LSI Financial Services Pvt. Ltd.
Creating value, partners in growth

INDIA SOLAR ENERGY LANDSCAPE 2018-2022

ARE SUNNY DAYS AHEAD IN THE RENEWABLE ENERGY SECTOR?

Our Profile

Incorporated in 1997, LSI Financial Services Private Ltd (LSI) is a leading provider of innovative financial solutions in India and abroad.

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. It is also providing Project Advisory services including preparation of Detail Project Reports (DPR) and Techno Economic Feasibility/Viability Reports (TEFR/TEVR) on behalf of Banks, Public and Private Sector Institutions and Companies.

Our services include:

- Debt Syndication
- Private Equity Advisory
- Issue Management
- Mergers and Acquisitions
- Financial Restructuring/Corporate Debt Restructuring
- Preparation of DPR/TEFR/TEVR
- Lender's Independent Engineers' (LIE) Services
- Due Diligence
- Valuation of Assets/Equity

Preface

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 Paris Climate Change accord, India has committed itself to building renewable energy projects with a combined capacity of 175 Gigawatt (GW) by 2022. Of this target, 100 GW will be solar and 60 GW wind. 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.

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. The top states for solar installations is Telengana, followed by Karnataka, Andhra Pradesh and Rajasthan.

Riding on 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.

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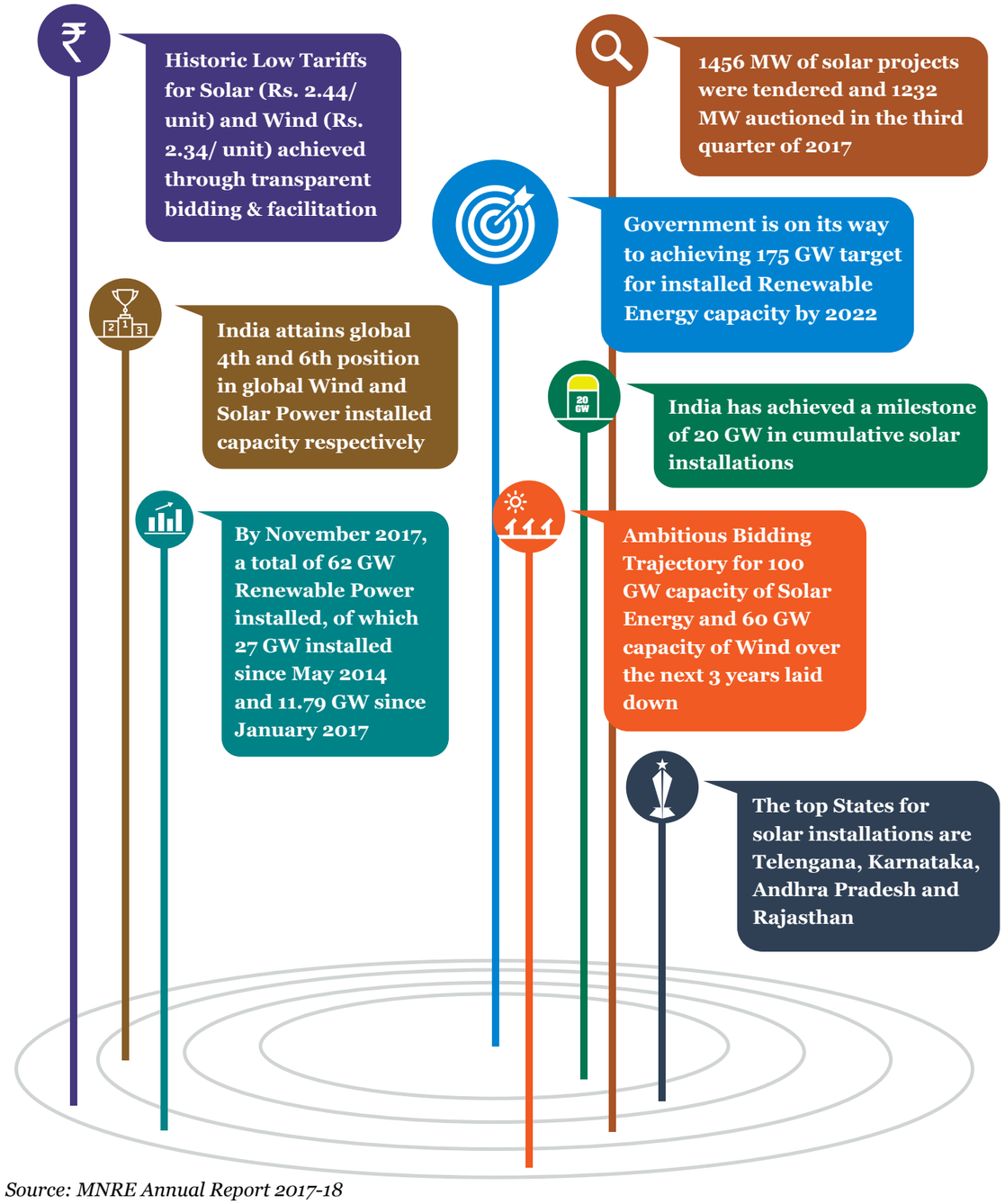


Source: MNRE Annual Report 2017-18

CHAPTER 1

Renewable Energy and its Contribution to Economic Development

Renewable energies are sources of clean, inexhaustible and increasingly competitive energy. They differ from fossil fuels principally in their diversity, abundance and potential for use and do not produce any greenhouse gases or polluting emissions. According to the International Renewable Energy Agency (IREA), doubling the renewable energy share in the world energy mix to 36% by 2030 will result in additional global growth of 1.1% by that year. It is expected that if the share of renewable energy in the world energy mix is met then it could provide employment to 24 million people by 2030 compared to only 9.2 million today.

