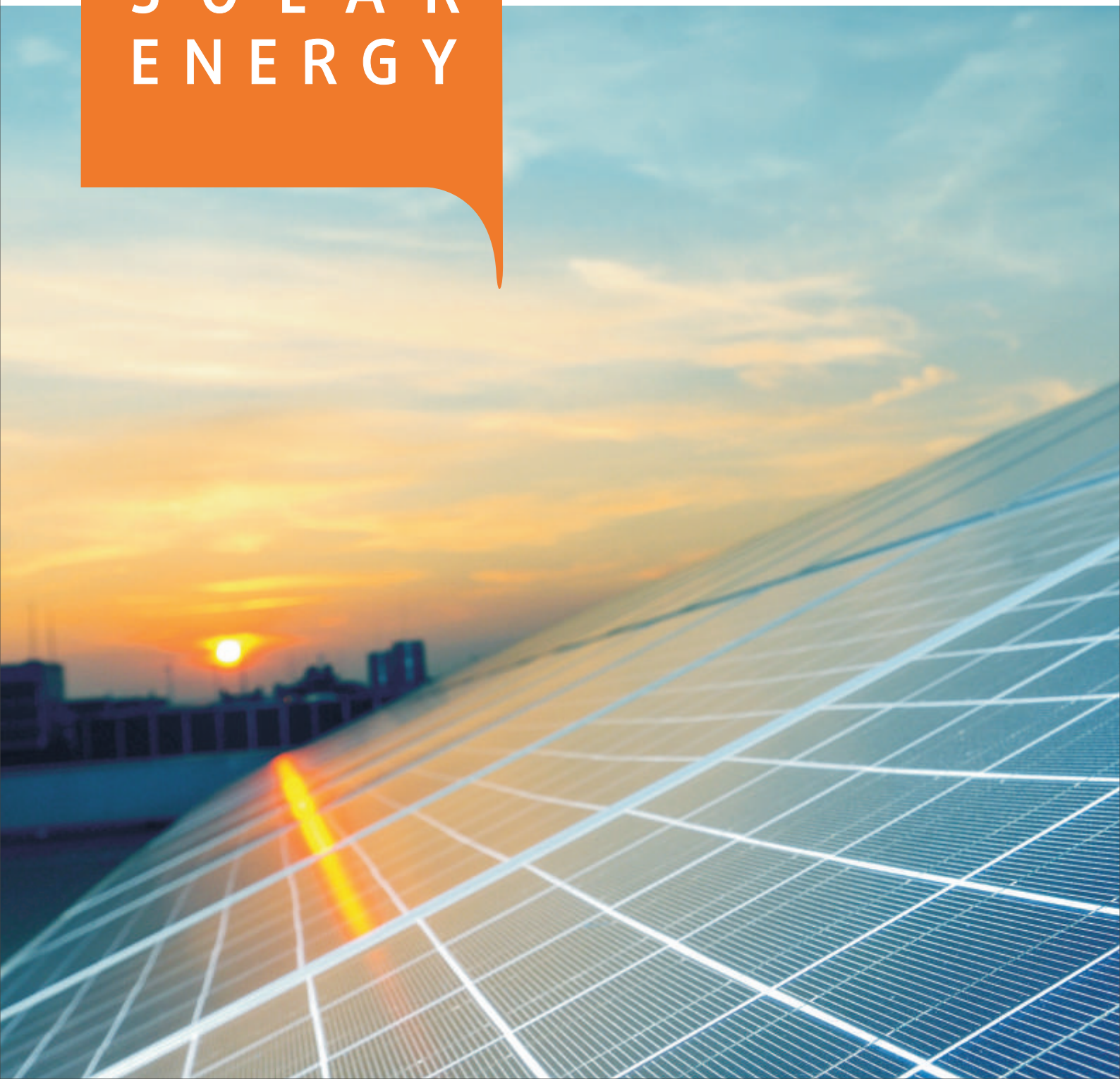
LSI Financial Services Pvt Ltd

# SOLAR ENERGY



# LSI Financial Services Pvt Ltd

## Creating value,
## partners in growth

LSI Financial Services is a leading provider of innovative financial solutions to corporate India for over a decade.

It has successfully raised funds for companies through structured financial products, spanning various sectors. With in depth domain knowledge, LSI strives to add value to the client's financial supply chain ensuring an effective and efficient capital structure.

## Our services include:

- Debt Syndication
- Private Equity Advisory
- Issue Management
- Mergers and Acquisitions
- Financial Restructuring
- Project Advisory Services

# From The Managing Director's Desk

India, the third largest producer and consumer of electricity, is currently facing an acute power shortage due to scarcity of coal, which supports approximately 68% of India's installed power generation capacity.

Under the "Power for All" mission, India has set a target of 88,000 MW of installed capacity by the end of the 12th Five Year Plan. The transmission segment has a major role to play in achieving this mission as an efficient transmission capacity and network will be essential to transfer power from generating stations to distribution networks. A combination of ageing infrastructure, rise in use of renewable energy sources, increase in demand for electricity and a need to improve transmission efficiency together with energy security is driving growth in the power sector.

As the world undertakes its journey towards development, growth and employment generation, it becomes imperative to appreciate the looming ramifications of environmental degradation and ecological imbalances, which are best reflected in carbon emissions. Growth in emission is directly linked to overall economic growth and this linkage is unlikely to be broken in the years to come. At the same time, it needs to be acknowledged that climate change is unequivocal and therefore, an international collective action is critical in driving an effective, efficient and equitable response to this challenge. Therefore, it is necessary that all non-carbon emitting resources become an integral part of an energy mix to ensure energy security to the country. Although renewable energy technologies currently represent a fraction of the energy market in India, they have tremendous potential for rapid growth and for providing alternative solution to fossil fuels. On account of varied agro climatic zones providing abundant natural sources like sunlight, wind, flowing water and flora, India has ample opportunities to shift to large scale use of new renewable energy sources.

With 5,000 TWh of solar insolation in India, it is one of the most abundant and freely available sources of energy in the country. Properly tapped solar power has the potential to reduce the current energy peak deficit significantly and improve power deficit situation. It is in this regard that the National Solar Mission is being backed by ambitious Central and State solar policies under which various projects have already been launched. The success of well laid State Policy is already showing desired results with Madhya Pradesh emerging as the preferred State for new solar investments based on various incentives provided by the State Government. Riding on such strong support from the Government, backed by concrete tangible measures, solar power is likely to become the cornerstone of the energy sector in India and we expect the country to be one of the leading solar power driven countries in the world.

As always, I seek your valuable comments.

**Raj Kajaria**

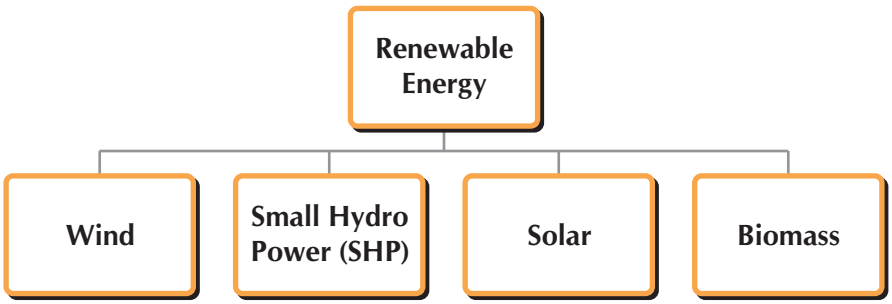

TÜRANOR PlanetSolar
CANDINO
SWISS WATCH
45
SUNPOWER
WALLENIUS WILHELMSEN
LOGISTICS

# Contents

# 1. Renewable Energy

Renewable energy sources are primarily, energy generated from resources that are naturally replenished. Besides being environment friendly, renewable energy can also be used in remote areas and is well suited for decentralised applications. The main sources of renewable power are Wind, Small Hydro Power (SHP), Solar, and Biomass.

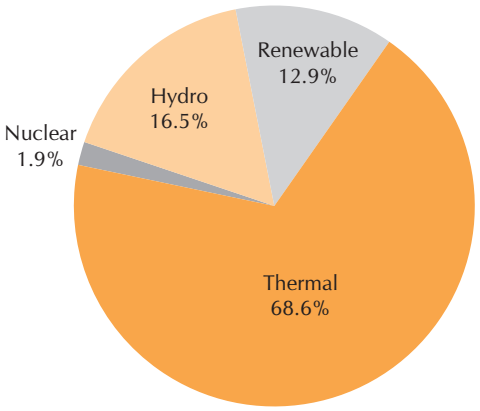
**Major renewable sources of energy**




The country's rising economic growth has led to a surge in demand for electricity. Despite a significant rise in installed capacity, the power demand-supply gap has persisted. The country faced a huge power deficit of about 6,103 MW in the peak hours during the FY2013-14.

So far, India has predominantly focused on conventional sources of energy (viz. Thermal, Hydro and to some extent Nuclear) for generation of electricity. Renewable sources were not given enough prominence in the past. With an installed capacity of approximately 32,424 MW as on July 31, 2014, grid interactive renewable energy sources form only about 13% (approximately) of the total installed power generation capacity of the country.

## Break up of India's installed power capacity by fuel (as on March 31, 2014)




| Particulars | (%) | MW |
|---|---|---|
| Thermal | 68.6 | 168,255 |
| Nuclear | 1.9 | 4,780 |
| Hydro | 16.5 | 40,531 |
| Renewable | 12.9 | 31,702 |
| **Total** | | **245,268** |

*Source: Ministry of New Renewable Energy (MNRE)*

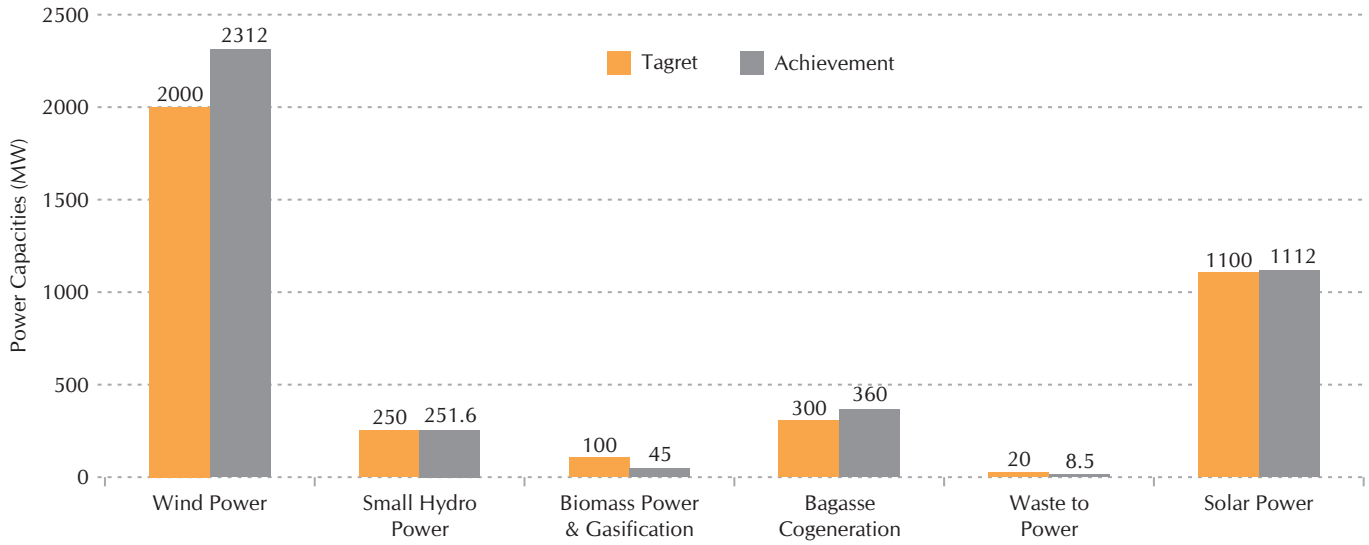
Limited reserves of fossil fuels, carbon emissions and emphasis on "greener world" have led to a global focus on generating power from renewable sources of electricity. In keeping with the global trend, India is also concentrating on increasing its generation from renewable sources. For this purpose, the Ministry of New and Renewable Energy (MNRE), which is the nodal Ministry of the Government for all matters relating to new and renewable energy is taking positive steps.

## Installed capacity of Grid interactive renewable power as on March 31, 2015

| Ministry of New & Renewable Energy<br>Programme/ Scheme wise Physical Progress in 2014-15<br>(During the month of March, 2015) | | | |
|---|---|---|---|
| **Sector** | **FY- 2014-15** | | **Cumulative Achievements (as on 31.03.15)** |
| | **Target** | **Achievement** | |
| **I. GRID-INTERACTIVE POWER (CAPACITIES IN MW)** | | | |
| Wind Power | 2,000.00 | 2,312.00 | 23,444.00 |
| Small Hydro Power | 250.00 | 251.61 | 4,055.36 |
| Biomass Power & Gasification | 100.00 | 45.00 | 1,410.20 |
| Bagasse Cogeneration | 300.00 | 360.00 | 3,008.35 |
| Waste to Power | 20.00 | 8.50 | 115.08 |
| Solar Power | 1,100.00 | 1,112.07 | 3,743.97 |
| **Total** | **3,770.00** | **4,089.18** | **35,776.96** |
| **II. OFF-GRID/CAPTIVE POWER (CAPACITIES IN $MW_{EQ}$)** | | | |
| Waste to Energy | 10.00 | 21.78 | 154.47 |
| Biomass (non-bagasse) Cogeneration | 80.00 | 60.05 | 591.87 |
| Aero-Genrators/Hybrid systems | 0.50 | 0.61 | 17.95 |
| SPV Systems | 60.00 | 6.15 | 152.05 |
| Water mills/micro hydel | 4.00 | 0.27 | 2.53 |
| Bio-gas based energy system | - | 60.00* | 234.35 |
| Biomass Gassifiers - Rural | 0.80 | 4.00 | 17.21 |
| Biomass Gassifiers - Industrial | 8.00 | 0.30 | 4.07 |
| **Total** | **163.30** | **93.16** | 1,174.50 |
| **III. OTHER RENEWABLE ENERGY SYSTEMS** | | | |
| Family Biogas Plants (numbers in lakh) | 1.10 | 0.65 | 48.18 |
| Solar Water Heating - Coll. Areas (million m2) | 0.50 | 0.72 | 8.82 |

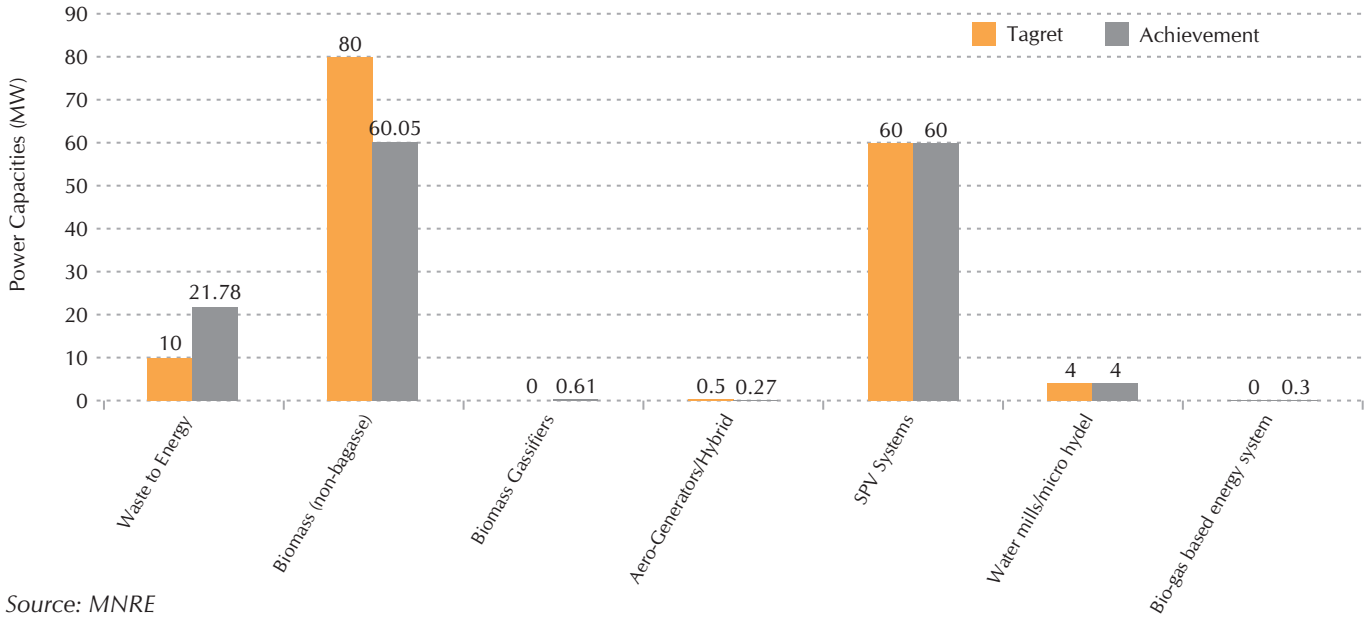
*Source: MNRE*

## I. Grid-Interactive Power Capacities (in MW), FY 2014-15



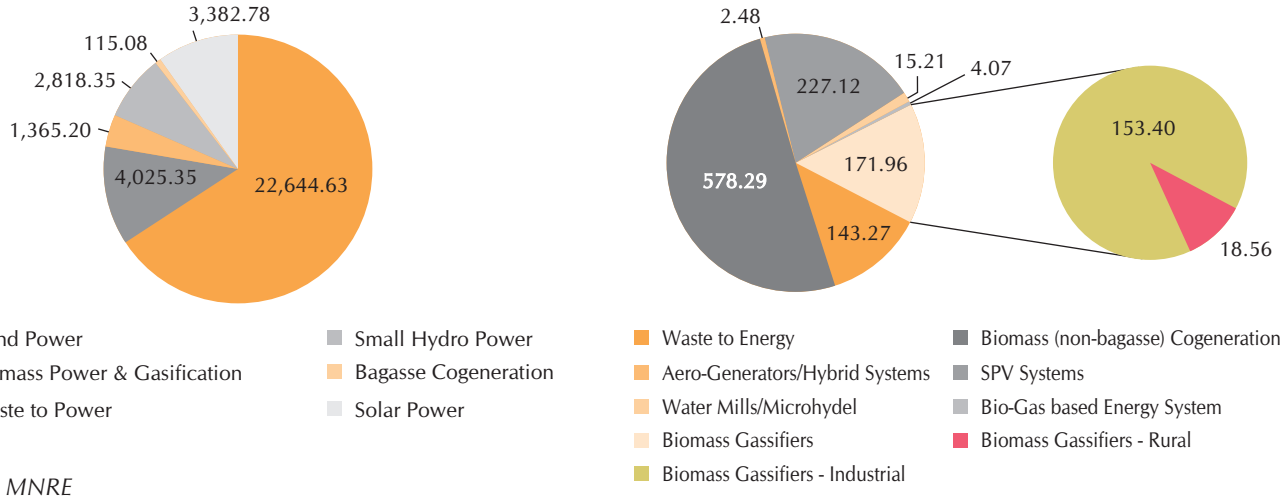

*Source: MNRE*

## II. Off-Grid/Captive Power Capacities (in MW), FY 2014-15




*Source: MNRE*

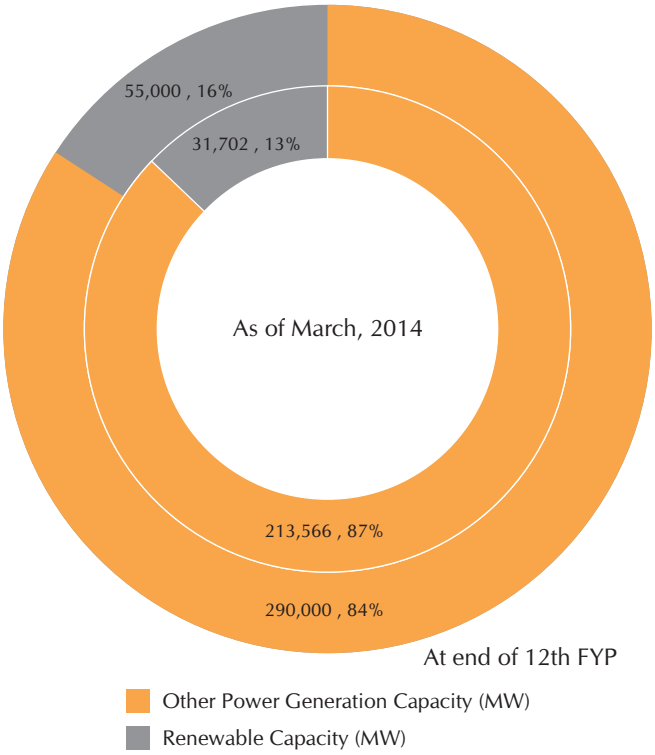
## III. Cumulative Achievements of Ministry of New & Renewable Energy Programme/Scheme wise Physical Progress in 2014-15 (During the month of February, 2015)




*Source: MNRE*

## 1.1. Government of India's initiatives

**Planned Augmentation in Renewable Energy Capacity by end of 12th Five Year Plan (2012-2017)**




As part of its policy initiatives in this regard, the Government has outlined multiple measures to facilitate both foreign and domestic investment in the renewable energy sector. In order to broaden the investor base, the Government will facilitate entry of Independent Power Producers (IPP). Various incentive schemes have also been initiated by both the Central and the State Governments under wind energy, solar energy and other renewable energy projects.

