, so that the full benefit of CSP can be tested and harnessed.
- CERC should allow the use of mixed fuel in the case of hybridized CSP plants and must decide a minimum percentage for solar fuel mix in order to qualify for the hybridized tariff. CERC also should work out a levelised cost of energy (LCOE) analysis for such plants.

BUILD IN STAGES

CSP projects not on the ground:

- Existing projects that have not yet been commissioned be cancelled and penalties be levied and bank guarantees of these projects should be encashed.
- Since the plants would not be coming up in the near future, they should be divided and re-auctioned.

REWORKING EXISTING PROJECTS

Optimal utilization of land and water:

- Government should declare available lands for CSP projects well in advance in the public domain based on DNI data actually measured on the ground, land slope, and groundwater availability for such projects.
- Since land requirement for CSP is a function of CUF, which is dependent upon thermal-storage capacity, it is always better to measure land requirement per giga-watt hour of generation per year rather than measure in terms of installation capacity and technology.
- The developer would be responsible for procuring the required land from respective state governments along with water linkage and for obtaining all necessary clearances before construction of the project.

RESOURCE EFFICIENCY IS CRITICAL

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