Understanding the Linkage Between Economic Growth and Carbon Dioxide Emissions

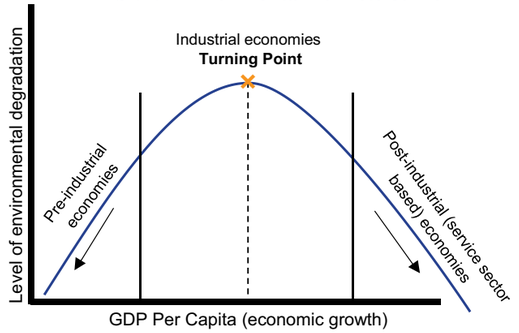
Carbon dioxide (CO_2) emissions increase energy usage and an increase in energy usage increases the economy's Gross Domestic Product (GDP). However, increased CO_2 emission also has a deaccelerating effect on a country's economic growth. Therefore, it is advisable that economies switch from fossil fuels to renewable energy for accelerated economic growth. Increasing the share of renewable energy in the economy's energy mix will not only fulfil the energy requirements of the country, but also drastically reduce environmental pollution. Furthermore, usage of renewable energy will make the country self-reliant by reducing its dependence on imports of fossil coals, specially coal.

It is important to understand the relationship between energy consumption, economic growth, and CO_2 emissions in emerging and developing economies so that their governments can clearly see and fully appreciate how much effort is required to change the energy consumption structure of the economies. The subsequent sections analyse this relationship in depth.

Introduction to the Environmental Kuznets Curve (EKC)

The relationship between environment and economic activities is very strong and the EKC is a helpful tool used to explore this relationship. The EKC suggests that economic development initially leads to a deterioration in the environment, but after a certain level of economic growth, a society begins to improve its relationship with the environment and the level of environmental degradation reduces. The curve has a shape of an inverted 'U' which is explained below.

Exhibit 1: Environmental Kuznets Curve



Source: LSI Research

The shape of the EKC suggests that environmental pressure increases faster than income at early stages of development and slows down relative to GDP growth at higher income levels.

The curve suggests that the world's poorest and richest countries have relatively clean environments, while middle-income countries are the most polluted.

The relationship between CO_2 emissions and GDP per capita for the economies of India and China have been analysed in the subsequent sections.

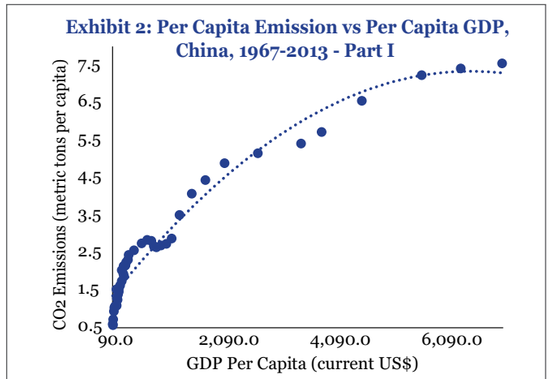
Empirical Analysis of EKC for The Economies of China and India for CO_2 Emissions

CHINA

The environment in China has suffered at the cost of financial and economic growth. Increased carbon emissions in China has been an inevitable by-product of its extraordinary economic growth. More pollution is generated as more factories are established, as more coal is burned to produce electricity, and as more private cars are produced, sold and used for commuting.

China's EKC

Exhibit 2: Per Capita Emission vs Per Capita GDP, China, 1967-2013 - Part I

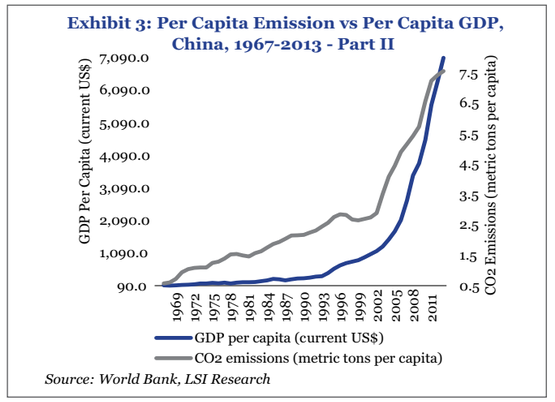


Source: World Bank, LSI Research

The Chinese economy peaked and reached the turning point between 2012-13. The curve for China conforms the prediction of EKC. The rate at which CO_2 emissions were increasing, started decreasing between 2012-13 China's decrease in carbon emissions between 2012-13 were in line with emission reductions globally. In 2012-13 the global carbon emissions slowed down to about 1% annually.

China has been trying to change its energy-dependent economic growth model. The growth in China's emissions are now stalling. The share of service sector in China's GDP has surpassed that of the highly energy-intensive industrial sector. In 2016, the industrial sector contributed 44% to China's GDP while the service sector contributed 46%.

Exhibit 3: Per Capita Emission vs Per Capita GDP, China, 1967-2013 - Part II



Source: World Bank, LSI Research

The growth in GDP and carbon emissions in China were accelerated between 2002 and 2007 as the manufacturing and thermal power growth drastically increased.

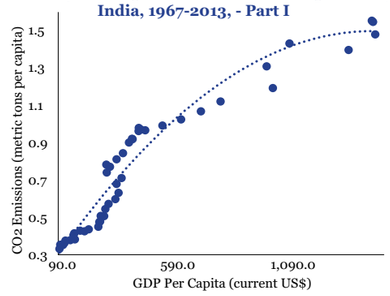
The slowdown in China's CO_2 emissions since 2012 reflect structural changes in China's economy towards a less energy-intensive service sector and a high value-adding manufacturing industry. China's manufacturing is now more energy efficient with a low carbon energy mix, focussing towards domestic consumption.