**Some of the major Government's initiatives are:**

- Investment target in the solar power sector set at $100 billion (approximately ₹6,00,000 crore) by FY2021-22
- Jawaharlal Nehru National Solar Mission launched to facilitate large scale capital investment in the solar energy sector
- 100% Foreign Direct Investment (FDI) through automatic route made available to investors in renewable energy projects
- 100% tax holiday for 10 years under section 80 I A of the Income Tax Act, if the renewable energy power plant starts generating power before March 31, 2017
- 10-year tax holiday for PV and thermal solar plants set up by CY2020
- Upto 80% of Accelerated Depreciation (AD)
- Central Government hoping to use part of a $5 billion (₹31,075 crore) line of credit to promote renewable energy projects, a move which could help bring down borrowing costs for solar and wind power companies
- Concessional Custom Duty; Reduction in customs duty on solar panels by 5% and exemption in excise duty on solar photovoltaic panels. Extension of the concessional basic customs duty of 5% to machinery and equipments required for setting up solar projects
- Nil Excise Duty
- Private sector companies to partner with Government and co-invest in R&D and technology development
- Preferential tariffs for grid interactive renewable power in certain States following the provisions made under the National Electricity Policy 2005 and National Tariff Policy 2006
- ₹500 crore allocated in the Union Budget 2014-15, Government for ultra mega power projects, to be taken up in Gujarat, Rajasthan, Andhra Pradesh, Tamil Nadu and Ladakh
- ₹400 crore was also assigned in the budget to launch a scheme for solar power driven agricultural pump sets and water pumping stations for energising one lakh pumps
- ₹100 crore allocated for the development of 1 MW solar parks on the banks of canals
- 25 solar parks and ultra-mega solar power projects of aggregate capacity of 20,000 MW to be set up in various states along with pilot-cum-demonstration project of 100 MW for development of grid connected solar photo voltaic power plants on canal banks and canal tops
- Scheme for setting up 1,000 MW of Grid-Connected Solar PV Power Projects by Central Public Sector Undertakings (CPSUs) with Viability Gap Funding (VGF) under Batch-V of Phase-II of JNNSM.

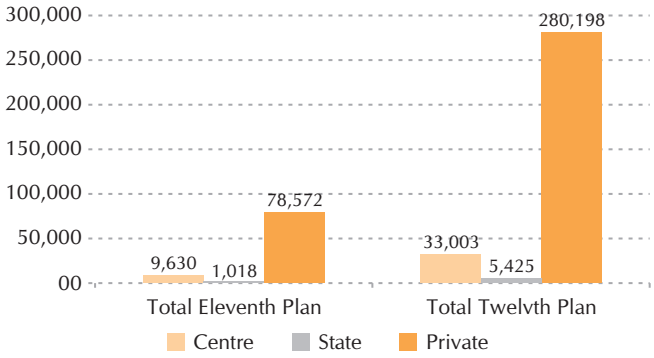
- MNRE to provide 30% capital subsidy on capital expenditure for rooftop solar PV system
- National Tariff Policy amended in January 2011 to prescribe solar-specific Renewable Purchase Obligation (RPO); to be increased from a minimum of 0.25% in FY2011-12 to 3% by FY2021-22
- Under Special Incentive Package Scheme for semi-conductors, Government providing an incentive of 20% capital expenditure during the first 10 years for the units in SEZs and 25% of the capital expenditure for other units. Benefit available to all units who can claim incentives in the form of capital subsidy or equity participation
- Development of Solar Cities for a minimum 10% reduction in projected demand of conventional energy at the end of five years, through a combination of enhancing supply from renewable energy sources in the city and energy efficiency measures.

### 1.2. Private Investment and PE

US-based private equity firm KKR and Co. is evaluating the possibility of investing around $100 million in renewable power projects of Greenko Group, a UK-based group that has power projects in India.

According to VccEdge, the renewable power space saw 14 deals worth $298 million during CY2014 till May 2014 against 32 private equity (PE) and merger &acquisition (M&A) deals worth $1,288 million during CY2013 General Electric Co's unit, GE Energy Financial Services plans to invest $24 million in a solar power project in Madhya Pradesh. The renewable energy space offers tremendous amount of opportunity due to various factors like no dependency on fuel (wind, solar), favorable Government's initiatives (mentioned above) and reduction in prices (in solar PV panels).

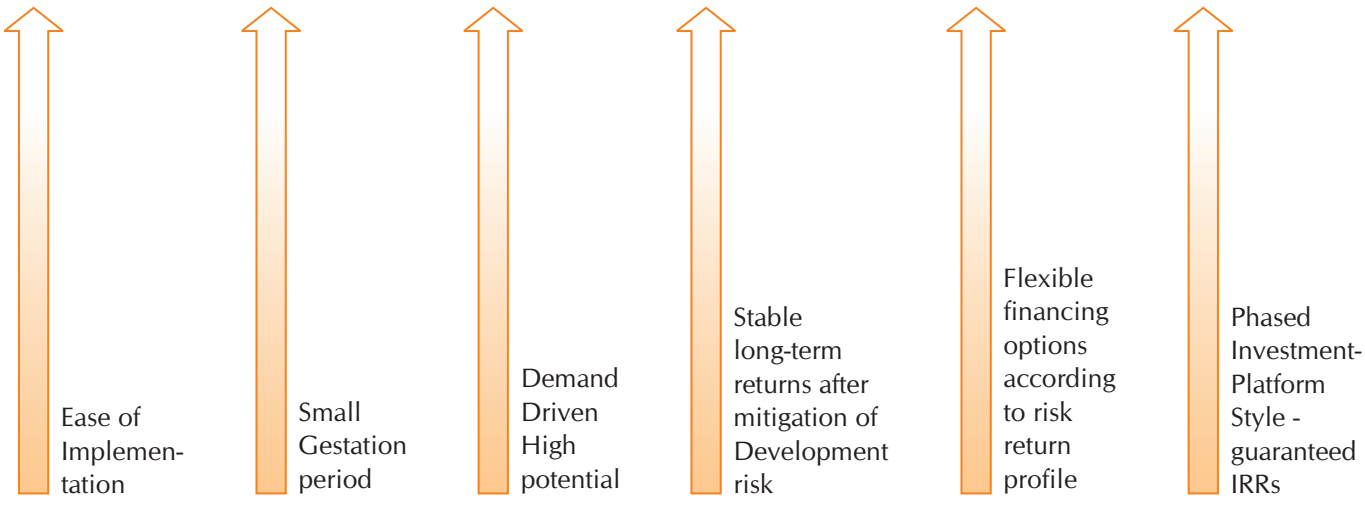
**Targeted Investment for Renewable Energy by Source for 11th and 12th Five Year Plans**




*Source: Planning Commission, Government of India*

India's 12th Five Year Plan sets an ambitious target for the development of renewable energy in the country. During the 12th Five Year Plan, renewable power capacity addition of 30,000 MW has been planned. According to the 12th Five Year Plan document, the projected investments in the renewable energy sector are estimated to be around ₹3.2 lakh crore during the 12th plan. Out of this ₹33,003 crore (Gross Budgetary Support (GBS) 19,113 + Internal and Extra Budgetary Resources (IEBR) of 13,890) are expected to come from Centre as an outlay for MNRE during the 12th plan. ₹5,425 crore is expected from States, which leaves a huge portion of private sector investments of ₹2,80,198 crore.

**Key drivers for PE investments in Renewable Energy in India**



# 2. Solar Power

Solar energy is the energy received from the sun that sustains life on earth. For many decades solar energy has been considered to be a huge source of energy and also an economical one because it is freely available. However, it is only now, after years of research, that technology has made it possible to harness solar energy.

Solar power is the conversion of sunlight into electricity, either directly using Photovoltaics (PV), or indirectly using Concentrated Solar Power (CSP) or Thermal Power. Thermal power systems use lenses or mirrors and tracking systems to focus a large area of sunlight into a small beam. Photovoltaics convert light into electric current using the photoelectric effect.

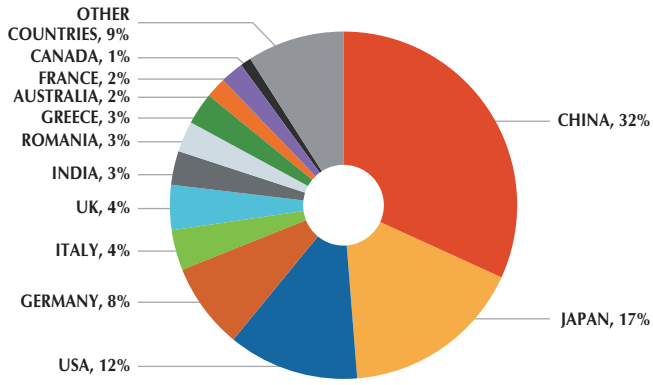
### Key Benefits of Solar Power

- Freely available
- Environment friendly
- No fuel cost
- Low operation & maintenance cost

### Global Market for Solar Power

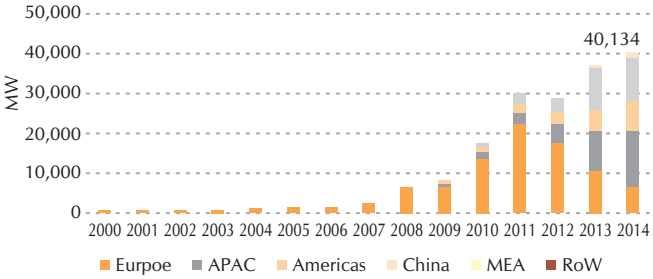
According to analysts, the global market for PV installations stood at 44.2 GW, likely to grow by 25 percent in 2015 as against 14 percent in 2014. One of the reasons for the lower than expected installs in 2014 was the decline in demand within European countries, despite record installs in the UK that made it the biggest market in Europe for the first time. European solar demand in 2014 declined by 30% to 7.9GW and in contrast, the largest absolute growth was said to have occurred in the APAC region, which was said to have increased by 5.5GW to reach 26.4GW in 2014 and accounted for 60% of total global demand.

### The Global PV Market 2013




*Source: IEA PVPS, EPIA*

### Evolution of Global Solar PV Annual Installed Capacity (MW), 2000-2014




*Source: Solar Power Europe 2015*

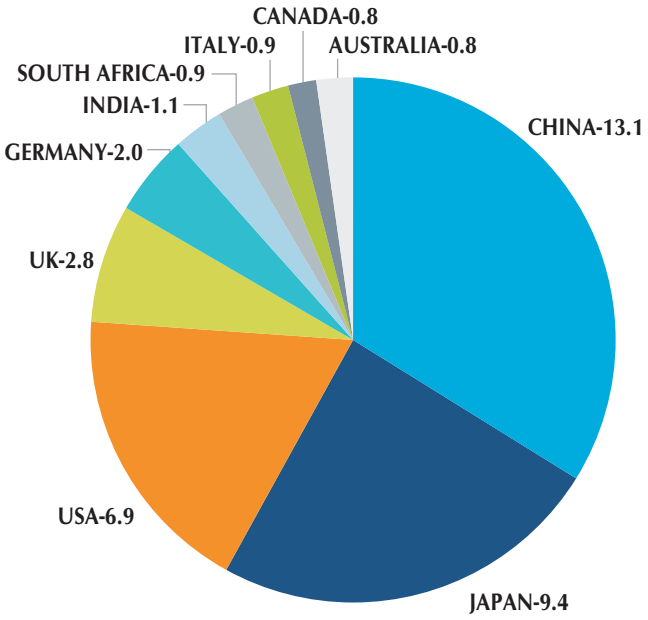
### Top 10 PV Countries in 2014 by Capacity – Total and Additions (MW)

| Total Capacity (MW) | | | Added Capacity (MW) | | |
|---|---|---|---|---|---|
| 1. | Germany | 38,200 | 1. | China | 10,560 |
| 2. | China | 28,199 | 2. | Japan | 9,700 |
| 3. | Japan | 23,300 | 3. | United States | 6,201 |
| 4. | Italy | 18,460 | 4. | UK | 2,273 |
| 5. | United States | 18,280 | 5. | Germany | 1,900 |
| 6. | France | 5,660 | 6. | France | 927 |
| 7. | Spain | 5,358 | 7. | Australia | 910 |
| 8. | UK | 5,104 | 8. | South Korea | 909 |
| 9. | Australia | 4,136 | 9. | South Africa | 800 |
| 10. | Belgium | 3,074 | 10. | India | 616 |

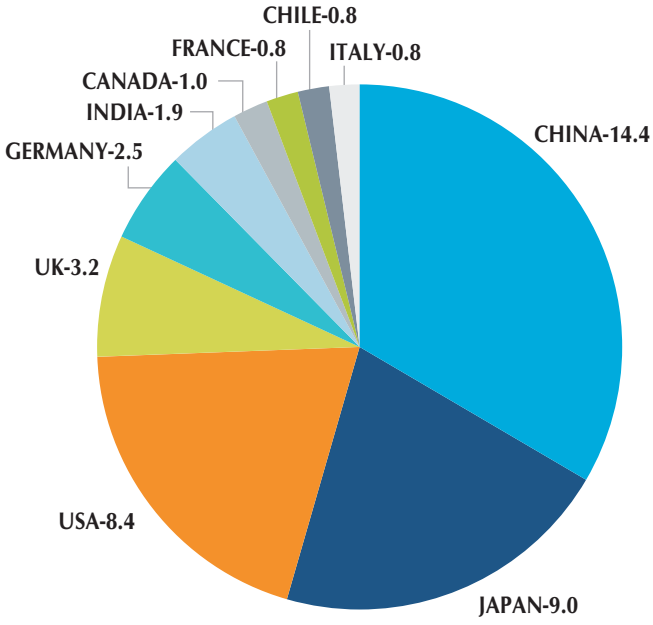
*Source: IEA-PVPS Snapshot of Global PV 1992–2014 report, March 2015*

China and Japan were the two largest markets in 2014. Growth in 2014 was led by China, which installed more capacity than the rest of Europe, followed by Japan and the United States. Despite having a virtually nonexistent domestic market, China, managed to capture 60-70% of the world solar market through favorable policy support offered by its Government. China has achieved this milestone through extensive financial support with longer loan re-payment schedules, low interest rates and other favorable investment climate created by its Government.

**PV Installation - 2014 (GW)**

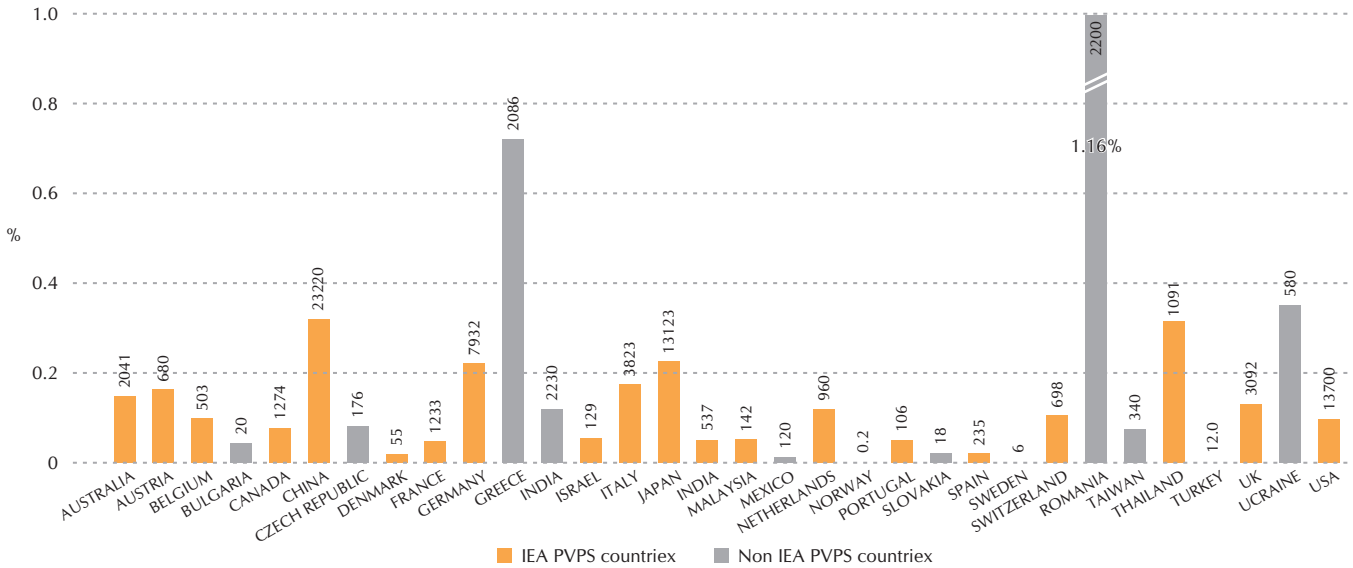



**PV Installation - 2015 (GW)**




*Source: IHS*

**Business Value of the Global PV Markets compared to GDP (% and Million US$)**




*Source: IEA PVPS*

## India's Solar Power Market

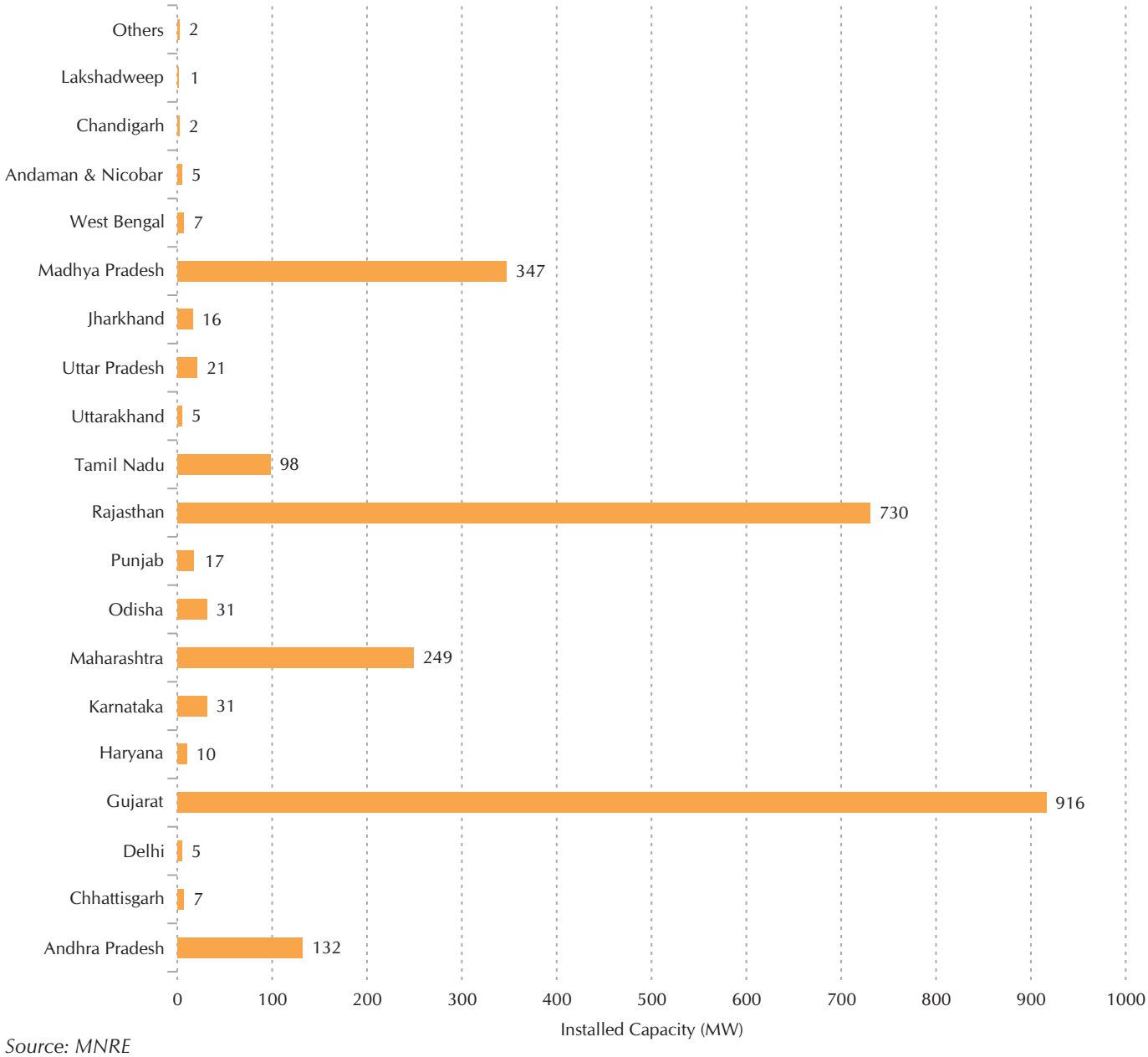
- India is located in the equatorial sun belt of the Earth and hence, receives abundant radiant energy from the Sun
- As on June 11, 2015, India crossed 4 GW of solar installed capacity, with the aggressive capacity addition in States of Gujarat, Rajasthan, Madhya Pradesh, Maharashtra, Tamil Nadu and Andhra Pradesh. As on July 31, 2014, solar installed capacity was 2,753 MW

| Central Government Policy | | State Government Policy | | REC Scheme | |
|---|---|---|---|---|---|
| State | Installed Capacity (MW) | State | Installed Capacity (MW) | State | Installed Capacity (MW) |
| Rajasthan | 889 | Gujarat | 974 | Rajasthan | 210 |
| Madhya Pradesh | 185 | Madhya Pradesh | 298 | Maharashtra | 121 |
| Andhra Pradesh | 95 | Maharashtra | 185 | Tamil Nadu | 98 |
| India Total | 1354 | India Total | 2056 | India Total | 601 |
| **Total Installed Solar Power Capacity as on 11 June 2015: 4011 MW** | | | | | |

*Source: RE Invest*

- Further, India expects to install an additional10,000 MW by 2017 and 100,000 MW by FY2021-22
- India's annual solar theoretical potential stand at 5,000 trillion kWh
- Many parts of India receive 300-330 sunny days in a year
- Most part of the country receives 4-7 KWh of solar radiation per square meter per day

**I. India's State-wise Grid Installed Solar Capacity as on March 31, 2014**




*Source: MNRE*

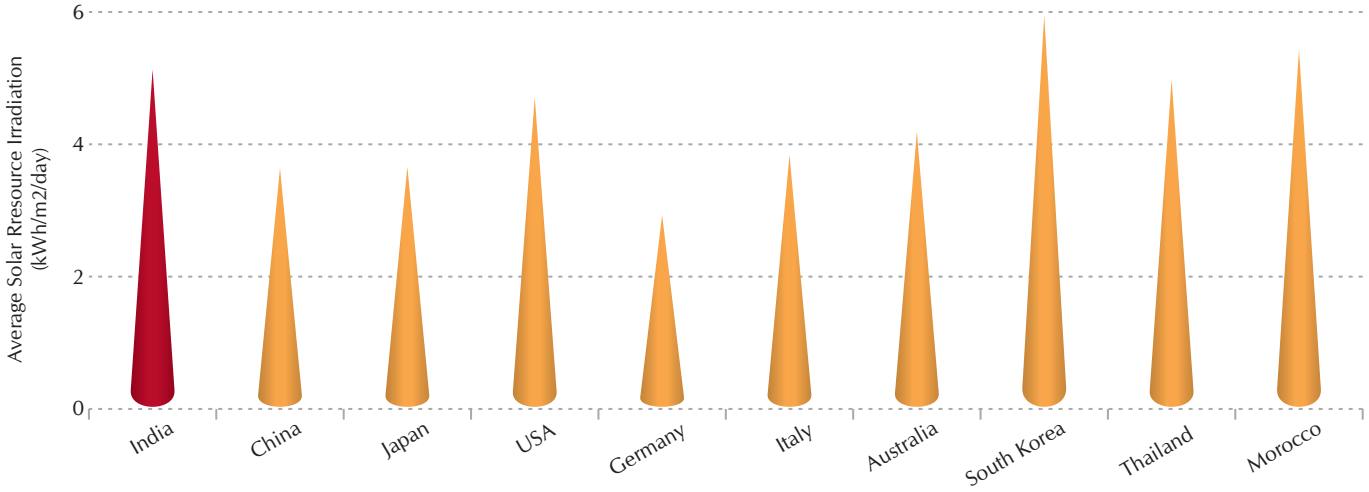
## Overview of international markets

| Countries | Average solar resource/ irradiation (kWh/m²/day) | Solar Target | Capacity installed during CY2013 | Installed capacity as on December 2014 |
|---|---|---|---|---|
| India | 5.10 | 100 GW by FY2021-22 | 1.1 GW | 2.3 GW |
| China | 3.61 | 50 GW by CY2020 | 11.3 GW | 18.3 GW |
| Japan | 3.63 | 33 GW by CY2020 | 6.9 GW | 13.6 GW |
| USA | 4.68 | Different Renewable Portfolio Standards for different States | 4.8 GW | 12.0 GW |
| Germany | 2.90 | 52 GW by CY2020 (35% and 80% of electricity from renewable by CY2020 and CY2050 respectively) | 3.3 GW | 35.5 GW |
| Italy | 3.81 | 23 GW by CY2017 | 1.5 GW | 17.6 GW |
| Australia | 4.16 | 23 GW by CY2030 | 0.9 GW | 4.1 GW |
| South Africa | 5.92 | 8.4 GW by CY2030 | N.A | N.A |
| Thailand | 4.95 | 2 GW by CY2022 | N.A | 360.0 MW |
| Morocco | | | N.A | |
| Saudi Arabia | 5.70 | 16 GW solar PV and 25 GW CSP by CY2032 | N.A | N.A |
| Chile | 4.62 | 1.5 GW by CY2025 | N.A | 3.6 MW |

*Source: International Energy Agency, Bridge to India and LSI Research*

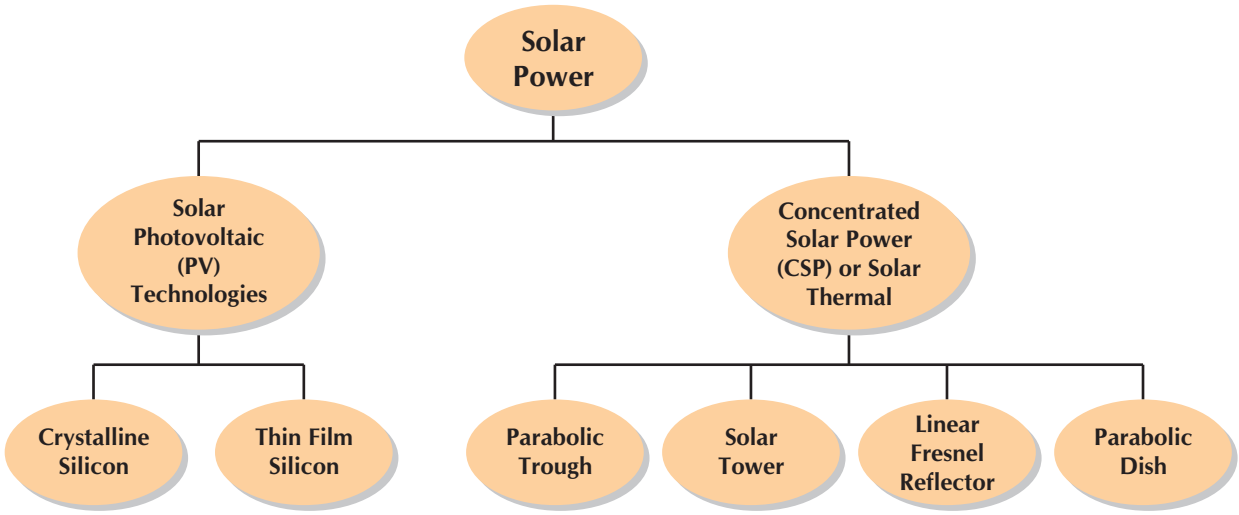
## II. India's Position in the Global Market for Solar Power

### Global Average Solar Rresource Irradiation (kWh/m2/day), 2015




*Source: Bridge to India*

## 2.1 Types of Solar Power




### 2.1.1. Solar Photovoltaic (PV)

Photovoltaic (PV) is a method of generating electrical power by converting solar radiation into direct current electricity using semiconductors that exhibit the photoelectric effect. Photovoltaic power generation employs solar panels composed of a number of solar cells containing a photovoltaic material. Materials presently used for photovoltaic include monocrystalline silicon, polycrystalline silicon and amorphous or thin film.

- **Monocrystalline silicon (c-Si):** It is single-crystal wafer cell and tends to be expensive. Since modules are cut from cylindrical ingots, they do not completely cover a square solar cell module without substantial waste of refined silicon. Hence, most c-Si panels have uncovered gaps at the four corners of the cells. However, c-Si remains the preferred choice because of efficiency, longevity, lower installation cost and various other advantages
- **Polycrystalline silicon or Multicrystalline silicon (poly-Si or mc-Si):** It is made from cast square ingots like large blocks of molten silicon carefully cooled and solidified. Poly-Si cells are less expensive to produce than single crystal silicon cells, but are less efficient as well
- **Amorphous or Thin film:** A thin film solar cell also called a thin film photovoltaic cell is a solar cell that is made by depositing one or more thin layers of photovoltaic material on a substrate. The thickness range of such a layer is wide and varies from a few nanometers to tens of micrometers. Thin-film technology reduces the amount of material required in creating the active material of solar cell. Most thin film solar cells are sandwiched between two panes of glass to make a module. Since silicon solar panels only use one pane of glass, thin film panels are approximately twice as heavy as crystalline silicon panels. The majority of film panels have significantly lower conversion efficiencies and lag silicon by 2-3%. Thin-film solar technologies have enjoyed large investment due to lower cost and flexibility compared to wafer silicon cells, but they have not become mainstream solar products due to their lower efficiency and corresponding larger area consumption per watt of production

**Key factors to consider for setting up a Solar PV plant**

- **Land availability:** The requirement of land can vary from 4-5 acres per MW to 8-9 acres per MW, based on the technology used
- **Solar radiation**: Higher the radiation, better the scope of generation
- **Clear sky:** Solar PV systems normally tend to perform better when the sky is clear
- **Temperature:** Solar PV systems deliver higher performance at lower temperature
- **Other factors:** Efficiency declines with the increase in temperature (Normally above 25°C)

**Comparison between various technologies for Solar PV**

| Indicators | Crystalline Silicon | Thin Film Silicon |
|---|---|---|
| Land requirement (per MW) | 4-5 acres | 8-9 acres |
| Lowest price per watt | $0.61 | $0.28 – $0.50 |
| Power extraction efficiency | 73 – 82% | 60 – 68% |
| Current conversion efficiency (%) | 13 – 20% | 6 – 13% |
| Typical length of warranty | 25 years | 10-25 years |

*Source: EAI, various other press releases*

### 2.1.2. Concentrated Solar Power (CSP) or Thermal Power

Concentrated Solar Power (CSP) or Solar Thermal systems use mirrors or lenses to concentrate a large area of sunlight onto a small area. Electrical power is produced when the concentrated light is converted into heat, which drives a heat engine (usually a steam turbine) connected to an electrical power generator.

Concentrating technologies exist in four common forms, namely, parabolic trough, parabolic dish, linear fresnel reflector and solar tower. Different types of concentrators produce different peak temperatures and correspondingly vary in thermodynamic efficiencies due to differences in the way that they track the sun and focus light.

- **Parabolic Trough:** It consists of a linear parabolic reflector that concentrates light onto a receiver positioned along the reflector's focal line. The receiver is a tube positioned directly above the middle of the parabolic mirror and filled with a working fluid. The reflector follows the sun during the daylight hours by tracking along a single axis. A working fluid (e.g. molten salt) is heated to 150–350°C as it flows through the receiver and is then used as a heat source for a power generation system
- **Parabolic Dish:** A dish engine system consists of a stand-alone parabolic reflector that concentrates light onto a receiver positioned at the reflector's focal point. The reflector tracks the sun along two axes. The working fluid in the receiver is heated to 250–700°C and then used by an engine to generate power. Parabolic-dish systems provide the highest solar-to-electric efficiency among CSP technologies and their modular nature provides scalability
- **Linear Fresnel:** Fresnel reflectors are made up of many thin and flat mirror strips to concentrate sunlight onto tubes through which working fluid is pumped. Flat mirrors allow more reflective surface in the same amount of space as a parabolic reflector, thus capturing more of the available sunlight and they are much cheaper than parabolic reflectors. Fresnel reflectors can be used in various sizes
- **Solar Tower:** It consists of an array of dual-axis tracking reflectors that concentrate sunlight on a central receiver at the top of a tower. The receiver contains a fluid deposit, which can consist of sea water. The working fluid in the receiver is heated to 500–1000°C and then used as a heat source for a power generation or energy storage system. Power-tower development is less advanced than trough systems, but offer higher efficiency and better energy storage capability

**Key factors to consider for setting up a Solar Thermal plant**

- **Solar radiation:** A minimum direct normal irradiation of 1,800 kWh/m2is required for the operation of the plant. It cannot utilize diffused solar radiation for operation
- **Land requirement:** Land is required normally in the range of 5-10 acres per MW, which should be flat in large continuous stretch
- **Water requirement:** Solar thermal plant requires around 3-4 $M^3$/MWh of water for the purpose of operation
- **Temperature:** Solar-to-thermal efficiency is better at highest ambient temperature

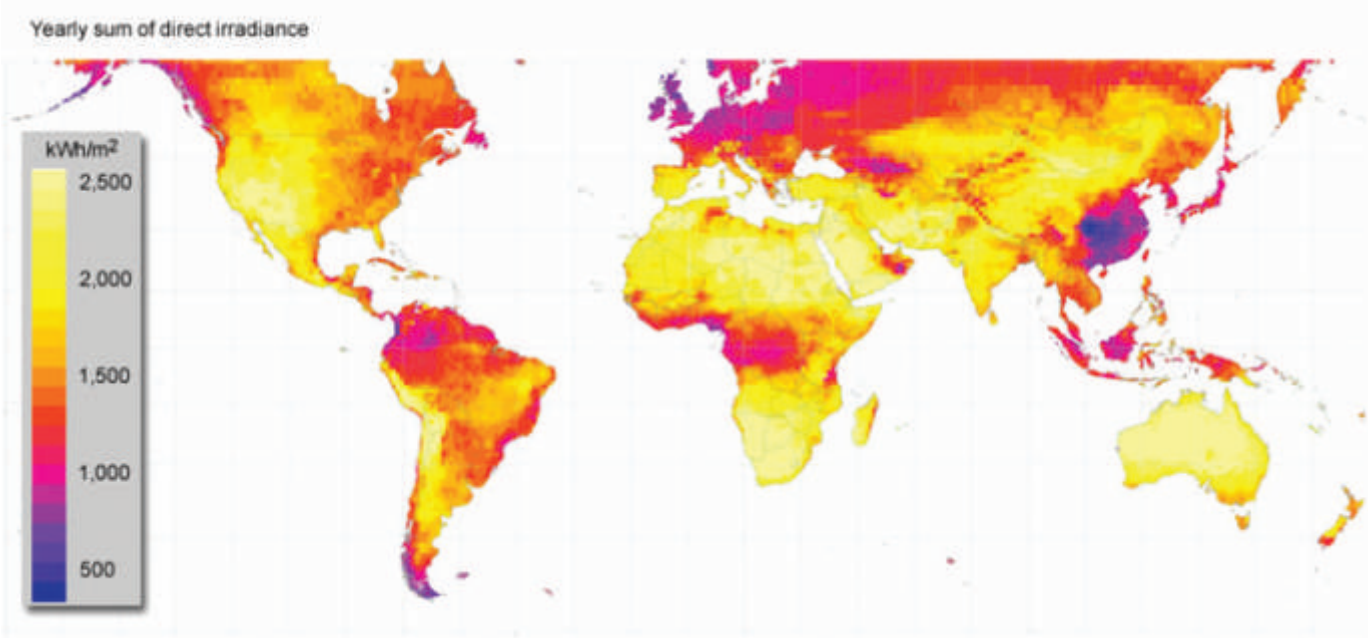
**Technological comparison for Solar Thermal**

| CSP Technology | Parabolic Trough | Solar Tower | Parabolic Dish | Linear Fresnel |
|---|---|---|---|---|
| Capacity Utilisation Factor (CUF) (%) | 20-25% | 40-45% | N.A | N.A |
| Water requirement (cubic meter per MWh) | 2.9-3.5 | 2.9-3.5 | Nil | 2.8 |
| Operating temperature (°C) | 300-400 | 500-1500 | 750 | 250-300 |
| Typical capacity (MW) | 10-200 | 10-150 | 0.01-0.04 | 1-200 |
| Maturity of technology | Commercially proven | Pilot commercial projects | Demonstrated projects | Pilot projects |
| Insolation enhancement (%) | 30-40 | 60-70 | 60-70 | 30-40 |
| Annual solar-to-electricity efficiency (net) (%) | 11-16 | 7-20 | 12-25 | 13 |

*Source: EAI, Indian Institute of Science*

## 2.2. Global Solar Irradiation and Solar Energy Highlights

**World's direct solar irradiation data and Global Trends in Solar Energy**



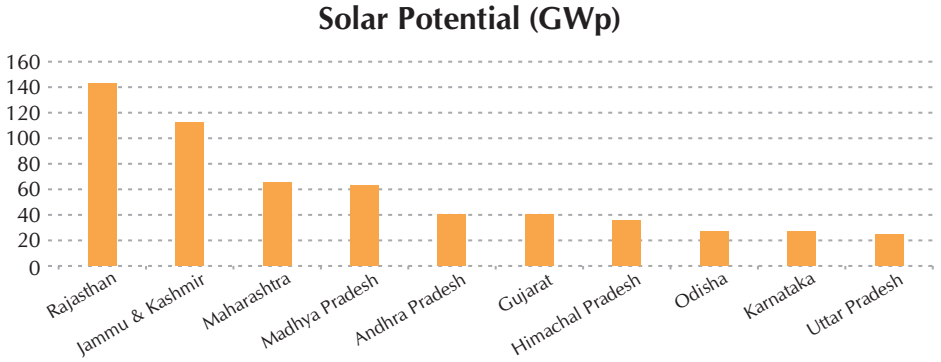

As can be seen from the map above, solar irradiation is highest in the African region along with other countries like India, Australia, UAE and some parts of USA & China. However, the world's largest solar market is Germany, followed by China, Italy, Japan and United States.

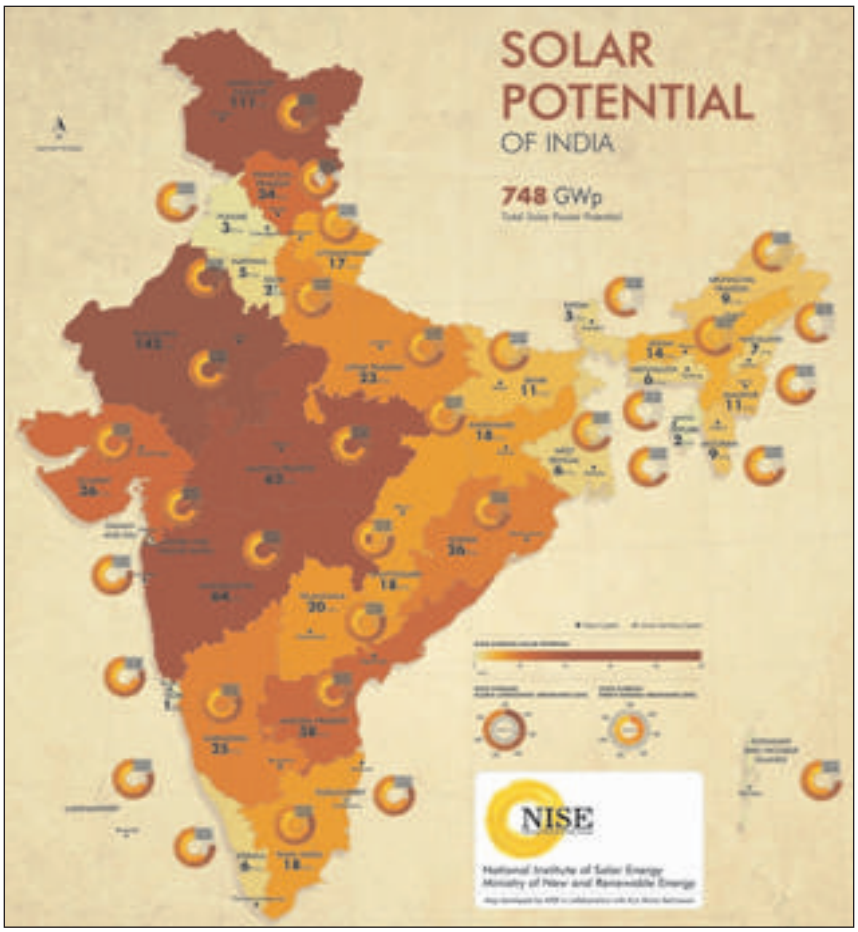
Solar power in Germany is generated mostly through the use of photovoltaics. The country has been the world's top PV installer for several years and still leads in terms of the overall installed capacity which accounted for approximately 38 GW as on October 2014, ahead of China, Italy, Japan, and the United States.