INDIA

India is experiencing ongoing growth of renewable energy and slowdown in the usage of coal. The country intends to produce 40% of its electricity in 2030 from 'non-fossil fuel based sources' like solar, wind or hydropower.

India's EKC

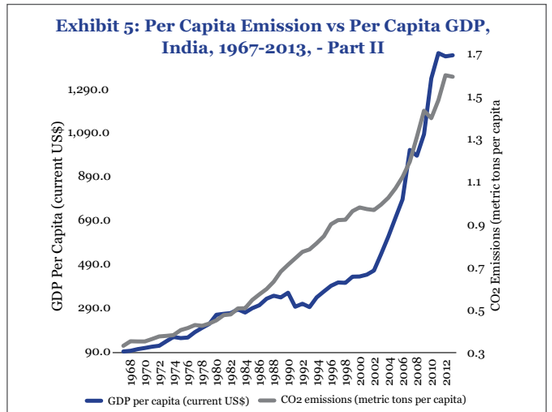
Exhibit 4: Per Capita Emission vs Per Capita GDP, India, 1967-2013, - Part I



Source: World Bank, LSI Research

The shape of EKC for India is similar to that of China's. India too has reached the turning point. For a developing country like India, GDP growth was enabled by electricity consumption that led to higher CO_2 emissions. The gradual shift from traditional production technologies to green improved ones had reduced the carbon intensity and CO_2 emissions in India. The analysis also suggests that growth of per capita income tends to reduce carbon emissions. At a broad level of development with higher per capita GDP, the rate of per capita emissions of CO_2 begins to decline.

Exhibit 5: Per Capita Emission vs Per Capita GDP, India, 1967-2013, - Part II



Source: World Bank, LSI Research

Until 2008, India's total fossil-fuel CO_2 emissions increased dramatically, with the fossil-fuel CO_2 emissions averaging 5.7% per year and becoming the world's third largest fossil-fuel CO_2 emitting country. There is a drop in CO_2 emissions for India between 2007-2010 as the intensity of CO_2 emissions by the Indian manufacturing sector dropped.

However, the growth in CO_2 emissions has always been on an upswing for India. Percentage growth in per capita CO_2 emission is however lower than the growth in GDP per capita for the recent years, suggesting that the country has experienced higher economic growth by substituting renewable energy for energy generated by burning fossil-fuels. India is gradually increasing the share of renewable energy in the total power capacity of the country.

India's Carbon-dioxide Emissions Policies

Under the Narendra Modi government, the timelines to achieve renewable capacity has been aggressively advanced, and the scale vastly enlarged. Following are some of the goals listed by India for the Global Climate Actions as INDCs (Intended Nationally Determined Contributions):

- To reduce the emissions intensity of its GDP by 33-35% by 2030 from the 2005 level.
- By 2030, 40% of the cumulative electric power installed capacity should be from non-fossil fuels. This with be achieved with the help better technology and low-cost international finance, including finance from Green Climate Fund.
- To create an additional carbon sink[1] of 2.5 to 3 billion tonnes of CO_2, equivalent through additional forest and green cover by 2030. National Mission for Green India with schemes like National Action Plan on Climate Change (NAPCC), Green Highways etc. would help here.
- To build capacities, create domestic framework and international architecture for quick diffusion of cutting-edge climate technology in India and for joint, collaborative R&D for such future technologies.
- Furthermore, in order to reduce its domestic carbon emissions, India has leapfrogged directly from Bharat Stage Emission Standards (BS) IV Norms to BS VI. The government has also planned to subsidise the renewable energy equipment especially solar PV panels.

This will incentivize the usage of such sources both for domestic and industrial use. India has also introduced an excise tax (the Clean Environment Cess) on coal production and imports, amounting to Rs. 400 per ton of coal in 2016. This coal cess is almost one-fifth the cost of mining coal, making India one of the most expensive places to produce coal-fired electricity. Also, India has a system of Renewable Purchase Obligations (RPOs)[2] on all electricity distribution companies and also captive producers.

Government Policies for The Renewable Energy Sector in India, 2016-2017

The Ministry of New and Renewable Energy (MNRE) is the nodal ministry of the Government of India for all matters relating to new and renewable energy. The broad aim of the Ministry is to develop and deploy new and renewable energy for supplementing the energy requirements of the country. The major policies framed by MNRE are:

- Increased budget allocation to MNRE to about $820 million (Rs. 5,473 crore)
- Increase of solar parks capacity by an additional 20GW
- 7,000 railway stations to be fed with solar power in the medium-term
- Cuts of import duty on solar, wind and biogas plant components
- 100% rural electrification to be achieved by May 2018

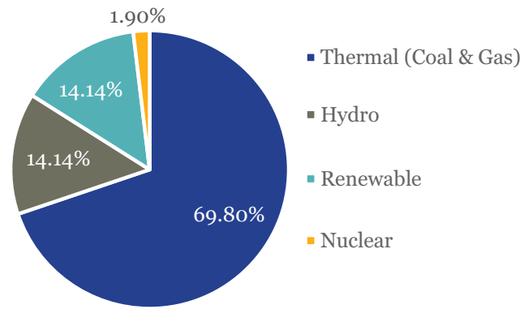
[1] A carbon sink is a natural or artificial reservoir that accumulates and stores some carbon-containing chemical compound for an indefinite period of time. Carbon sinks remove carbon dioxide (CO_2) from the atmosphere.

[2] Renewable Purchase Obligation (RPO) is the obligation of certain entities who have to meet a part of their electricity consumption using electricity from renewable sources. The companies may purchase Renewable Energy Certificates (RECs) in order to meet their RPO requirements. The companies do also have the option of producing renewable energy themselves in order to meet the target.

Large Renewable Energy Capacity	India's current renewable energy contribution stands at 44.812GW. It has the fourth largest installed capacity of wind power and the third largest installed capacity of concentrated solar power (CSP).
Renewable Energy in Power Mix	Renewable Energy contributes 17.5% of the total installed power capacity in the country as of April 2017.
Renewable Energy Target by 2022	India has set a target of 175GW of renewable power by 2022 which will include 100GW of solar power, 60GW from wind power, 10GW from biomass and 5GW from small hydropower.
Renewable Energy Attractiveness Index	India has ranked second in the Global Renewable Energy Attractiveness Index created and released by Ernst & Young (EY).
Favourable Policy Environment	100% FDI is allowed under the automatic route in the renewable energy segment.

Source: Make in India, Economic Times, EY Renewable Energy Country Attractiveness Index, India Brand Equity Foundation (IBEF)

Exhibit 6: Sources of Power with Shares in Total Installed Capacity, India, 2016



Source: IBEF, LSI Research

Exhibit 7: Fuel wise Total Installed Capacity of Power in India, 2016

Installed Capacity (GW)	
Thermal	213.22
Hydro	43.11
Nuclear	5.8
RES* (MNRE)	44.23

* Installed Capacity in respect of RES (MNRE)

RES (Renewable Energy Sources) include Small Hydro Project, Biomass Gasifier, Biomass Power, Urban and Industrial Waste Power, Solar and Wind Energy

Source: IBEF, LSI Research

India is increasing its investments in renewable energy power generation, this represents an important element in the country's goals to become energy self-sufficient. In fact, India aspires to become a global leader for renewable energy and has an ambitious plan to install 175GW of renewable energy by 2022, including 100GW of solar and 60GW from wind. This is to be done with the help of transfer of technology and low cost International Finance which includes Green Climate Fund. However, In India, over 95% of the investments made in installing renewable energy in the country is by the private sector. Therefore, India will need to attract a great deal more private investment in renewables generation to meet these targets.

Exhibit 8: Future Targets for Various Renewable Energy Sources (in MW), India

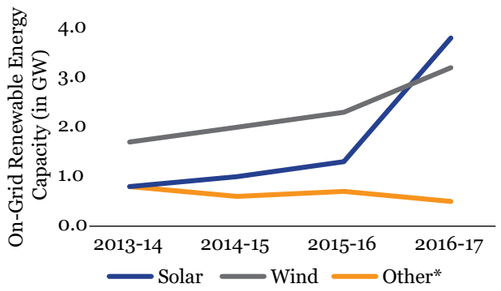
Source	2017-2018	2018-2019
Solar Power	15,000	16,000
Wind	4,600	5,200
Biomass	750	850
SHP*	100	100
Total	**20,450**	**22,150**

*Small hydel projects

Source: MNRE, LSI Research

India is setting up a Rs. 38,000 crore Green Energy Corridor to ensure evacuation of Renewable Energy

Exhibit 9: On-grid Renewable Energy Capacity (MW), India, 2013-2017

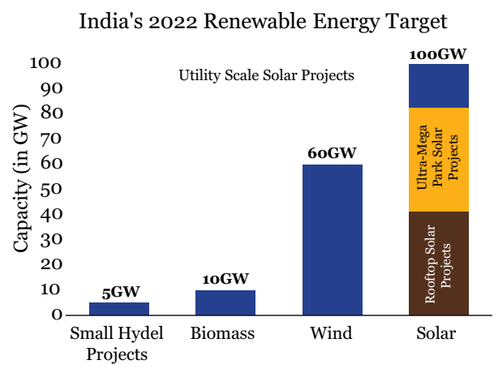


*Includes small hydro, biomass and waste to energy

Source: Bloomberg New Energy Finance, MNRE

In 2016-2017, renewable power projects output rose by approximately 26%, which makes India's renewable energy sector as the fastest growing in the world. India added 18.7GW renewable energy capacity in 4 years.

Exhibit 10: India's 2022 Renewable Energy Target



Source: MNRE, LSI Research

In order to achieve the 2022 targets, India will have to significantly step up the pace of renewable capacity additions, from an average of 11GW per year to at least 24GW per year.

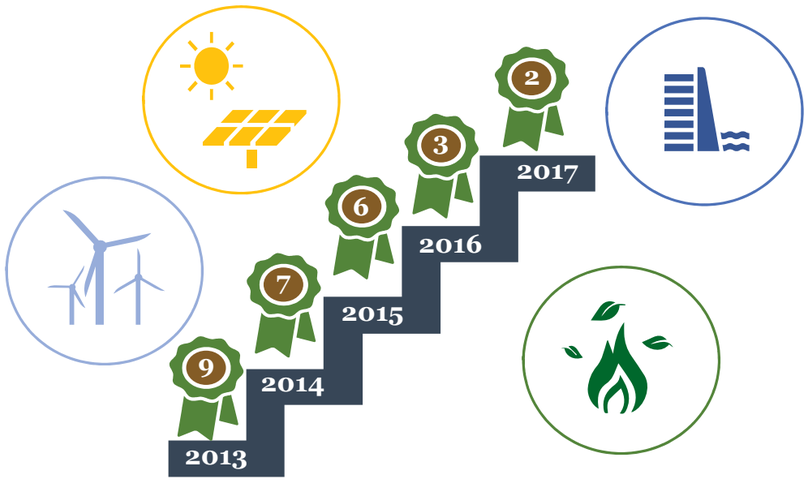
India had lagged in the renewable energy space for many decades. However, since 2014, the government has largely turned towards renewable energy to fix India's chronic power shortages and reduce dependence on coal.