About 1.4 million photovoltaic systems installed all over Germany, from small roof-top systems to medium commercial and large utility-scale solar parks, altogether contributed 7% to the overall electricity generation during the first six months of CY2014. This brings the country's share of renewable energy to almost 31% and in line with the official Governmental goal of reaching 35% by the end of the decade.

The solar energy market in China has also been booming over the past few years, driven largely by favourable Government policies. The Chinese Government which intends to meet a greater portion of the country's growing energy needs from cleaner sources is also driving demand for domestic solar panel manufacturers. During CY2013, China installed a total of about 11GW of new solar capacity, up from just about 3 GW in CY2012.

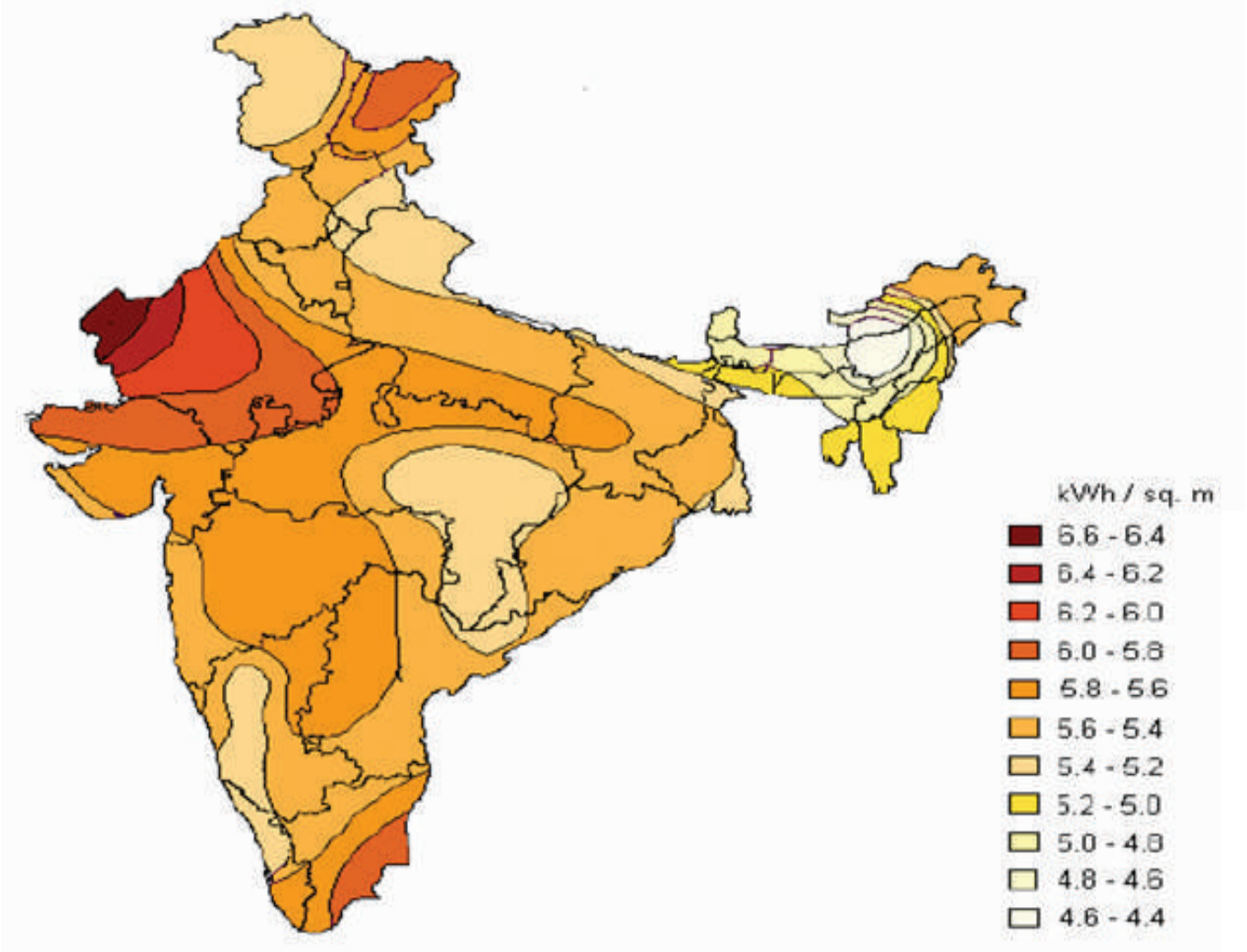
### 2.3. Solar Potential in India




| State | Solar Potential (GWp) | State | Solar Potential (GWp) | State | Solar Potential (GWp) |
|---|---|---|---|---|---|
| Rajasthan | 142.31 | Telangana | 20.41 | Nagaland | 7.29 |
| Jammu & Kashmir | 111.05 | Chhattisgarh | 18.27 | West Bengal | 6.26 |
| Maharashtra | 64.32 | Jharkhand | 18.18 | Kerala | 6.11 |
| Madhya Pradesh | 61.66 | Tamil Nadu | 17.67 | Meghalaya | 5.86 |
| Andhra Pradesh | 38.44 | Uttarakhand | 16.80 | Sikkim | 4.94 |
| Gujarat | 35.77 | Assam | 13.76 | Haryana | 4.56 |
| Himachal Pradesh | 33.84 | Bihar | 11.20 | Punjab | 2.81 |
| Odisha | 25.78 | Manipur | 10.63 | Tripura | 2.08 |
| Karnataka | 24.70 | Mizoram | 9.09 | Delhi | 2.05 |
| Uttar Pradesh | 22.83 | Arunachal Pradesh | 8.65 | Goa | 0.88 |
| | | | | UTs | 0.79 |

### 2.3.1. India's direct solar irradiation data and Development of Solar Energy Sector




- **Districts with Highest Solar Irradiation**: Sikar, Udaipur and Barmer in Rajasthan, Kutch and Bharuch in Gujarat, certain parts of Tamil Nadu
- **Lowest Solar Irradiation Areas**: North-Eastern part, Chhattisgarh, Uttarakhand and Karnataka
- **States with progressive Regulatory Framework**: Many States like Gujarat and Rajasthan have formulated transparent and progressive regulatory framework in order to boost the solar industry. Notably, the Charanka Solar Park with a power generation capacity of 600 MW covers approximately 3,000 acres of wasteland bordering the Rann of Kutch in Gujarat. The installed capacity at this solar park is 221 MW of PV, making it larger than Golmud Solar Park in China, which has a capacity of 200 MW. The new solar park is unique in having 21 companies involved in its management and development, including four companies from the USA. In addition to solar energy, the park will also manufacture solar power plant panels and other related equipments. According to the Gujarat Government, the above solar project will lead to 8 million tonnes reduction in carbon-dioxide emission
- **Role Model in Capacity Addition**: Rajasthan has recently pipped Gujarat in terms of solar capacity addition to become the state with the largest installed solar capacity as of FY 2014-15, owing to the massive push provided by the inherently high solar irradiation receiving state. Gujarat had always been touted as a role model for solar capacity addition in the country with the state government providing attractive tariffs assured cash flow due to good financial Discom condition and dedicated evacuation infrastructure. Rajasthan has now emulated this trend.

- **States with Emerging Potential**: Madhya Pradesh (MP) has emerged as the preferred State for new solar investments, overtaking earlier favorites Gujarat and Rajasthan. With close to 347 MW of solar capacity installed as on March 31, 2014, MP is now ranked third after Gujarat and Rajasthan in cumulative terms.

The following table provides the Total Installed Solar Capacity of leading states in India between 2012 and 2014.

| State | 2012-13 | 2013-14 | 2014-15 |
|---|---|---|---|
| Rajasthan | 301.15 | 666.7 | 1128 |
| Gujarat | 824.09 | 860.4 | 953 |
| Madhya Pradesh | 11.75 | 130 | 637 |
| Maharashtra | 75.5 | 150 | 354 |
| Punjab | NA | 9.3 | 239 |
| Andhra Pradesh | 76.95 | 92.9 | 228 |
| Tamil Nadu | 19.11 | 31.8 | 164 |
| Karnataka | 79 | 31 | 104 |
| Telangana | NA | NA | 83 |
| Uttar Pradesh | NA | NA | 73 |
| **Total Installed Capacity** | **1387.55** | **2208*** | **4000*** |

*Source: MNRE* **Minor installations in other states also added in final total*

- Key factors driving this growth have been:
  - Transmission and loss charges in MP (about ₹0.62 or $0.01) are lower than in most other States
  - The State Government offering land at almost free of cost to solar power developers and introduction of a "right to use" concept for Government land to reduce the time and cost of land allotment
  - Simplification of the process of clearances, approvals and inspections for setting up solar plants
  - Rise in demand and supply gap for power with a high peak energy deficit of 8-10%
  - Good sites and irradiation (5.5-5.8 kWh/m2) and a digital land database for several thousand hectares accessible to developers which has made site identification easy; Bureaucratic processes also streamlined

**Year wise solar installation in MP (MW)**

| | |
|---|---|
| CY2012 | 14 |
| CY2013 | 232 |
| CY2014 (Jan to August 2014) | 77 |

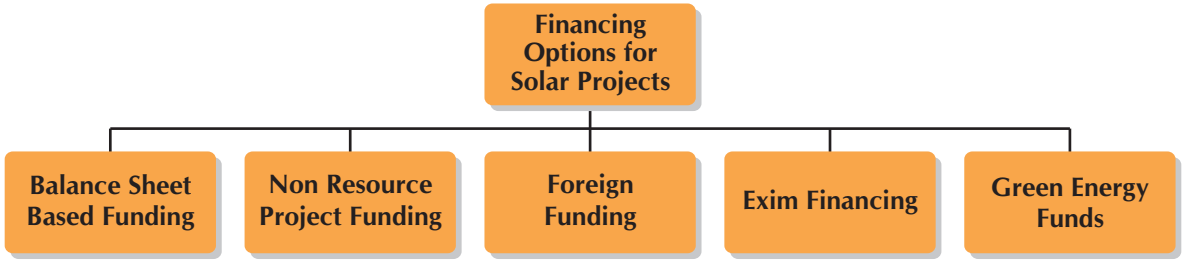
*Source: Bridge to India*

The State aims to take the total installed capacity to 2,654 MW by CY2017. A number of large solar projects are currently planned in MP. These include one ultra mega solar power plant of 750 MW to be set up by NTPC in the district of Rewa. About one-third of JNNSM phase-II projects have been allotted to developers wanting to construct in MP. Recently, the Ministry of Power has announced that if the State Government provides land, Coal India Limited would set up a 1,500 MW solar plant in MP.

Another indication of the attractiveness of MP to solar developers was evident when recently Tata Power Delhi Distribution Pvt Ltd invited proposals for 750 MW of solar plants under the "open access" system, most bidders chose MP as a location for their plant. Azure Power, which opted for Rajasthan and submitted three bids with two plants of 40 MW each and another of 20 MW, was rejected, mainly because of the high transmission and loss charges in Rajasthan, which makes the landed cost of solar power in Rajasthan higher than that in MP, despite a slightly higher irradiation in the former.

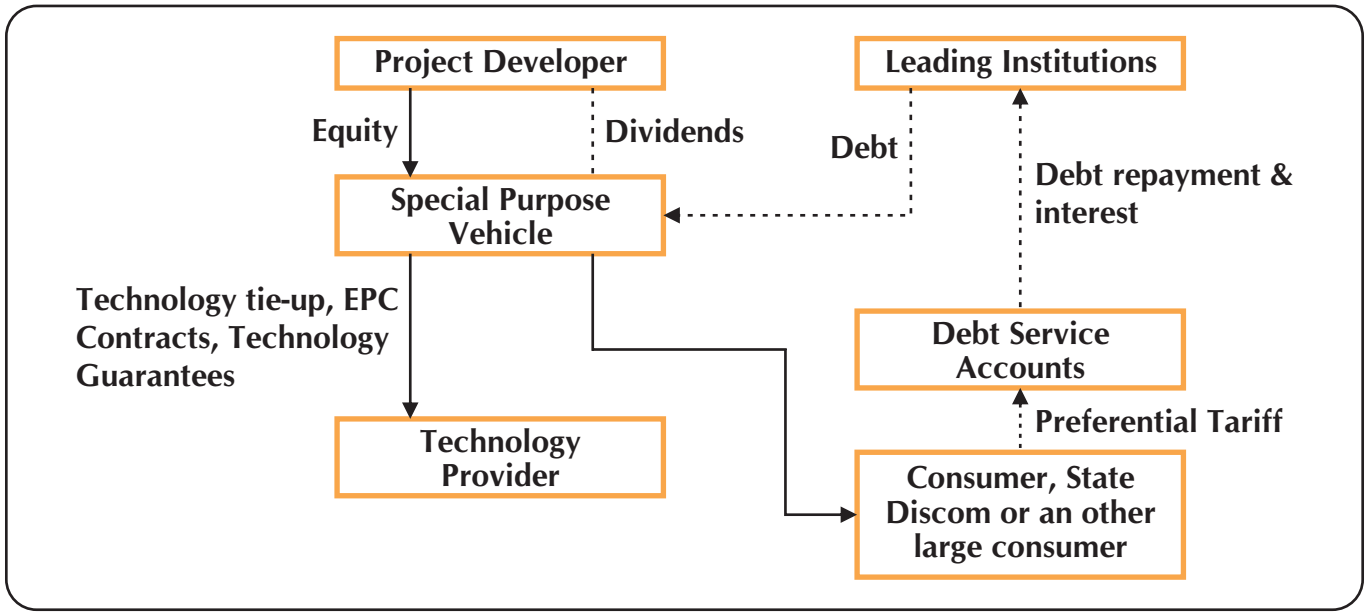
## 2.4. Financials of Solar Projects

### 2.4.1. Debt financing of solar projects




The capital structure of solar projects is in the ratio of 70:30 and debts are generally financed through Balance-Sheet based financing and Non-Recourse project financing.

- **Balance-sheet based financing** – This option is available for large conglomerates with a healthy balance sheet that can support large projects. For the large corporates, this is a good option as it allows large industrial houses to get lower rates of interest using their existing relations with the banks. However, this would put the company's balance sheet at risk and the entire burden of the project failing or under-performing will fall on the developers
- **Non-recourse project financing** – This is the preferred financing structure, wherein the lending institutions would provide debt to a SPV set up for the project and would have a lien on the project's cash-flows. However, as this structure does not provide recourse to the developer's balance sheet, lending institutions require rock-solid agreements for revenue from the projects and the developer needs to ensure that the following are in place to make the lending institutions comfortable:
  - Performance – Contractual guarantees from technology providers for the long-term performance of the plant
  - Revenue – Long-term PPA with credible consumers, i.e. direct sale of power to the consumer
  - Project viability – Developers must convince lenders that projects are viable and have the capability of repaying debt without outside assistance; this could mean that the project has to fund a Debt-Service-Reserve-Account in addition to a healthy Debt-Service-Coverage-Ratio (DSCR)




### 2.4.2. Financials of solar projects

According to CERC, for FY2015-16 the normative capital cost of solar projects range from ₹587.33 lakh/MW to ₹1,200 lakh/MW, of which, debt accounts for 70%, and equity the balance. The payback period of solar project is approximately 13 – 14 years.

| Parameter | Capital cost (₹lakh/MW) |
|---|---|
| Solar PV | 587.33 |
| Solar Thermal | 1,200.00 |

The capital cost of Solar PV has come down from approximately ₹1,500 lakh/MW during FY2010-11 to ₹587.33 lakh/MW currently due to the decrease in the cost of PV module from ₹915 lakh/MW to just ₹366 lakh/MW during FY2014-15.

Sub-Regulation (2) of Regulation 16 of the RE Tariff Regulations stipulates the normative ROE:

(a) 20% per annum for the first 10 years and

(b) 24% per annum from the 11th year onwards.

Useful life of solar project is 25 years. However, during the useful life, the capacity utilisation of a plant differs according to the technology which the project uses. The breakup of the utilisation factor is detailed below:

| Technology | Capacity Utilisation factor (CUF) |
|---|---|
| Solar PV | 19% |
| Solar Thermal | 23% |

Regulations 31, 37, 50, 64, 69 and 79 of the RE Tariff Regulations stipulate the auxiliary power consumption factor, which has been considered for determination of tariff of RE projects, as 10% for solar thermal projects.

**A Snapshot of Costs associated with an Average Solar PV project in India**

| Sr. No. | Assumption head | Sub head (1) | Sub head (2) | Unit | Detail |
|---|---|---|---|---|---|
| 1 | Power generation | Capacity | Installed power generation capacity | MW | 1 |
| | | | Capacity utilisation factor | % | 19 |
| | | | Useful life | Years | 25 |
| 2 | Project cost | Capital cost/MW | Power plant cost | ₹ lakh/MW | 587.33 |
| 3 | Sources of fund | Debt: Equity | Tariff period | Years | 25 |
| | | | Debt | % | 70 |
| | | | Equity | % | 30 |
| | | | Total debt amount | ₹ lakh | 411.13 |
| | | | Total equity amount | ₹ lakh | 176.20 |
| | | Debt component | Loan amount | ₹ lakh | 411.13 |
| | | | Moratorium period | Years | 0 |
| | | | Repayment period | Years | 12 |
| | | | Interest rate | % p.a. | 13.00 |
| | | Equity component | Equity amount | ₹ lakh | 176.20 |
| | | | Return on equity for first 10 years | % p.a. | 20.00 |
| | | | Return on equity 11th year onwards | % p.a. | 24.00 |
| | | | Weighted average of ROE | % | 22.40 |
| | | | Discount rate | % | 10.81 |
| 4 | Financial assumptions | Fiscal assumptions | Income tax* | % | 33.99 |
| | | Depreciation | Rate for first 12 years | % | 5.83 |
| | | | Rate 13th year onwards | % | 1.54 |
| 5 | Working capital | O&M expense | % of O&M expense | Months | 1 |
| | | Maintenance spare | | % | 15.00 |
| | | Receivables | | Months | 2 |
| | | Interest on working capital | | % | 13.50 |
| 6 | O&M | Power plant (FY2015-16) | | ₹ lakh/MW | 13.00 |
| | | Total O&M expense escalation | | % | 5.72 |
| | | O&M Expense (FY 2012-13) | | ₹ lakh | 11.00 |

*Source: CERC*

* We have assumed the income tax @ 33.99% despite the tax holiday of 10 years as the solar policy may change in subsequent years. As it is, over the next few years, Corporate Tax shall be reduced to 25%, but several exemptions shall also be disallowed henceforth. The true Tax Rates can only be understood after a detailed list of withdrawn tax exemptions is published.

## A Snapshot of Costs associated with Average Solar thermal Projects in India

| Sr. No. | Assumption head | Sub head (1) | Sub head (2) | Unit | Detail |
|---|---|---|---|---|---|
| 1 | Power generation | Capacity | Installed power generation capacity | MW | 1 |
| | | | Capacity utilisation factor | % | 23 |
| | | | Auxiliary Consumption | % | 10 |
| | | | Useful life | Years | 25 |
| 2 | Project cost | Capital cost/MW | Power plant cost | ₹ lakh/MW | 1200.00 |
| 3 | Sources of fund | Debt: Equity | Tariff period | Years | 25 |
| | | | Debt | % | 70 |
| | | | Equity | % | 30 |
| | | | Total debt amount | ₹ lakh | 840.00 |
| | | | Total equity amount | ₹ lakh | 360.00 |
| | | Debt component | Loan amount | ₹ lakh | 840.00 |
| | | | Moratorium period | Years | 0 |
| | | | Repayment period | Years | 12 |
| | | | Interest rate | % p.a. | 13.00 |
| | | Equity component | Equity amount | ₹ lakh | 360.00 |
| | | | Return on equity for first 10 years | % p.a. | 20.00 |
| | | | Return on equity 11th year onwards | % p.a. | 24.00 |
| | | | Weighted average of ROE | % | 22.40 |
| | | | Discount rate | % | 10.81 |
| 4 | Financial assumptions | Fiscal assumptions | Income tax* | % | 33.99 |
| | | Depreciation | Rate for first 12 years | % | 5.83 |
| | | | Rate from 13th year onwards | % | 1.54 |
| 5 | Working capital | O&M expense | % of O&M expense | Months | 1 |
| | | Maintenance spare | | % | 15.00 |
| | | Receivables | | Months | 2 |
| | | Interest on working capital | | % | 13.50 |
| 6 | O&M | Power plant (FY2014-15) | | ₹ lakh/MW | 17.72 |
| | | Total O&M expense escalation | | % | 5.72 |
| | | O&M Expense (FY2012-13) | | ₹ lakh | 15.00 |

*Source: CERC*

* Please refer to comments on the Tax Rates as above.