In 2015, India even held its first conference on renewable energy investment, where private companies committed around $200 billion in investments into green energy. These included large investments into solar and wind power.

A combination of strong government support and increasingly attractive economics has helped to push India into second place in the Renewable energy country attractiveness index 2017 created by Ernst & Young (EY). In 2016, India was ranked third on the list behind US and China. In 2014, the country stood seventh on the list, while it was at 9th in 2013.

An increase of renewable energy consumption drives a growth of real gross domestic product and per capita annual income of economies. Renewable energy is emerging not only as a solution to meet growing energy demands while sharply reducing carbon emissions but also as a potential engine for economic growth and diversification.

India's Improving Rank in EY Renewable Energy Country Attractiveness Index



"An increase in Renewable Energy consumption drives a growth of Real Gross Domestic Product and Per Capita Income of economies."

Source: Ernst & Young Renewable Energy Country Attractiveness Index; LSI Research

CHAPTER 2

India's Solar Power Sector

Solar energy is the energy received from the sun that sustains life on earth. For 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.

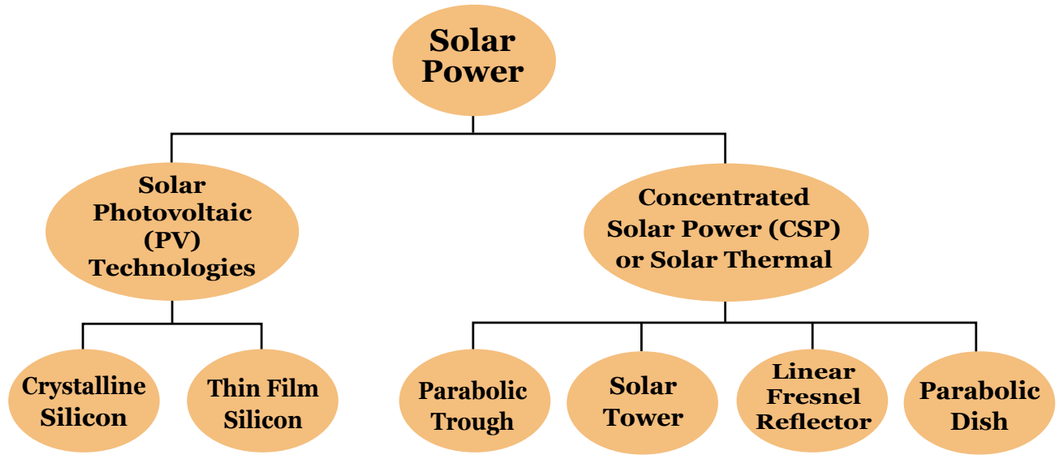
Key Benefits of Solar Power

Freely available

Environment friendly

Low operation and maintenance cost

Exhibit 11: Types of Solar Power



Source: LSI Research

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 Multi-crystalline 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 nano-meters 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. Photovoltaic

Key factors to consider for setting up a Solar PV plant

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

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.

Exhibit 12: Comparison between various technologies for Solar PV

Indicator	Crystalline silicon	Tin Film Silicon
Land requirement	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

Key factors to consider for setting up a Solar Thermal plant

Solar Radiation	Land Requirement	Water Requirement	Temperature
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 is required normally in the range of 5 – 10 acres per MW, which should be flat in large continuous stretch.	Solar thermal plant 3 requires around 3-4 M / MWh of water for the purpose of operation.	Solar to thermal efficiency is better at highest ambient temperature.

Solar Potential in India

India is endowed with a very vast solar energy potential. Most parts of the country have about 300 sunny days. Average solar radiation incident over the land is in the range of 4-7 kWh per day. Over the last three decades several solar energy based systems and devices have been developed and deployed in India which are successfully providing energy solutions for lighting, cooking, water heating, air heating and cooling, and electricity generation.

National Solar Mission (NSM) was launched on 11th January, 2010. The Mission targeted include

i) deployment of 20,000 MW of grid connected solar power by 2022,

ii) 2,000 MW of off-grid solar applications including 20 million solar lights by 2022,

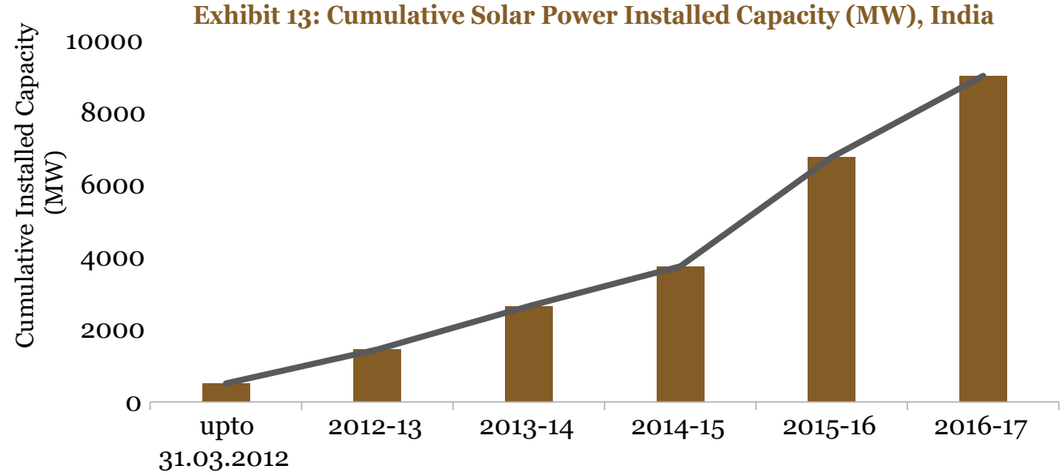
iii) 20 million sq. m. solar thermal collector area

iv) to create favourable conditions for developing solar manufacturing capability in the country

v) support R&D and capacity building activities to achieve grid parity by 2022. The Mission is to be implemented in three phases.