## Breakup of the Capital Cost Per MW of Solar PV Project

| Particulars | Percentage (%) | Estimated cost (₹ lakh) |
|---|---|---|
| PV modules | 55 | 322.44 |
| Land cost | 4 | 24.08 |
| Civil and General Works | 8 | 48.75 |
| Mounting Structures | 8 | 48.75 |
| Power Conditioning Unit | 7 | 43.46 |
| Evacuation Cost up to Inter-connection Point (Cables and Transformers) | 9 | 53.45 |
| Preliminary and Pre-Operative Expenses including IDC and contingency | 8 | 46.40 |
| **Total Capital Cost** | **100** | **587.33** |

*Source: CERC*

### Breakup of the Capital Expense per MW of Solar Thermal project

| Particulars | Percentage (%) | Estimated cost (₹ lakh) |
|---|---|---|
| Solar field cost | 67 | 804.00 |
| Power block cost | 20 | 240.00 |
| Land cost | 1 | 12.00 |
| Site development | 3 | 36.00 |
| Erection and commissioning charges | 2 | 24.00 |
| Preliminary & pre-operative expenses, contingency & IDC | 7 | 84.00 |
| **Total capital cost** | **100** | **1200.00** |

*Source: CERC*

### Capital cost of Solar PV plant countrywise (2013)

| Geography | Capital expenditure ($ million/MW) | Operating expenditure ($/MW/year) | Capacity factor (%) | Levelised cost of solar electricity (LCOE) ($/MWh) |
|---|---|---|---|---|
| China | 1.45-1.05 | 17,000 | 11-20 | 79-145 |
| Spain | 1.63 | 25,000 | 19 | 109 |
| USA | 1.77 | 25,000-60,000 | 12-21 | 117-239 |
| Australia | 2.41 | 27,330 | 14-21 | 127-191 |
| Germany | 1.63 | 60,000 | 11 | 226 |
| Japan | 2.66 | 50,000 | 12 | 439 |
| India* | 1.53-1.61 | 11,063-14,750 | 15-20 | 87-137 |

*Source: Bloomberg New Energy Finance*
*Note: The given range is an average scenario and does not reflect actual maximum and minimum values*
** Latest detailed figures (beyond 2013) on the countrywise LCOE are not available on a comparable global basis. However for India the Capital Expenditure has come down to $1.16 million approximately and LCOE is expected to have come down proportionately. The exchange rate is taken as Rs.60/US$*

### Capital cost of Solar Thermal plant countrywise (2013)

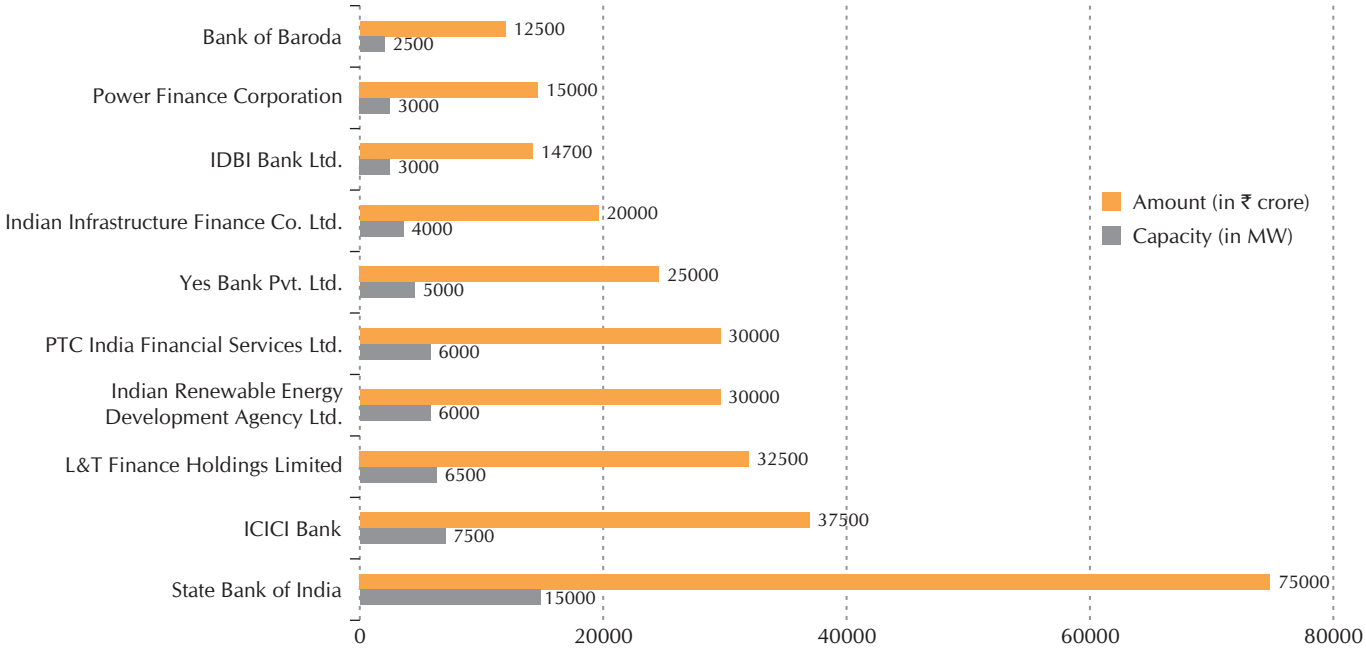
| Geography | Type | Capital expenditure ($ million/MW) | Operating expenditure ($/MW/year) | Capacity factor (%) | LCOE ($/MWh) |
|---|---|---|---|---|---|
| Spain, USA & Australia | No storage | 3.42-7.67 | 59,907 - 68,265 | 24-28 | 201-490 |
| | With storage | 6.00-10.96 | 61,574- 117,313 | 28-42 | 156-469 |
| China | No storage | 3.08-4.55 | 44,000- 45,000 | 24-28 | 123-248 |
| India | No storage | 2.0* | 28,000* | 23 | |

*Source: Bloomberg New Energy Finance*
*Note: The given range is an average scenario range and does not reflect actual maximum and minimum values*
** The exchange rate is taken as Rs.60/US$*

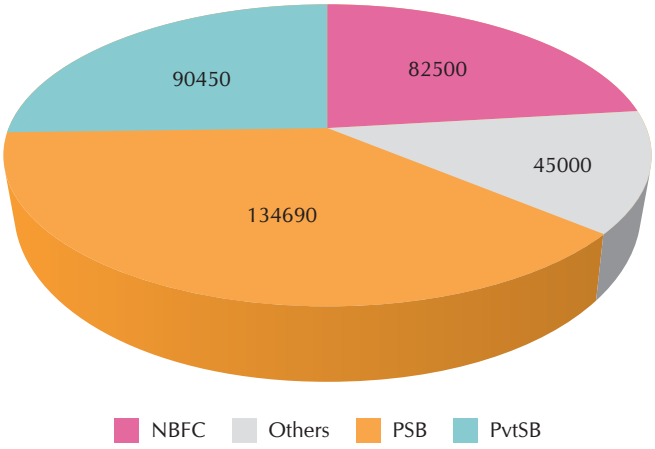
#### 2.4.3. Recent Commitments by Lenders towards Green Energy Initiatives

During the Re Invest 2015 conference, 14 companies from seven countries have given Green Energy Commitments for 58 GW. At the same time, 22 PSUs have given commitments for 18 GW, 257 private sector companies for 190 GW and the Railways for 5000 MW for renewable energy.

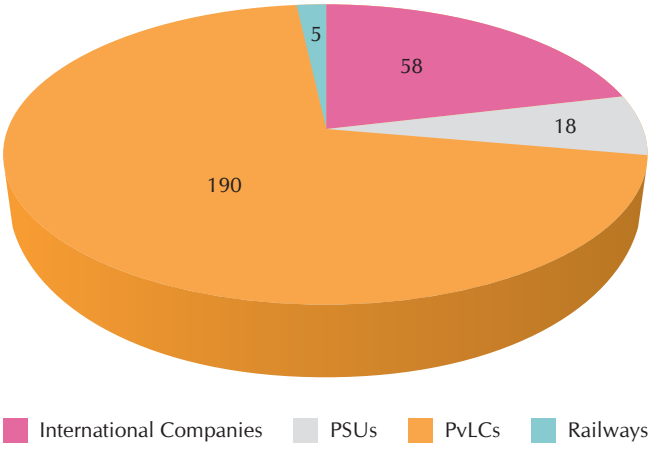
## Leading Capacity Commitments and Capital Commitments in the Green Energy Sector made by Banks and FIs




### Capital Commitments made by Banks (in ₹ Crore)




### Capacity Commitments (in GW)




A total of about ₹3,52,640 crores was committed by various BFIs towards funding of 70,505 MW of Green Power. State Bank of India led the way with ₹75,000 crore ($12 billion) over the next five years to support 15,000 megawatts (MW) of capacity addition. Other major commitments were given by ICICI Bank, L & T Finance, PTC India.

Overall, the Public Sector Banks led in their commitments, with almost 38% of the overall commitments. Interestingly, Power Finance companies also chipped in with commitments to the extent of ₹45,000 Crore. It is expected that a major portion of these Green Energy Commitments would be directed towards the Solar Power Sector.

In the same conference, 14 companies from seven countries have their Green Energy Commitments for 58 GW. Similarly, 22 PSUs for 18 GW, 257 private limited companies (PvLCs) for 190 GW and the Railways for 5000MW submitted their commitments for renewable energy

### 2.4.4 Tariff

**Feed-in-tariff for the FY2015-16**

| Parameter | Levelised tariff (without AD benefit) (₹/kWh) | Benefit of AD (if availed) (₹/kWh) | Net levelised tariff (upon adjusting for AD benefit) (₹/kWh) |
|---|---|---|---|
| Solar PV | 6.86 | 0.67 | 6.20 |
| Solar Thermal | 12.05 | 1.25 | 10.80 |

*Source: CERC*

**Global Tariff of solar PV and solar thermal plant across Countries**

| Geography | LCOE in PV ($/MWh) | LCOE in thermal ($/MWh) |
|---|---|---|
| China | 79-145 | 123-248 |
| Spain | 109 | 156-490 |
| USA | 117-239 | 156-490 |
| Australia | 127-191 | 156-490 |
| Germany | 226 | NA |
| Japan | 439 | NA |
| India | 116* | 178* |

* The exchange rate taken as ₹60/US$ and rounded off

### 2.4.5 Solar Renewable Purchase Obligations

Renewable Purchase Obligation (RPO) refers to the obligation, whereby State Electricity Regulatory Commissions (SERCs) are obligated by law to buy a certain percentage of electricity from renewable energy sources. The guidelines issued in 2010 by CERC had recommended a standardised RPO target of 5% in every State with linear increase of 1% annually till CY2020 to achieve the National Action Plan on Climate Change (NAPCC) target of 15%. It is categorized as solar and non-solar RPOs.

- Solar RPO is to generate electricity based on solar as renewable energy source.
- Non-solar RPO is to generate electricity based on renewable energy sources other than solar.

**Obligated entities are:**

- Discoms (State Power Distribution Company)
- Captive Power Producers
- Open-Access Consumers

**Present State-wise Solar RPO targets**

| States | FY2014-15 | FY2015-16 | FY2016-17 | FY2017-18 | FY2018-19 | FY2019-20 | FY2020-21 | FY2021-22 |
|---|---|---|---|---|---|---|---|---|
| Andhra Pradesh | 0.25% | 0.25% | 0.25% | | | | | |
| Assam | 0.25% | | | | | | | |
| Bihar | 0.75% | 1.00% | 1.25% | 1.50% | 1.75% | 2.00% | 2.50% | 3.00% |
| Chhattisgarh | | | | | | | | |
| Delhi | 0.25% | 0.30% | 0.35% | | | | | |
| Himachal Pradesh | 0.25% | 0.25% | 0.25% | 0.50% | 0.75% | 1.00% | 2.00% | 3.00% |
| Kerala | 0.25% | 0.25% | 0.25% | 0.25% | 0.25% | 0.25% | 0.25% | 0.25% |
| Madhya Pradesh | 1.00% | | | | | | | |
| Maharashtra | 0.50% | 0.50% | | | | | | |
| Odisha | 0.25% | 0.30% | | | | | | |
| Punjab | 0.19% | | | | | | | |
| West Bengal | 0.30% | 0.40% | 0.50% | 0.60% | | | | |

*Source: SERCs Order on RPO Regulations*

## 2.5. Government of India Schemes for Solar Power

### 2.5.1. Jawaharlal Nehru National Solar Mission (JNNSM)

The Jawaharlal Nehru National Solar Mission – JNNSM (also known as the National Solar Mission) was the major initiative of the Government of India (GOI) and State Governments to promote ecologically sustainable growth while addressing India's energy security challenges. It plays a prime role in India's contribution to the fight against issues of climate change, which is a big concern across the globe. The launch of the National Solar Mission has given a big impetus to solar energy in India. The Mission adopted a 3 phase approach, spanning the period of the 11th Five Year Plan and first year of the 12th Five Year Plan (up to FY2012-13) as Phase 1, the remaining 4 years of the 12th Plan (FY2013-17) as Phase 2 and the 13th Plan (FY2017-22) as Phase 3. The highlights of the mission are given below:

- Installed capacity of 20,000 MW by FY2021-22 (revised recently to 100,000 MW*),
- Envisages an investment of ₹90,000 crore over the next 30 years
- Initial investment of ₹4,337 crore provided by the GOI.

**JNNSM phase wise targets**

| | Target capacity | Target capacity | Target capacity |
|---|---|---|---|
| | **Phase I (FY2010-13)** | **Phase I (FY2013-17)** | **Phase I (FY2017-22)** |
| Grid based (MW) | 1,100 | 10,000 | 20,000* |
| Off-grid based (MW) | 200 | 1,000 | 2,000 |
| **Total** | **1,300** | **11,000** | **22,000** |

*Source: MNRE* Revised by five-fold to 100,000 MW w.e.f 18th June 2015*

To facilitate grid connected solar power generation under phase I without any Government subsidy, GOI approved NTPC Vidyut Vyapar Nigam Ltd (NVVN) as the nodal agency to purchase 1,000 MW from project developers and sell this bundled power to the distribution utilities. The concept of Bundling was introduced to select projects of 500 MW capacity each based on solar thermal and PV technologies.

*On 18th June 2015, in a major policy move, the government has announced a massive scaling up of the targets for India's solar power capacity target under Jawaharlal Nehru National Solar Mission (JNNSM) by five times, reaching 1,00,000 MW by 2022. The target will principally comprise of 40 GW (solar) rooftop and 60 GW through large and medium scale grid connected solar power projects. With this ambitious target, India is touted to become one of the world's largest green energy producers, surpassing several developed countries. Toward achieving this target the government envisages a total investment in setting up 100 GW will be around Rs 6,00,000 crore. In the first phase, the Government of India is providing Rs 15,050 crore as capital subsidy to encourage solar energy based projects. This capital subsidy will be provided for Rooftop Solar projects in various cities and towns, for Viability Gap Funding (VGF) based projects to be developed through the Solar Energy Corporation of India (SECI) and for decentralised generation through small solar projects. The new solar target of 100 GW is expected to result in the reduction of over 170 million tonnes of carbon dioxide, a gas contributing to climate change.

### 2.5.1.1 JNNSM phase-I

During Phase I, a total of 1,000 MW of solar power projects were selected, with solar PV and solar thermal projects to be allocated in the ratio of 50:50. It was divided into batch-I & II over FY2010-11 and FY2011-12, respectively. During batch-I, grid-connected capacity addition of 150 MW solar PV plants and 500 MW of solar thermal plants was envisaged. However, during batch-II, the remaining targeted capacity i.e. 350 MW of solar PV was awarded (of which 330 MW has already been installed), while for off-grid, 99 MW was allotted. The balance 100 MW and 101 MW was not allotted for grid-based and off-grid projects respectively.

**State / UT Wise Status of Solar Projects Commissioned under JNNSM Phase I**

**(Capacity in MW)**

| State | NVVN Batch I | NVVN Batch I Solar Thermal | NVVN Batch II | RPSSGP | Migration | Total |
|---|---|---|---|---|---|---|
| Andhra Pradesh | 15.00 | - | 20.00 | 9.75 | - | 44.75 |
| Haryana | - | - | - | 7.80 | - | 7.80 |
| Jharkhand | - | - | - | 16.00 | - | 16.00 |
| Karnataka | 5.00 | - | - | - | - | 5.00 |
| Madhya Pradesh | - | - | - | 5.25 | - | 5.25 |
| Maharashtra | 5.00 | 2.50 | 40.00 | 5.00 | 11.00 | 63.50 |
| Odisha | 5.00 | - | - | 7.00 | - | 12.00 |
| Punjab | - | - | - | 6.00 | 2.00 | 8.00 |
| Rajasthan | 100.00 | 50.00 | 270.00 | 12.00 | 35.00 | 467.00 |
| Tamil Nadu | 5.00 | - | - | 6.00 | - | 11.00 |
| Uttar Pradesh | 5.00 | - | - | 7.00 | - | 12.00 |
| Uttarakhand | - | - | - | 5.00 | - | 5.00 |
| Chhatisgarh | - | - | - | 4.00 | - | 4.00 |
| **Total** | **140.00** | **52.50** | **330.00** | **90.80** | **48.00** | **661.30** |

*Source: MNRE*

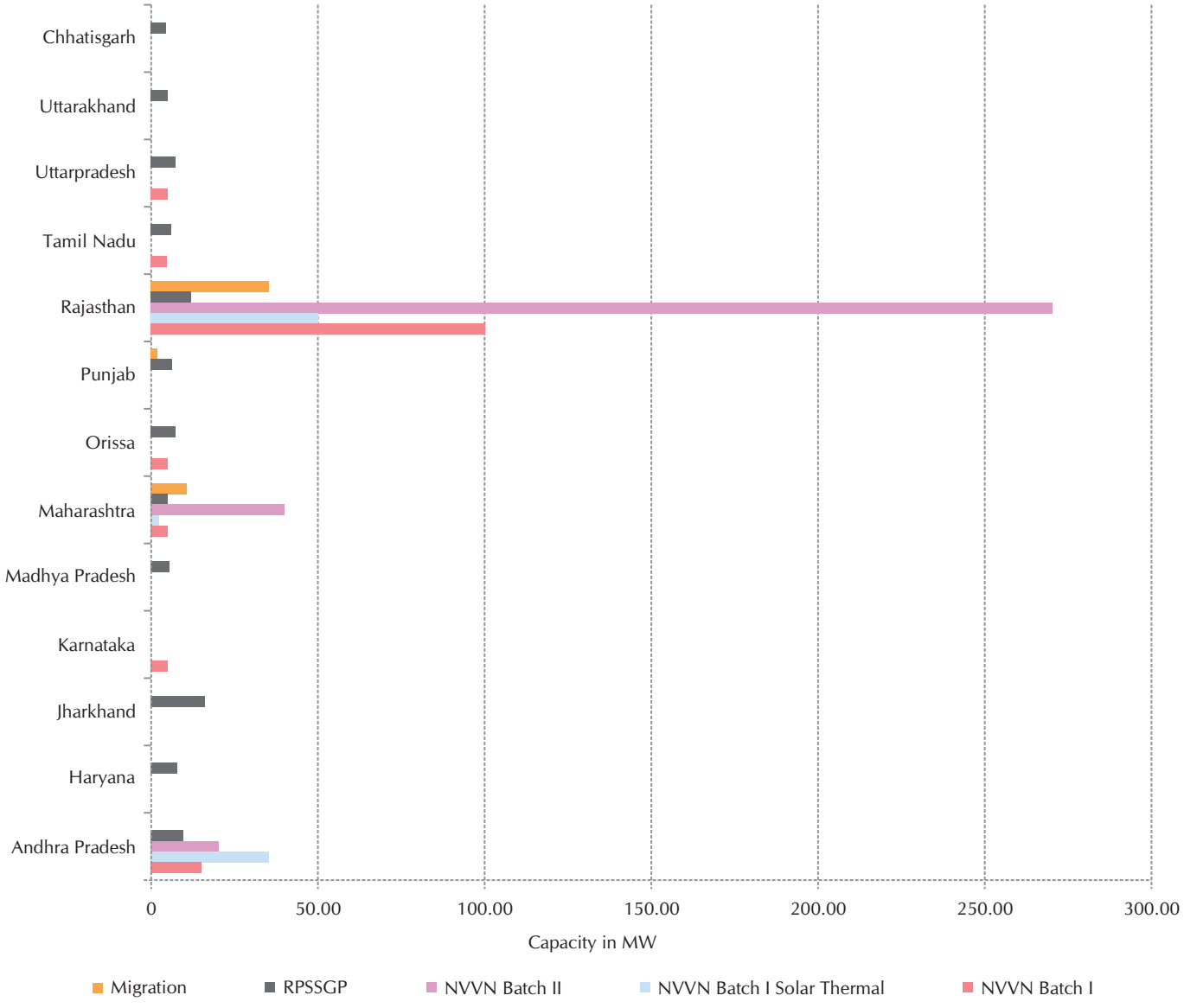
## Status of batch-I & II JNNSM (grid and off-grid projects) as on April 30, 2014

| Schemes | Projects allotted | | CERC tariff | Lowest tariff discovered |
|---|---|---|---|---|
| | Nos | MW | ₹/kWhr | ₹/kWhr |
| **Batch I** | | | | |
| PV projects through NVVN | 30 | 150.00 | 17.91 | 10.95 |
| CSP projects through NVVN | 7 | 470.00 | 15.31 | 10.49 |
| **Migration scheme-PV | 13 | 54.00 | - | - |
| Migration scheme-CSP | 3 | 30.00 | - | - |
| RPSSGP (off-grid)* | 78 | 98.05 | - | - |
| **Batch II** | | | | |
| PV projects through NVVN | 25 | 340.00 | 9.44 (Max tariff) | 7.49 |

*Source: MNRE*

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

**The migration scheme refers to solar power projects under development before the advent of the National Solar Mission and which moved under the mission guidelines later.