The Indian solar power market is going through many ups and downs at the moment. New capacity addition for 2017 is expected to touch 8.8 GW, a rise of 76% over 2016 and making India the third biggest solar market worldwide. About 12.4 GW of projects have completed auctions and are in execution stages right now. 7 developers have built up project portfolios exceeding 1 GW mark.

Exhibit 13: Cumulative Solar Power Installed Capacity (MW), India



Source: MNRE, LSI Research

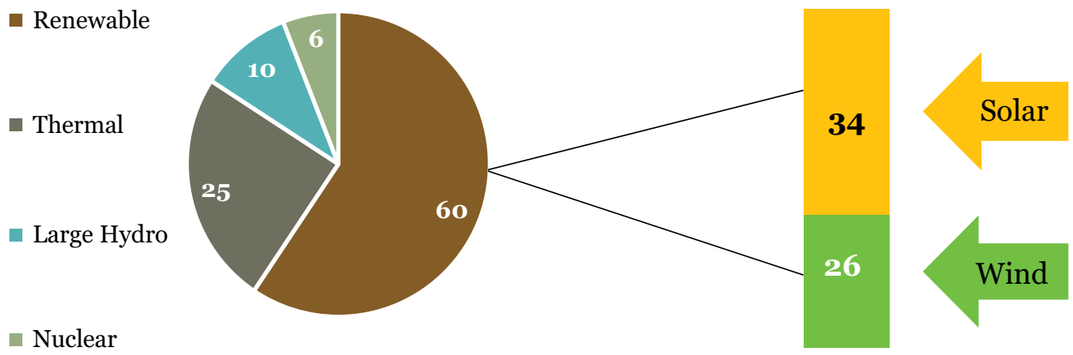
India's Solar Power Market

- India is located on the equatorial sun belt of the Earth and hence, receives abundant radiant energy from the sun.
- India has an estimated renewable energy potential of about 900 GW from commercially exploitable sources viz. Wind – 102 GW (at 80 metre mast height); Small Hydro – 20 GW; Bioenergy – 25 GW; and 750 GW solar power, assuming 3% wasteland is made available.
- The Government has up-scaled the target of renewable energy capacity to 175 GW by the year 2022 which includes 100 GW from solar, 60 GW from wind, 10 GW from bio-power and 5 GW from small hydro-power.
- As of March 31, 2017, India had installed 12.2 GW of utility scale solar PV capacity.
- Tamil Nadu, Andhra Pradesh and Telangana have emerged as the fastest growing states. In 2017, nearly 60% of total new capacity addition is expected to come in three southern states of Telangana, Andhra Pradesh and Karnataka.
- There has been a significant slowdown in the pace of new tender announcements mainly due to weak power demand growth in the country.

2017 has been a good year for Indian solar power market when compared to the developments in the coal-based power market. By 30th September 2017, 5759 MW of solar capacity addition has taken place which is a record amount of solar power capacity addition. This figure is more than the capacity added during the entire 2016; which was 4666 MW.

Out of the 10,140 MW of renewable energy capacity added in 2017, solar's share stand at an impressive 57%. A net power generation capacity added across all technologies, of 17,011 MW in the first 10 months of the year, 34% of this came from solar and 26% from wind with the total share of renewable energy at 60%.

Exhibit 14: Share of Capacity Added in 2017 (%), India

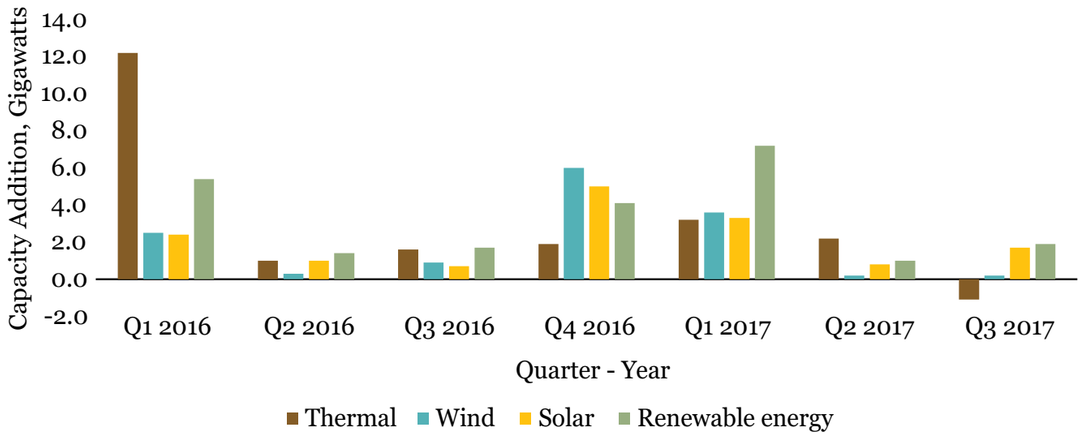


*Source: CleanTechnica, * till 30.09.2017*

With some of the old power plants retiring, India is continuing to add solar power projects at a rapid pace. Thanks to the large number of competitive auctions at the Central as well as the State levels.

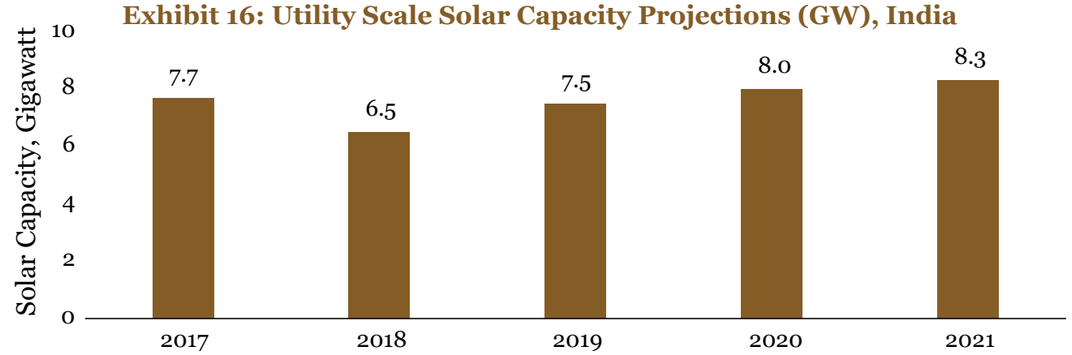
As per the Indian government, the country's coal-based power capacity reduced by 1126 MW while solar power grew by 1657 MW in Q3 2017. This phenomenon occurred almost after six quarters, the last being in Q2 2015. As of September 2017, India's coal based power capacity stood at 193.4 GW, down from the all-time high of 195.6 GW in May 2017.

Exhibit 15: Trends in Thermal and Renewable Energy Capacity Addition (GW), India



*Source: CleanTechnica, * till 30.09.2017*

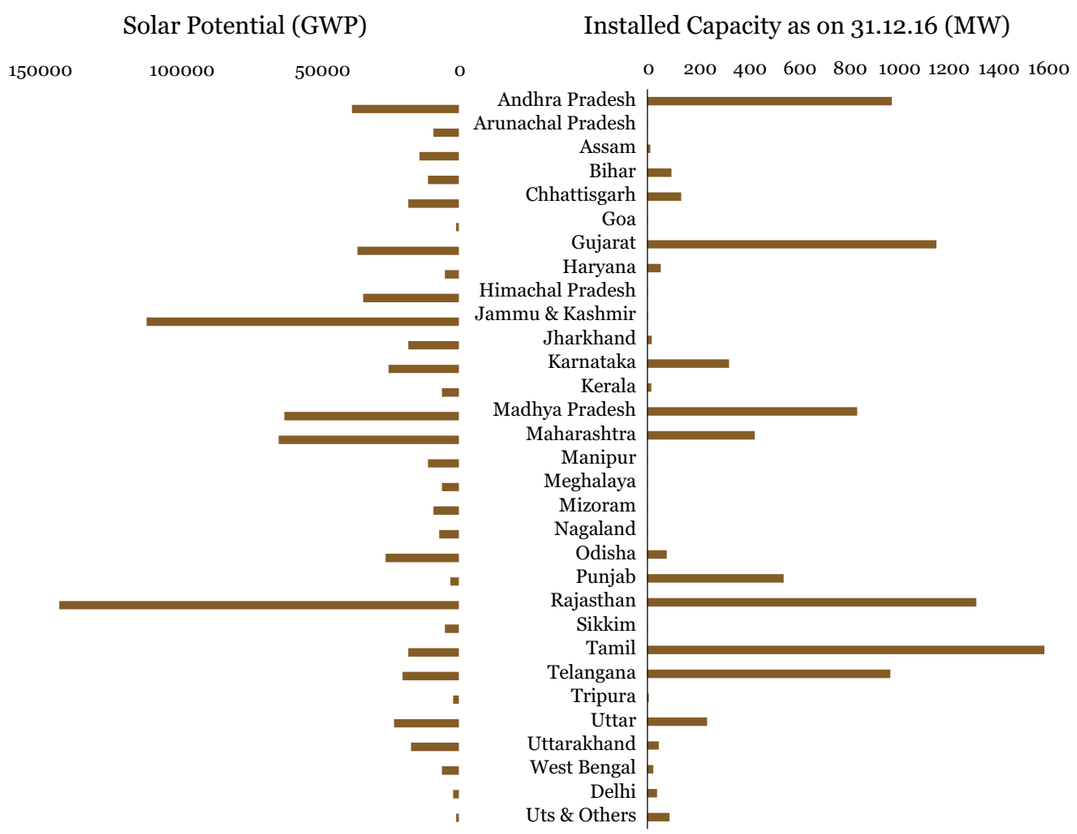
Exhibit 16: Utility Scale Solar Capacity Projections (GW), India