### 2.5.1.2. JNNSM phase-II

Under the second phase, the target was set for installing 9,000 MW of grid-connected solar power and 800 MW of off-grid application. Of this, 3,600 MW will be under the Central scheme and 5,400 MW under the various State initiatives, which will be met by the enforcement of RPO.

**Proposed share of Solar PV and Solar Thermal atCentral/State levels during phase II:**

**Inter-technology targets at Central and State level**

| Item description | Ratio | Central Schemes | State Schemes |
|---|---|---|---|
| Solar PV | 70% | 40% | 60% |
| Solar Thermal | 30% | 40% | 60% |

**Technology wise capacity allocation (MW)**

| Item description | Ratio | Central Schemes | State Schemes |
|---|---|---|---|
| Solar PV | 6,300 | 2,520 | 3,780 |
| Solar Thermal | 2,700 | 1,080 | 1,620 |
| **Total** | **9,000** | **3,600** | **5,400** |

**The timeline for achieving the targets under the Central scheme is given below:**

**Target capacity matrix for phase II (MW)**

| Item description | FY2013-14 | FY2014-15 | Total |
|---|---|---|---|
| Rooftop & small solar- PV | 100 | 100 | 200 |
| Bundling - PV | 800 | - | 800 |
| VGF<br>- PV<br>- CSP | 750 | 770<br>1,080 | 1,520<br>1,080 |
| Total<br>- PV<br>- CSP | 1,650<br>1,650 | 1,950<br>870<br>1,080 | 3,600<br>2,520<br>1,080 |

MNRE on April 18, 2013 released draft guidelines for setting up of 750 MW Grid Solar PV plants through Viability Gap Funding (VGF) route under JNNSM Phase-II, Batch- I. Solar Energy Corporation of India (SECI) has been designated as implementing agency by MNRE for the implementation of 750 MW of grid connected solar power projects under JNNSM Phase-II, Batch-I. The Government has been supporting the solar power projects through GBI and bundling scheme, wherein solar energy is bundled with conventional energy. However, in view of the prevailing uncertainty about adequate availability of Central Government's unallocated conventional power, MNRE has mooted the idea of tapping the clean energy fund to subsidise solar sector through VGF mechanism.

VGF is a mechanism wherein the Government supports infrastructure projects through capital grants and incentives to make them commercially viable. Infrastructure projects typically requires high upfront capital, has long gestation period and offer fixed returns. Thus, to make it attractive for the private sector, Government introduced VGF in 2004 by subsidising the capital cost through PPP (Public Private Partnership) framework. VGF has been

used in the past in PPP projects in sectors like roads, highways, ports, conventional power plants, railways and airport projects. Projects in these sectors have one common running characteristic returns that the investors get from these projects which have high economic and social values for the country, may not always be lucrative enough to make them commercially viable on standalone basis.

**Model Mechanism of Operation of VGF in Solar Power Sector:**

1. Fixed tariff of ₹5.45 per kWh for 25 years period for projects not availing AD benefits and ₹4.95 per kWh for projects availing AD benefits
2. Upper limit of VGF set at 30% of the project cost or ₹2.5 crore/MW, whichever is lower
3. Equity contribution of at least ₹1.5 crore/MW
4. Remaining amount can be raised as loan from any source by the developer
5. VGF when paid by the SECI, may be used to return part of the loan or developer contribution (in excess of ₹1.5 crore/MW) or a combination thereof as the case may be, in case investments have already been made; SECI issues a letter confirming sanction/ grant of VGF, so that bidder is able to achieve financial closure for full amount, if required at the time of signing of PPA
6. Disbursement of VGF amount to be done in six tranches:

   50% on successful commissioning of the full capacity. Balance 50% disbursed progressively over next 5 years, subject to the plant meeting generation requirements (Capacity Utilisation Factor i.e. CUF within specified range) as under:

   i. Upon Commissioning of full Capacity of Project (COD) – 50%
   ii. End of 1st Year from COD – 10%
   iii. End of 2nd Year from COD – 10%
   iv. End of 3rd Year from COD – 10%
   v. End of 4th Year from COD – 10%
   vi. End of 5th Year from COD – 10%
7. Conditions to be Fulfilled for Disbursement of VGF:

   First instalment of 50% of VGF amount indicated to be released at a date not earlier than three (3) months from Scheduled Commissioning Date as per PPA subject to fulfilment of following conditions:

   i) Successful commissioning of the full capacity of the Project as per the "Schedule 6 of the PPA"; a duly constituted Committee to physically inspect and certify satisfactory commissioning of the Project
   ii) Creation of charge as clarified in the Agreement, including registration of the same with the Registrar of Companies (ROC)
   iii) Solar Power Developer (SPD) to furnish financing documents (including financing agreements) to SECI
8. For the purpose of determination of annual CUF, SPD to declare the annual CUF of the Project at the time of commissioning and shall be allowed to revise the same only once within 1 year of Commissioning. The declared annual CUF shall in no case be less than 17% over a year. The SPD to maintain generation so as to achieve annual CUF within minus (-)15% and plus (+)10% of the declared value till the end of 10 years subject to the annual CUF remaining over a minimum of 15%. For the remaining term of the PPA, the SPD to maintain generation so as to achieve annual CUF within minus (-) 20% and plus (+) 10% of the declared annual CUF. The CUF will be calculated every year from 1st April of the year to the 31st March next year. For the purpose of release of VGF, CUF will be calculated every year from the COD up to completion of 1 year from the COD. The upper limit will not be applicable for the purpose of release of VGF. The lower limit will, however, be relaxable by SECI in case of non-availability of grid for evacuation which is beyond the control of the SPD and /or abnormally low annual Global Horizontal Irradiance (GHI) year (i.e. if the actual annual GHI in the year under consideration is less than 50% of average values of two (2) years of annual GHI as available from the nearest IMD/SRRA stations)

9. The lending institution (if any) to have first charge on the project assets and the SPD (Solar Project Developer) shall create charge according to the requirement laid down by the lending institution. The SPD shall create second charge along with the first charge of the lending institution on the same project assets (save and except book debts) by way of mortgage/ hypothecation in favour of SECI to securitize the sanctioned VGF amount

10. In the absence of any charge in favour of the lending institution, SECI to have the first charge on the project assets to the extent of 110% of sanctioned VGF Amount. The order of preference of project assets for creation of charge in favour of SECI for securing value of 110% of the sanctioned VGF amount shall be project land, PV modules and any other project equipment respectively

11. Notwithstanding as provided in the clause above, SECI shall cede its first charge and accept second charge over the project assets upon the SPD availing finance from lending institution (if any) after the COD. SECI shall have no-objection in creating first charge over project assets in favour of lending institution as per their requirement by SPD and for filling requisite form for modification of charge with the Registrar of Companies (ROC)

12. Notwithstanding the SPD taking Loans from any Lender/Lending Institution subject to the SPD bringing minimum ₹1.5 Cr. per MW as Equity contribution, the mortgage / hypothecation and all other securities/ charges stipulated above, shall rank the charges created/to be created in favour of SECI subordinate (as a second charge holder) to term loan Lending Institutions (if any)

**Total capacity of grid connected Solar PV technology projects: 750 MW**

- The solar power projects are required to be designed for inter-connection with transmission network of STU/CTU at voltage level of 33kV or above
- Minimum capacity of each project is 10 MW
- Maximum capacity of each project is 50 MW
- Plant capacity is allocated in multiples of 10 MW
- Maximum aggregate capacity per company (including its parent, affiliate or ultimate parent or any group company) is 100 MW with a maximum of 3 projects at different locations

**Processing fees (Non-refundable):**

- Up to 20 MW: ₹1 lakh
- Above 20 MW: ₹2 lakh

**Qualification criteria:**

- **Financial criteria**: Net worth of the company should be equal to or greater than the value calculated at the rate of ₹2 crore or equivalent US$ per MW of the project capacity upto 20 MW. For every MW of additional capacity, beyond 20 MW, additional net worth of ₹1 crore needs to be demonstrated. For computation of net worth, the best year in the last 4 years (from the year of qualification) is considered. For companies which were newly incorporated, the net worth criteria should be met 7 days prior to the date of submission of RfS by the company
- **Technical criteria**: To minimise the technology risk and to achieve the commissioning of the projects, only commercially established and operational technologies are proposed to be promoted
- **Connectivity with the grid**
  - The plant should be designed for inter-connection with the transmission network of STU/CTU or any other transmission utility at voltage level of 33 KV or above. The project developer should submit a letter from the STU / CTU/Transmission Utility along with RfS confirming technical feasibility of connectivity of plant to substation
  - The responsibility of getting connectivity and open access with the transmission system owned by the STU / CTU or any other transmission utility, as may be required, should be with the project developer
  - The arrangement of connectivity should be made by the SPD through a dedicated

transmission line, which the SPD may construct himself or get constructed by STU or any other agency. The entire cost of transmission, including the cost of construction of line, wheeling charges, losses etc. from the project upto the interconnection point has to be borne by the project developer and not by the STU. This connectivity can also be achieved through a shared line with any agency or any existing line of Discoms or STU, provided the energy accounts are bifurcated and clearly demarcated for the power generated at solar project and are issued by the STU/State Load Dispatch Center(SLDC) concerned

  - The project developer may, however, shift interconnection point closer to his project if 33 kV substation comes closer to the project during the tenure of PPA, provided the interconnection is maintained at 33 KV or above and energy at solar project is clearly demarcated for the power generated at solar project and energy accounts are issued by the STU/ SLDC concerned. The costs associated with this arrangement would also be borne by the project developer, including the wheeling charges and losses up to the interconnect point

- **Clearances**: Project developer must obtain necessary clearances from the State Government and other local bodies
- **Domestic Content Requirement (DCR):** Out of the total capacity of 750 MW under phase-II batch-I, a capacity of 375 MW was kept for bidding with Domestic Content Requirement (DCR). Under DCR, the solar cells and modules used in the power plant must be made in India
- **PPA**: It should be executed between SECI and the project developer along with the invitation for submission of Rfs. Simultaneously, SECI issues letters to all State Utilities/ Discoms to invite EOI from State Utilities/ Discoms who are willing to procure the power. Solar power is purchased @₹5.50/ kWh (including trading margin of SECI @ 5 paisa/kWh) under VGF scheme
- **Bank Guarantees**
  - EMD of ₹10 lakh/MW in the form of BG along with Rfs
  - Performance BG of ₹20 lakh/MW at the time of signing of PPA
- **Part commissioning**: It is accepted by SECI with a minimum capacity of 10 MW and in multiples thereof. PPA is for a period of 25 years from the date of part commissioning.
- **Payment security mechanism**: To ensure timely payment to the developers, SECI set up the payment security mechanism with a fund which had a corpus enough to cover 3 months payment. The money received from encashment of BGs, interest earned on this fund, incentives for early payment, extra money coming from 10% lower tariff to developers claiming AD and grants from Government/ NCEF were used to build this fund.

## List of Companies allocated under Phase-II batch I

| S. No. | Name of Developer | Projects Allocated in MW | | | Total VGF (in Rs. Crores) | | |
|---|---|---|---|---|---|---|---|
| | | Part A (DCR) | Part B (Open) | Total | Part A (DCR) | Part B (Open) | Total |
| 1. | Azure Power India | 60 | 40 | 100 | 134 | 52 | 186 |
| 2. | Sun Edison | 50 | 50 | 100 | 86 | 41 | 127 |
| 3. | Acme Group (includes Ranji Solar & Medha Energy) | 20 | 80 | 100 | 49 | 92 | 141 |
| 4. | Waaree Energies | 50 | 0 | 50 | 118 | | 118 |
| 5. | Today Homes & Infrastructure | 30 | 20 | 50 | 52 | 22 | 74 |
| 6. | IL&FS Energy Development | 40 | 0 | 40 | 96 | | 96 |
| 7. | Finsurya Energy | 0 | 40 | 40 | 0 | 37 | 37 |
| 8. | Focal Energy | 0 | 40 | 40 | 0 | 48 | 48 |
| 9. | Solairdirect | 30 | 0 | 30 | 67 | | 67 |
| 10. | Hero Solar Energies | 10 | 20 | 30 | 24 | 25 | 49 |
| 11. | Green Energy Development Corporation | 20 | 0 | 20 | 48 | | 48 |
| 12. | Swelect Energy Systems | 10 | 0 | 10 | 13 | 0 | 13 |
| 13. | Sharda Construction & Corporation | 10 | 0 | 10 | 14 | 0 | 14 |
| 14. | Laxmi Diamond | 10 | 0 | 10 | 20 | | 20 |
| 15. | RDA Energy | 10 | 0 | 10 | 21 | | 21 |
| 16. | Palimarwar Solar Project | 10 | 0 | 10 | 22 | | 22 |
| 17. | Karnataka Power Corporation | 10 | 0 | 10 | 22 | | 22 |
| 18. | Gujarat Power Corporation | 0 | 10 | 10 | 0 | 2 | 2 |
| 19. | Rishabh Buildwell | 0 | 10 | 10 | 0 | 9 | 9 |
| 20. | Backbone Enterprises | 0 | 10 | 10 | 0 | 10 | 10 |
| 21. | Gujarat State Electricity Corporation | 0 | 10 | 10 | 0 | 10 | 10 |
| 22. | Enersan Power | 0 | 10 | 10 | 0 | 11 | 11 |
| 23. | Belectric Photovoltaic India | 0 | 10 | 10 | 0 | 12 | 12 |
| 24. | 4G Identitiy Solutions | 0 | 10 | 10 | 0 | 12 | 12 |
| 25. | Vishwaj Energy | 0 | 10 | 10 | 0 | 13 | 13 |
| 26. | Welspun Renewables | 5 | 0 | 5 | 0 | | 0 |
| 27. | Sunil Hitech Engineers | 0 | 5 | 5 | 12 | 7 | 19 |
| | **Total** | **375** | **375** | **750** | **798** | **403** | **1201** |

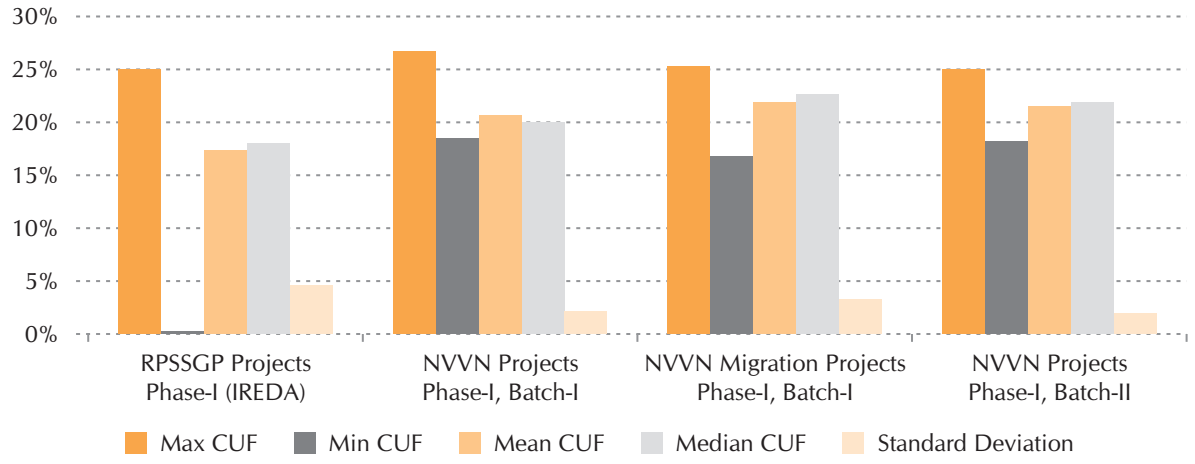
*Source: Resolve*

**The time frame for JNNSM Phase-II Batch I, is as follows:**

| Sr. No. | Event | Date |
|---|---|---|
| 1. | Approval of RfS document by SECI Board | Zero date |
| 2. | Issue of RfS document (Sale of Documents) | Zero date + 7 days |
| 3. | Submission of bids (Techno-Commercial & Financial) and Opening of Techno-Commercial bids | Within 60 days from Issue of RfS |
| 4. | Evaluation of Techno-Commercial bids and short-listing of bidders | Within 60 days from submission of bids |
| 5. | Opening of financial bids | Within 7 days from shortlisting of bidders |
| 6. | Issue of Letter of Intent (LoIs) | Over a period of 15 days after opening of financial bids |
| 7. | PPA signing | Within 30 days from the date of issue of Letter of Intent |
| 8. | Financing arrangement | Within 210 days from the date of signing of PPA |
| 9. | Commissioning of project | Within 13 months from the date of signing of PPA |

*Source: MNRE*

**Statistics of Net Exported Power – February 2015**




*Source: MNRE*

| | Max CUF | Min CUF | Mean CUF | Median CUF | Std. Dev |
|---|---|---|---|---|---|
| RPSSGP Projects Phase-I (IREDA) | 24.77% | 0.18% | 17.28% | 17.79% | 4.38% |
| NVVN Projects Phase-I, Batch-I | 26.50% | 18.15% | 20.36% | 19.87% | 2.04% |
| NVVN Migration Projects Phase-I, Batch-I | 25.02% | 16.58% | 21.71% | 22.53% | 3.00% |
| NVVN Projects Phase-I, Batch-II | 24.82% | 17.92% | 21.35% | 21.69% | 1.81% |

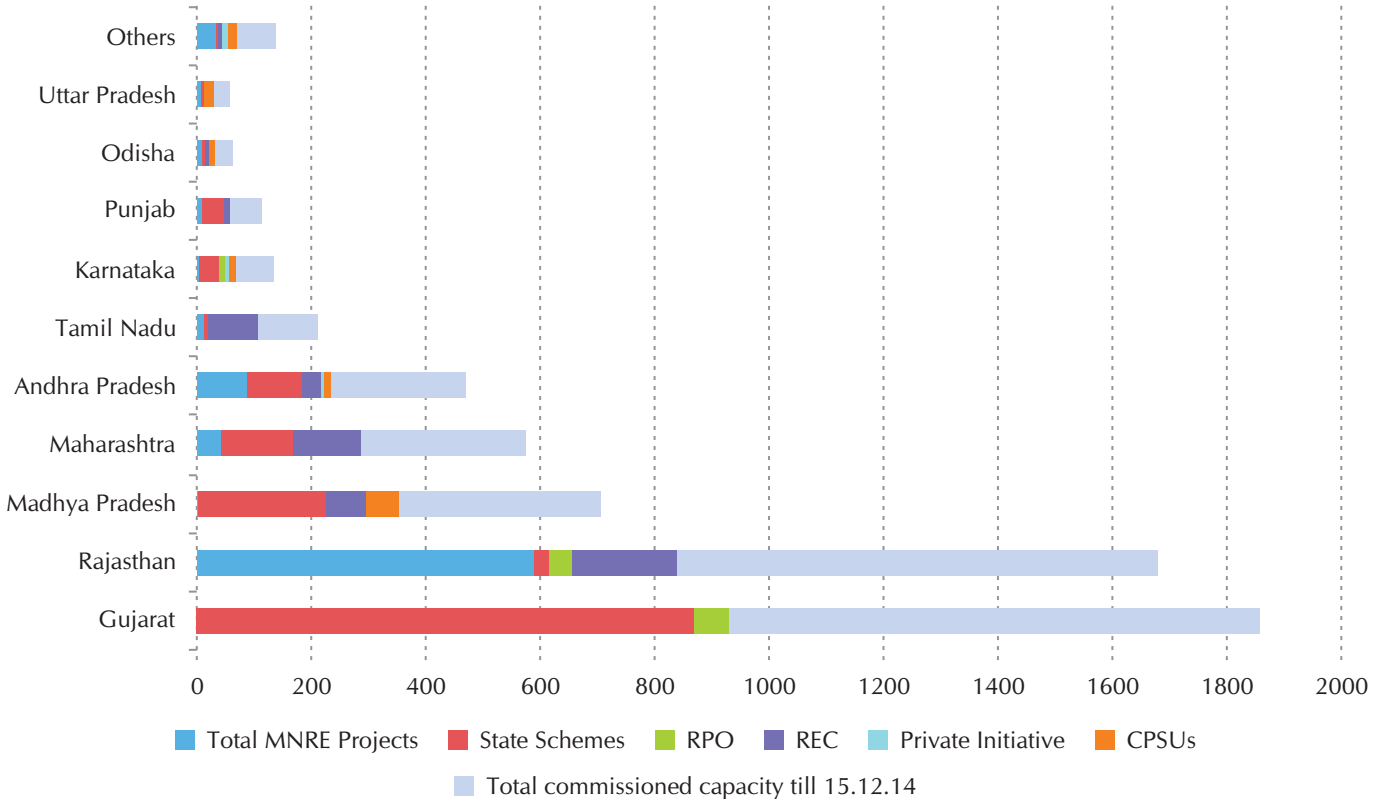
## 2.6. State Policies for the Solar Energy Sector

In addition to the National Solar Policy, various States have also announced State Level Policies, aimed at encouraging investments in the particular states.

**States which have notified the State Solar Policies**

| | |
|---|---|
| Andhra Pradesh Solar Power Policy, 2015 | Notified on 12.02.2015 |
| Chhattisgarh State Solar Energy Policy, 2012-17 | Notified in 2012 |
| Gujarat Solar Power Policy, 2009 | Notified on 6th January, 2009 |
| Haryana Solar Power Policy, 2014 | Notified on 4th September, 2014 |
| Jharkhand Solar Policy, 2013 | Draft Jharkhand Solar Policy, 2013 notified in 2013 |
| J&K Solar Power Policy | Notified on 18.03.2013 |
| i) Karnataka Solar Policy, 2011-16 | i) Notified on 01.07.2011 |
| ii) Karnataka Solar Policy, 2014-21 | ii) Notified on 22.05.2014 |
| Kerala Solar Energy Policy, 2013 | Notified on 25.11.2013 |
| Madhya Pradesh Solar Power Policy, 2012 | Notified in 2012 |
| Odisha Solar Policy, 2013 | Draft Solar Policy,2013 notified in 2013 |
| Rajasthan Solar Energy Policy, 2014 | Effective from October 8, 2014 |
| Tamil Nadu Solar Energy Policy, 2012 | Notified in 2012 |
| Uttarakhand Solar Energy Policy, 2013 | Notified on 27.06.2013 |
| Uttar Pradesh Solar Power Policy, 2013 | Notified in 2013 |

**State Wise Installed Capacity of Solar Projects under Various Schemes**




*Source: MNRE*

## 2.6.1. Comparison of Solar Energy Policies for Different States

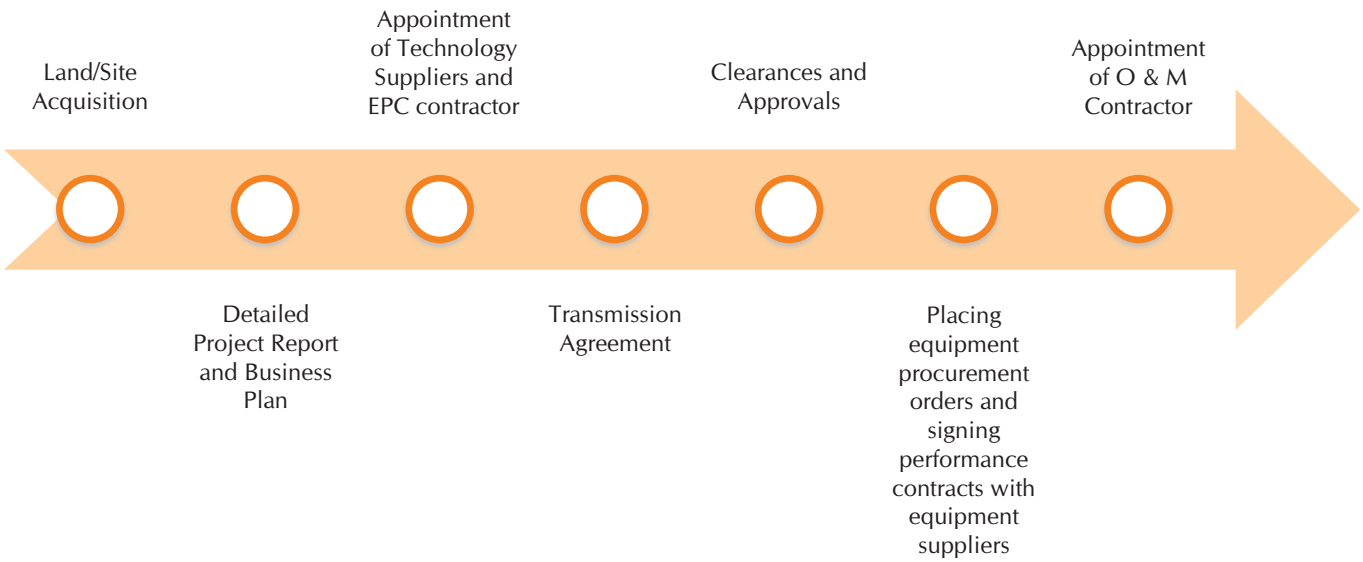
(As per the Latest Available Information)

| State (Issuing Authorities) | Solar Rooftop Target | Metering Mechanism | Capping of System Capacity/ generation | Eligibility | Incentives | Remarks |
|---|---|---|---|---|---|---|
| Karnataka (Govt. of Karnataka & KERC) | 400 MW by 2018 | Net metering (excess electricity to be billed as per solar tariff) | Not mentioned | All consumers | Wheeling, Banking and cross subsidy surcharge exempted for 10 years | |
| West Bengal (Govt. of West Bengal & WBERC) | 34 MW by 2018 | Net metering | Injection not more than 90% of the consumption from the licensee's supply in a year | All consumers | Wheeling, Banking and cross subsidy surcharge as applicable | |
| Chhattisgarh (Govt. of Chhattisgarh & CSERC) | 500-1000 MW by March 2017 | Net metering (excess electricity to be billed @) 50% of the solar tariff) | Injection not more than 49% of the annual net generation | 50kWp to 1 MWp capacity | Wheeling, Banking and cross subsidy surcharge exempted. VAT exempted on equipment's/ materials. | |
| Tamil Nadu (Govt. of Tamil Nadu & TNERC)) | 350 MW by 2015 | Net metering | Capped commercially at 90% of the electricity consumption at the end of the settlement period. Excess energy generated beyond the 90% cap shall be treated as lapsed. | All consumers | For domestic consumers subsidy of ₹20, 000 per kW for 1 kWp system is provided. Wheeling, Banking and cross subsidy surcharge as applicable. Electricity tax is exempted. | Mandatory for all new Govt./ local body buildings. For existing buildings installation in a phased manner |
| Kerala (Govt. of Kerala & KERC) | Not specified | Net metering | Capacity shall be in conformity with the provisions relating to the connected load or contract demand permissible at each voltage level as specified in the Kerala Electricity Supply Code, 2014. | Not Specified | Wheeling, Banking, open access surcharge exempted. Exemption from electricity duty. | |
| Gujarat (Govt. of Gujarat & GERC) | 30 MW in 6 cities | Feed-in tariff | Not mentioned | All consumers | Exemption from wheeling, banking and cross subsidy surcharge. | |
| Delhi (DERC order) | Not specified | Net metering | Capacity will be above 1 kWp and as per sanctioned load. For above sanctioned load service line cum development charges to be paid. | All consumers | Exemption from wheeling, banking, cross subsidy and other charges for a period of 5 years | |
| Andhra Pradesh (Govt. of Andhra Pradesh & APERC) | Not specified | Net metering/ Gross Metering | Capped commercially at 100% of the electricity consumption in a billing month. | All 3 phase service consumers | State's 20% subsidy for system up to 3 kWp in domestic sector only. Exemption from wheeling, banking and cross subsidy surcharge. No charge for open access for third party sale. Electricity duty exemption, VAT refund. | |

| State (Issuing Authorities) | Solar Rooftop Target | Metering Mechanism | Capping of System Capacity/ generation | Eligibility | Incentives | Remarks |
|---|---|---|---|---|---|---|
| Haryana (Govt. of Haryana) | 50 MW till 2017 | Net metering | Not specified | All consumers | 10% state subsidy in addition to 30% MNRE subsidy, exemption from external development charges, scrutiny fee and infra-structure deve-lopment charges, no application and processing fee | HERC order under issue Mandatory 5% for connected load upto 1000 kWp for all consumers including residential houses on a plot size of 500 sq. yard and above |
| Rajasthan (Govt. of Rajasthan) | Not specified | Net metering | Not specified | All consumer(s) of the DISCOMs | Incentives available to industrial units under Rajasthan Investment Promotional Scheme available to industrial solar power projects, Banking will be allowed | RERC regulatory orders yet to be issued. |
| Uttarakhand (Govt. of Uttarakhand & UERC) | 5 MW per year (2013- 2015) | Net metering | Not specified | All consumers | No transmission and wheeling charges | |
| Uttar Pradesh (Govt. of Uttar Pradesh) | 20 MW (by 2016- 17) | Net metering | Not specified | All consumers | State funds for technical assessment and deployment of rooftop SPV on government owned/Public Institutions | At least 25% of available plinth area to be utilized for rooftop. UPERC regulatory orders yet to be issued. |
| Punjab (Govt. of Punjab) | Not specified | Net metering | Maximum capacity upto 80% of the sanctioned/ connected load with minimum capacity of 1kWp. | All consumers | Exemption from wheeling, banking and cross subsidy surcharge. No charge for open access for third party sale. | PERC Regulatory order yet to be issued. |
| Odisha | 15 MW (by 2017) 20 MW (by 2018) | Net metering | Banking of Energy through a captive solar power plant shall be allowed on annual basis. Unutilized energy during the year may be paid as per rates to be negotiated between GRIDCO/ DISCOM and the developer. Banking charges are applicable. | All consumers | Solar power units shall be deemed status of new industrial unit and exempted from electricity duty. Various fiscal and financial incentives under MNRE policy guidelines will be extended to solar cities on priority basis. | |

*Source: Natural Group*

## 2.7. Steps to set-up a solar plant in India




**1. Land/site acquisition** - Includes two sub-steps procuring a land lease agreement and conversion of land to industrial land, if and when necessary.

**2. DPR and Detailed Business Plan** - A detailed project report and business plan covering the site, technology, cost estimates planning for debt, cash flows, risks and returns is prepared at this stage. The DPR would include information regarding the potential equipment providers or vendors and must also exhibit the credibility of vendors shortlisted for final selection.

**3. Appointment of technology suppliers and main Engineering, Procurement, Construction (EPC) contractor** - The project developer needs to sign a technology supply agreement with a technology supplier after establishing the viability of the proposed project. The developer also needs to establish whether the supplier meets all the criteria set out in the RfS. The developer shall appoint either a single or multiple EPC contractors or a consortium of EPC contractors. The EPC contractor(s) / consortium shall undertake detailed component design with inputs from the technology supplier and the developer. The project developer shall also enter into a detailed EPC agreement with the EPC contractor(s) / consortium where the agreement shall spell out key deliverables like project completion timelines, performance guarantees (for specific components / systems) and the specifications of the equipment to be used during the project construction.

**4. Transmission agreement** - The project developer will need to sign a transmission agreement with the States' respective STU.

**5. Clearances & approvals** - Approval or clearances will need to be obtained during project construction from various departments. State Nodal Agency may in some of the States act as facilitator for getting these clearances. Major clearances which need to be obtained are:

- Consent to Establish and Consent to Operate from State Pollution Control Board
- Import/License in case of import of plant and machinery
- No objection certificate from Civil Aviation Department
- No objection certificate from District Collector for setting up the project
- No objection certificate from the Panchayat under which the project area is located
- Approval for water requirement in case of solar thermal projects
- Permission for laying power evacuation lines from Chief Electrical Inspector
- No Objection Certificate from energy department
- Permission for 'Implementation of Metering Code', 'Protection System' to be obtained from host Distribution Utility or the STU or the Central Transmission Utility as the case may be.

**6. Placing equipment procurement orders and signing performance contracts with equipment suppliers** - The project developer will need to place orders for the equipment and enter into performance guarantee agreements with the technology/ equipment suppliers and EPC contractor. The project developer will need to see the lead time for equipment procurement and delivery, while also provisioning time for obtaining customs and import duty exemptions.

**7. Appointment of Operation and Maintenance (O&M) contractor** - The project developer shall appoint a private O&M contractor and enter into an O&M contract. This shall specify details regarding project uptime, personnel required, spare acquisition etc. for project operation and management.

**Some of the consultants to solar projects in India are:**

- Development Consultants
- Surya Enertech
- Headway Solar
- Urvish Dave Renewable Energy Solutions & Consulting
- Rays Experts
- World Institute of Sustainable Energy

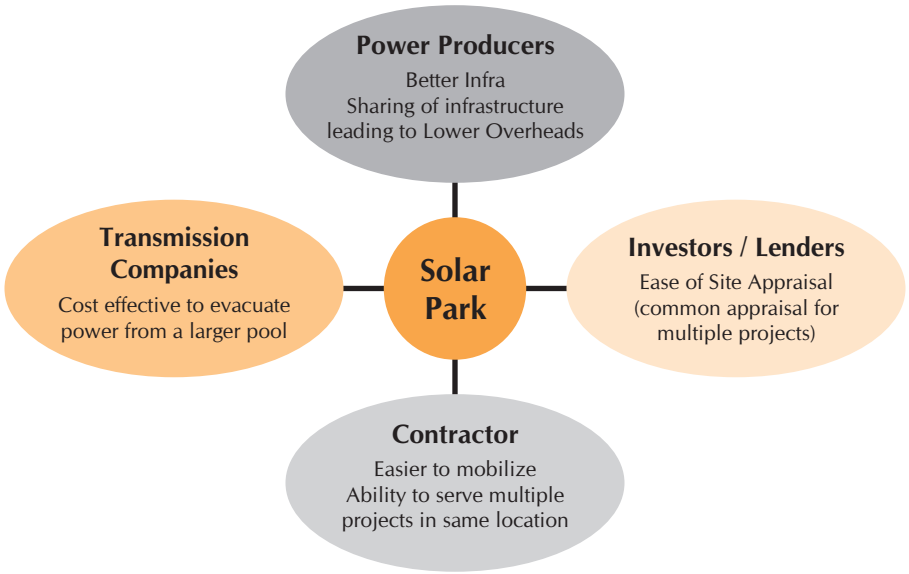
# 3. Solar Parks
## – New Initiative for Operational Excellence

Ministry of New and Renewable Energy (MNRE) plans to set up number of solar parks across various states in the country, each with a capacity of Solar Projects generally above 500 MW. Under the scheme, the Government will provide financial support to establish solar parks with an aim to facilitate creation of infrastructure necessary for setting up new solar power projects in terms of allocation of land, transmission and evacuation lines, access roads, availability of water and others, in a focused manner. SECI would be the implementation agency for the scheme on behalf of the Government. Each State shall designate a nodal agency for implementation of the solar park.

The Solar Park is a concentrated zone of development of solar power generation projects. As part of Solar park development, land required for development of Solar Power Projects with cumulative capacity of 500 MW and above will be identified and acquired and various infrastructure like transmission system, water, road connectivity and communication network etc. will be developed. The parks will be characterized by well developed proper infrastructure where the risk & gestation period of the projects will be minimized. At the State level, the solar park will enable the States to bring in significant investment from project developers in Solar Power sector, to meet its Solar Purchase Obligation (SPO) mandates and provide employment opportunities to local population. The State will also be able to reduce its carbon footprint by avoiding emissions equivalent to the solar park's generated capacity.

### 3.1. What makes Solar Parks an attractive proposition

- Utilization of large available wastelands
- Better network optimization, better grid integration and reduced transmission losses
- Huge potential for savings in terms of basic infrastructure facilities like land, water, construction power, roads, power evacuation system
- The removal of regulatory hurdles allowing for accelerated deployment
- A 20% reduction in CAPEX from building within a Solar Park can lead to almost 18% reduction in tariff



### 3.2 Estimated Cost for Developing a 1000 MW Solar Park

| Particulars | Cost (₹ in Cr.) | | % of the Project Cost |
|---|---|---|---|
| Land | | - | 0.00% |
| Site Development | | 87.75 | 12.50% |
| - Roads (40 km 30m wide @ ₹1.2 Cr./km) | 36.00 | | |
| - Roads (30 km 15m wide @ ₹0.95 Cr/km) | 19.00 | | |
| - Land levelling/grading etc. (5 million cu.m. @ ₹35/ cu.m) | 22.75 | | |
| - Water Supply System | 10.00 | | |
| Power Infrastructure within Solar Park | | 230.00 | 32.80% |
| - 33 kV substation (4*300 MVA @ 33/Cr/S/s plus 80 km cabling between projects) | 200.00 | | |
| - Power Infrastructure - 220 kV | 30.00 | | |
| Building and Establishment | | 10.00 | 1.40% |
| **Sub Total-A** | | **327.75** | |
| Power Infrastructure from Solar Parks to CTU (400/220 kV s/s) | | 320.00 | 45.70% |
| Preliminary Exp. @ 3% of Sub Total-A | | 9.83 | 1.40% |
| IEDC and Contingency @ 3% of Sub Total-A | | 9.83 | 1.40% |
| IDC @ 10% of Sub Total-A | | 32.78 | 4.70% |
| **Project Cost Total** | | **700.00** | **100%** |

### 3.3 Timeline for Implementation of the Projects

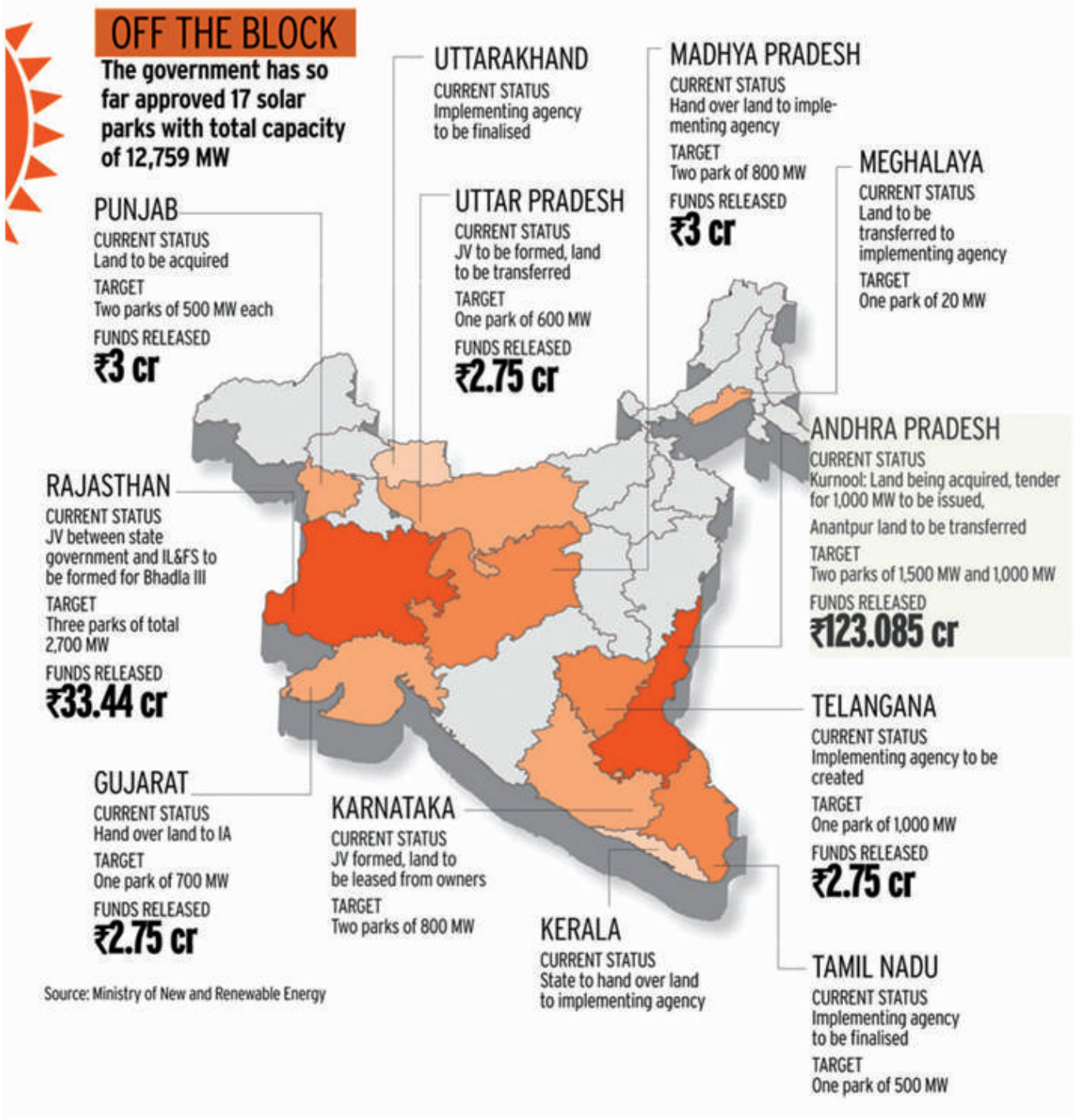
| Sl. No. | Milestone | Timelines |
|---|---|---|
| 1. | Date of issue of administrative approval | Zero Date |
| 2. | Land acquisition and Financial Closure | 6 months from zero date |
| 3. | Construction of Pooling Substation, Land Development and other Common facilities as per DPR | 15 months from zero date |
| 4. | Transmission line and Grid Connectivity | 18 months from zero date |
| 5. | Receipt of final instalment on completion | 18 months from zero date |

### 3.4 Financial Support under the Solar Park Development Scheme

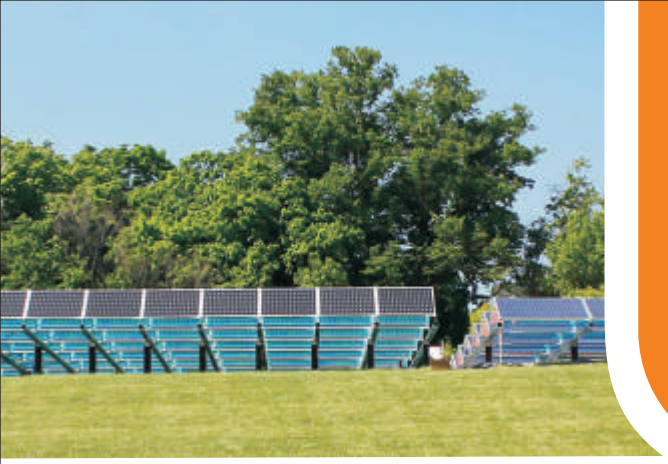
- Grant upto ₹25 lakhs for preparing DPR, conducting surveys etc.
- Grant at the rate of up to ₹20 lakhs/MW or 30% of the project cost including Grid-connectivity cost, whichever is lower, which will be released as per the following timelines:

| Milestone | % of subsidy disbursed |
|---|---|
| Date of issue of administrative approval | 5 |
| Land acquisition (50% land acquired) | 20 |
| Transmission plan finalization (internal and external) | 10 |
| 75% of Land acquisition and start of work on transmission | 20 |
| Remaining to be disbursed based on progress and requirements of funds | 35 |
| Final Instalment | 10 |

### 3.5 Current Status of Solar Parks in India



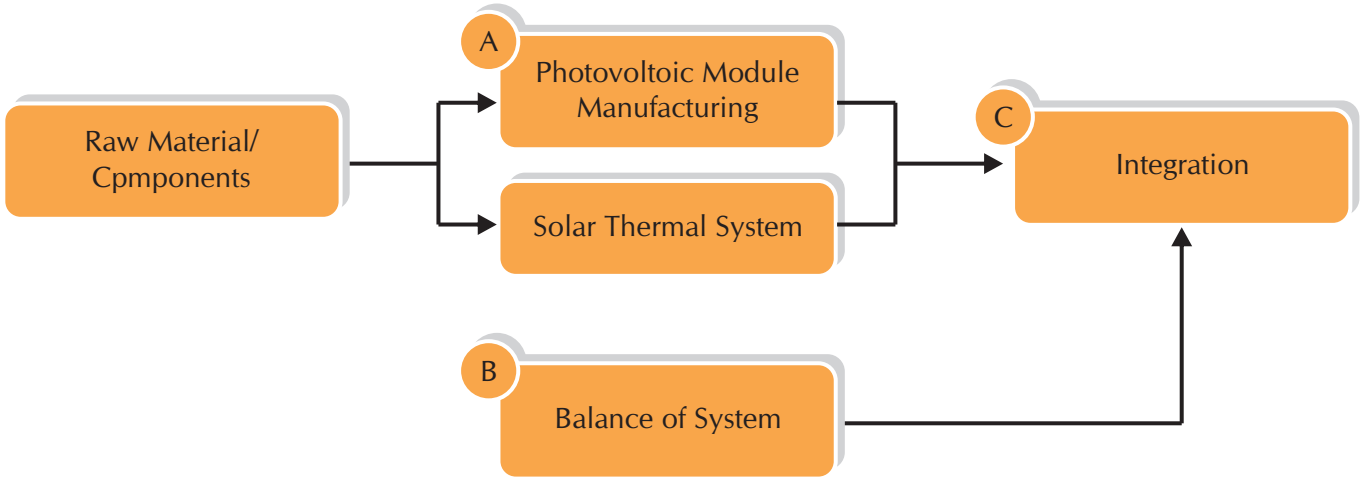

*Source: MNRE*



# 4. The Solar Supply Chain in India

The main elements of the solar energy supply chain framework comprise raw material/ component suppliers to solar photovoltaic module and solar thermal system manufacturing, balance of system which includes inverters, connecting wires, trackers etc. and the integration of the different components. Integration of various components with proper specifications and compatibility is extremely important as even the slightest variations could result in losses or failure in the final output.

**Framework of Solar Energy Supply Chain**




*Source: FICCI*

Manufacturers of solar energy in India, currently, mainly comprise PV Cell and module manufactures with 1100 MW of cells and 1800 MW of solar modules with very limited and disparate fabrication and assembly capacities for solar thermal products and accessories. Moreover, to a large extent, the industry has been dependent on imports of critical raw materials such as EVA, back-sheet, reflective glass, balance of system (BOS) for Solar Thermal and PV as also core machinery. As far as the PV industry is concerned, till recently, it remained a major exporter of its finished products to developed western markets. There is clearly tremendous scope for development of domestic production base for some of the key inputs to secure and strengthen the supply chain to reduce the foreign exchange outflow and create direct and indirect long term employment in the solar industry.

The following figure shows the solar industry supply chain in India in detail and the estimate of the potential demand for the PV supply chain as estimated by the Federation of the Indian Chamber of Commerce and Industry on a study of the supply chain in the solar industry, taking into account the sudden interest of the foreign investors in the Indian solar market given the large incentives under the JNNSM scheme by the Government of India and assuming a growth rate of 30-40 percent in the industry based on the targets set by the Government and its solar mission:

## India : Solar Industry Supply Chain

| Supply Chain | Solar Photovoltaic Sector (Without Storage) | Solar Thermal Sector |
|---|---|---|
| Primary Components (Developer View) | • PV Modules<br>• Thin Film<br>• Inverters<br>• Tractors | • Reflectors<br>• Receiver Tubes<br>• Vacuum Tubes<br>• Solar Turbines |
| Manufacturing Value Chain (Manufacture View) | • PV Cells<br>• Silicon Wafers<br>• Silicon Ingots<br>• Poly Silicon | • Reflector Coatings<br>• Absorber Coatings |
| Supply Chain Eco system | • Low Iron Glass<br>• Junction Box<br>• Aluminium Frames<br>• EVA<br>• Back sheet<br>• Silver Paste<br>• Cutting Wires<br>• Graphite Parts<br>• Crucibles<br>• Silicon Carbide<br>• MG Silicon<br>• Monosilane gas | • Reflector Stands<br>• Solar MirrorSteam Drum<br>• Receive<br>• Level Controller<br>• Level Switch<br>• Pressure Gauge<br>• Pressure Switch<br>• Valves<br>• Piping<br>• Pumps<br>• Tracking System<br>• PLC |
| Infrastructure eco system for solar manufacturing | • Quality power<br>• Low cost power<br>• Solar manufacturing parks | • Solar manufacturing parks<br>• Policy support for importing required capital equipment |

*Source: FICCI*

## Existing and Project Requirement of Equipment for Solar Farms and Off-Grid Solar Systems, 2012

| Supply Chain | Existing Capacities in India (CY 2012) | Quantities to meet total domestic requirement at the end of 3-4 years | Quantities to meet total domestic requirement at the end of 5-10 years |
|---|---|---|---|
| PV Modules | 1,800 MW / Year | 2,500-3,500 MW/year | 3,500-6,000 MW/year |
| Solar Inverters | < 100 MW/year | 2,500-3,500 MW/year | 3,500-10,000 MW/year |
| Trackers<br>- Single Axis (PV)<br>- 2 Axis for Thermal | <br>NIL<br>NIL | 2.5-3.5 Million<br>50%<br>50% | 25 Million<br>50%<br>50% |
| Solar Batteries (For Off Grid Applications) | Capacity meets the demand, however, cost and maintenance is an issue | 300-1000 MW | > 3000-5000 MW |
| Reflector Glass | NIL | 11 million square meters in next 5 years | 53 million square meters in next 10 years |
| Receiver Tubes | NIL | 0.9 million meters in next 5 years | 4.4 million meters in next 10 years |
| Solar Turbines | NIL | 30 numbers of 50 MW each in next 5 years | 150 number of 50 MW each in next ten years |
| Vacuum Tubes | NIL | To be estimated | To be estimated |

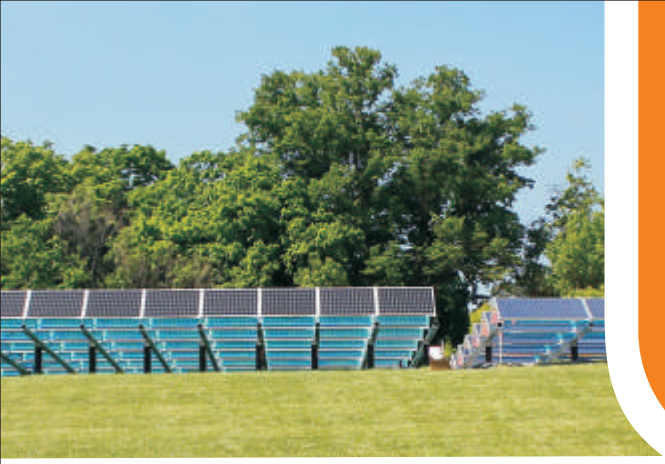
*Source: FICCI*

**Based on earlier assumption of Solar target of 20,000 MW by 2022 which has subsequently been revised to 100 GW as of June 2015.*

## Demand in Solar PV Value Chain, 2010-2022

| | Unit | 2010-2011 | 2011-2012 | 2012-2013 | 2013-2014 | 2014-2015 | 2015-2016 | 2016-2017 | 2017-2018 | 2018-2019 | 2019-2020 | 2020-2021 | 2021-2022 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **NSM PV Demand** | | 140 | 350 | 10 | 650 | 750 | 800 | 600 | 1,000 | 1,500 | 1,500 | 2,000 | 2,000 |
| **State PV Demand** | | 320 | 366 | 770 | 2,500 | 1,500 | 2,000 | 1,500 | 2,000 | 2,500 | 2,500 | 3,000 | 3,000 |
| **Comment** | | Gujarat 300 MW; 20 MW Rajasthan/ misc | Gujarat 250 MW; Rajasthan 40 MW; Karnataka 10 MW; 50 MW misc | Gujarat 300 MW; Karnataka 70 MW; Misc 400 MW (MP/ TN/Orissa/ UP/others) | TN 490 MW; AP 1000 MW; Raj 100 MW; Pun 300 MW; UP 200 M; Bihar 150 MW; MP/Karnataka/ Orissa/ Misc 300 MW | NSM demand estimate basis: October declaration stating that PV share of NSM II goals can go up at the expense of solar thermal/ State solar demand assumed constant at NSM II goals - however, indications are that this may also go up given the strong growth in future. Given that the Rajasthan State solar thermal response is nil- current outlook has been that the market for states will shift totally to PV. | | | Estimated Figures for 2017-22 are a likely scenario bringing the total solar installed base by 2022 to an installed capacity of 28GW solar PV and upto 7GW Solar thermal; This period will also see the off-grid solar applications take off and move to mainstream markets as the projected solar efficiencies rise, cost/watt drives down grid parity and early adapter success fuels the early majority of the mainstream market-essentially, this is likely the last major intervention by the government in catalyzing the solar market as the tipping point should be reached in this quarter. | | | |
| **Total PV installation (On & Off-grid) -1yr shift** | MW/yr | 460 | 716 | 780 | 3,250 | 2,150 | 2,800 | 2,100 | 3,000 | 4,000 | 4,000 | 5,000 | 5,000 |
| **Total PV installation (On & Off-grid) -1yr shift** | MW/yr | 25 | 435 | 716 | 780 | 3,250 | 2,150 | 2,800 | 2,100 | 3,000 | 4,000 | 4,000 | 5,000 |
| **c-Si Market Share** | | 60% | 35% | 56% | 60% | 65% | 65% | 65% | 66% | 65% | 65% | 65% | 65% |
| **Module** | MW/yr | 16 | 160 | 413 | 491 | 2,218 | 1,467 | 1,911 | 1,433 | 2,048 | 2,730 | 2,730 | 3,413 |
| **Cell Demand** | MW/yr | 17 | 168 | 434 | 516 | 2,329 | 1,541 | 2,007 | 1,505 | 2,150 | 2,867 | 2,867 | 3,583 |
| **Water** | MW/yr | 17 | 176 | 456 | 542 | 2,445 | 1,618 | 2,107 | 1,580 | 2,257 | 3,010 | 3,010 | 3,762 |
| **Ingots** | MT/yr | 122 | 1,234 | 3,191 | 3,792 | 14,673 | 9,707 | 12,641 | 9,481 | 12,416 | 16,554 | 16,554 | 20,693 |
| **Polysillicon** | MT/yr | 143 | 1,451 | 3,754 | 4,462 | 17,262 | 11,420 | 14,872 | 11,154 | 14,607 | 19,475 | 19,475 | 24,344 |
| **(Assumption: Aberration in batch 2 guidelines corrected by phase 2 NSM; 7 gm Poly-si/watt till 2015 & 5.5 gm Poly-si/wtt post 2018)** | | | | | | | | | | | | | |
| **TF mid share** | MW/yr | 9 | 275 | 303 | 289 | 1,032 | 683 | 889 | 667 | 953 | 1,270 | 1,270 | 1,588 |

*Source: FICCI; FICCI Assumptions for demand forecast: Assume Water availability will constrain solar thermal plant growth, PV shares factored in total Solar above. State demand factored as a best case estimate as long run forecast not available unlike NSM. However, expect solar expansion across all states over a period of time giving rise to a sustained demand at the state level, fuelled further by technology/ commercial breakthroughs to grid parity. (For supply-chain, we have assumed that the installation inputs are 1 year staggered before the end user demand as timelines are scheduled for completion in Q1, calendar year). *Based on earlier assumption of Solar target of 20,000 MW by 2022 which has subsequently been revised to 100 GW as of June 2015.*



# 5. SWOT Analysis
## of the Solar Energy Sector in India

**Strengths:**

1. High growth industry with significant future potential.
2. Sunlight is available in sufficient quantity in many regions.
3. Proven technology with low operation & maintenance cost, which is also scalable.
4. Availability of Government Incentives for growth and expansion.

**Weakness:**

1. Owing to high capital costs, the business needs external incentives to be economically feasible, thus increasing dependence on Governmental policies.
2. The capital intensive nature of the business might favour larger businesses over smaller ones.
3. The distributed and intermittent nature of solar energy makes it difficult for utilities to rely on Solar PV for their base load.

**SWOT ANALYSIS**

**Opportunities:**

1. Government's ambitious target and attractive policies open up many avenues for investment.
2. Opportunities exist all along the solar PV business value chain, not just for power plants.
3. Entirely new opportunities could open up as there is high innovation in technology, especially with reduction in costs in future.

**Threats:**

1. The large scale up of capacity could face distribution and evacuation challenges due to inability to scale up transmission on a similar scale.
2. Off-peak season reduces cash flow.
3. Industry is new, so finding skilled workforce could be a problem.
4. Solar panels work only at 22 percent efficiency, therefore achieving solar targets could be difficult despite scaling up due to the 'spike and ebb effect '(of day and night).

# 6. Companies Operating in the Sector – A Glance

**Major solar power companies in India are:**

- Tata Power
- Indosolar
- Orient Green Power
- NTPC
- Moser Bear
- Bharat Solar Energy
- Lanco
- Reliance Power
- Topsun Energy
- Azure Power
- Welspun Energy
- Waaree Energies

**Major solar power companies in the world are:**

- GCL-Poly Energy Holdings
- First Solar
- SMA Solar Technology AG
- GT Advanced Technologies
- SZ Topray Solar
- Motech Industries
- Conergy
- SunPower Corp.
- LDK Solar Co.
- Yingli Green Energy Holding ADS

# 7. Outlook

Electricity consumption in India has been increasing at one of the fastest rates in the world due to population growth and economic development. India's economy faces increasing challenges because energy supply is struggling to keep pace with demand and there is energy shortage almost everywhere in the country. This is compounded by the fact that the power sector continues its struggle to meet power generation goals as conventional sources, especially coal, has not been able to keep up with the country's ever-increasing demand. Such chronic lack of energy and unreliable supplies threaten India's economic growth. As a result, interest has shifted towards renewable sources of energy.

Solar energy is the prime free source of inexhaustible energy available to mankind and the geographical position of India makes it a sunlight rich country, blessed with about 5,000 TWh of solar insolation every year. Even if a tenth of this potential can be utilised, it could mark the end of India's power problems by judiciously using the country's deserts and farmland to construct solar plants. At the same time, renewable energy also has the potential to re-energise India's economy by creating millions of new jobs, allowing the country to achieve energy independence, reduce its trade deficits and propel it forward as a "Green Nation."

Solar energy has the potential to reduce the current energy peak deficit significantly and improve delivery due to its distributed nature, provided, it gets the appropriate financial support from the Centre as well as the States. Over the next few years, solar power will gain significant importance in India's energy mix owing to, both financial viability and availability perspectives along with proper channelization of the energy produced. It can thus be said that the sun will continue to power the economic and energy growth in the current millennium.

As stated earlier in this report, Madhya Pradesh has emerged as the preferred State for new solar investments, overtaking earlier favorites Gujarat and Rajasthan. With close to 347 MW of solar capacity installed, MP is now ranked third after Gujarat and Rajasthan in cumulative terms.

India is slowly gaining prominence in the generation of solar power due to the comprehensive and ambitious solar policies and projects being undertaken by the Centre and states. Further, the National Solar Mission is also a positive step in the endeavor towards a solar energy driven nation. In the latest budget, the Government has proposed an amount of Rs.500 crore to develop some mega solar power plants in Gujarat, Rajasthan, Andhra Pradesh, Tamil Nadu and Ladakh. Solar power-driven agricultural water pumping stations and 1 MW solar parks on canal banks will also be developed in the country at an estimated cost of approximately Rs. 444 crore and Rs. 111 crore, respectively.

In a further boost to the Green Energy Power Sector major commitments, 271 GW in terms of capacity, were received from various international and domestic companies in addition to the PSUs and the Railways. Availability of finance for the Green Energy sector which is normally perceived to be a big hindrance to the sector, has also been addressed by various Banks and FIs, with commitment to Green Energy flagged at Rs. 3,52,640 Crore for installation of about 71 GW of capacity during the conference. It is expected that a substantial portion of these Green Energy commitments will be channelised towards the Solar Power Sector. Considering all these facts, the plans, the commitments and hopes for a smooth execution of these plans, we expect India to be a leading solar power driven country in the world sooner rather than later.

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