Source: Bridge To India, India Solar Handbook, 2017, LSI Research

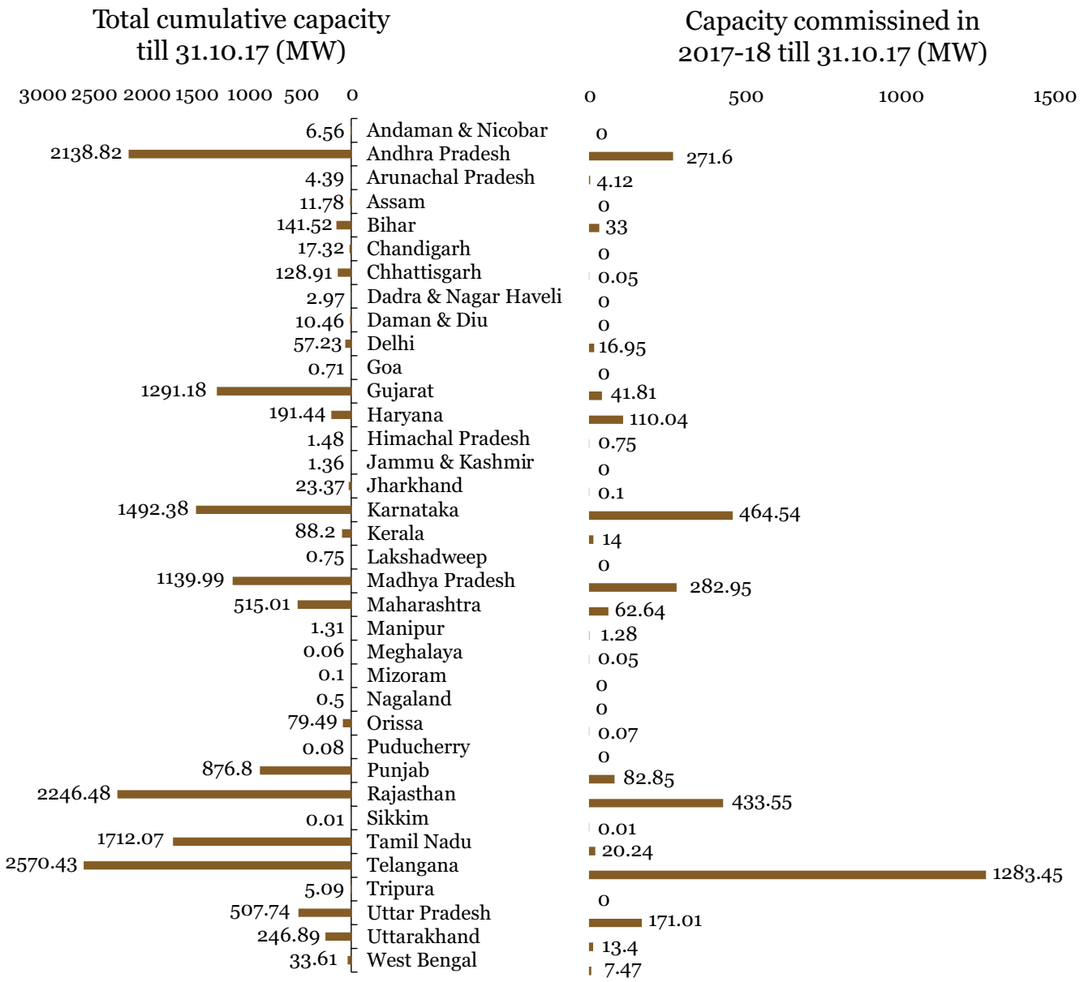
According to BRIDGE TO INDIA, 44 GW of cumulative utility scale capacity will be added in India until 2021. A slowdown is expected in 2018 because of pause in recent tender activity but demand is expected to pick up again from 2019 onwards.

Exhibit 17: State-wise Estimated Solar Energy Potential vs Installed Solar Capacity in India



Source: MNRE Annual Report 2016-17, LSI Research

Exhibit 18: Commissioning Status of Grid Connected Solar Projects



Source: MNRE Annual Report 2016-17, LSI Research

Trends in Rooftop Solar Installations

The target of 100 GW capacity set under the National Solar Mission (NSM) will principally comprise of 40 GW Rooftop and 60 GW through Large and Medium Scale Grid Connected Solar Power Projects. With this target, India will become one of the largest Green Energy producers in the world, surpassing several developed countries. Government of India in its submission to the United Nations Framework Convention on Climate Change on Intended Nationally Determined Contribution (INDC) has stated that India will achieve 40% cumulative electric power capacity from non-fossil fuel based energy resources by 2030.

India's total installed rooftop solar capacity is estimated at 1,247 MW as of December 31, 2016.

Capital Expenditure (CAPEX) route accounts for nearly 84% of total installed capacity but the Operating Expenditure (OPEX) model has been gaining ground in the last couple of years.

Exhibit 19: Rooftop Solar Annual Capacity Addition, India

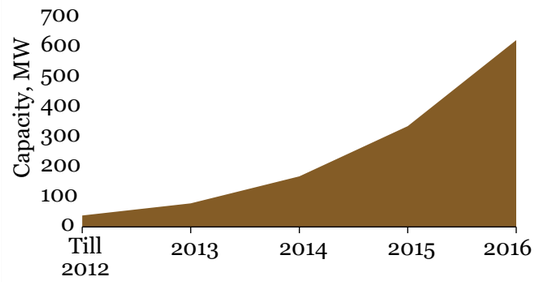
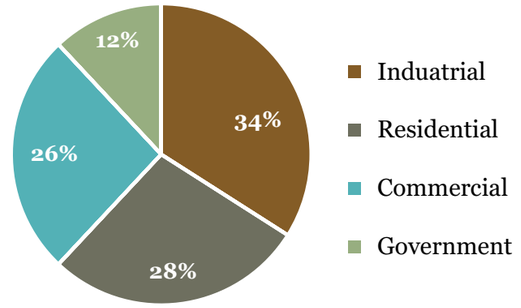


Exhibit 20: Sector wise share of Rooftop Solar Capacity



Source: Bridge to India, India Solar Handbook, 2017, LSI Research

2017 was an eventful year, during which annual capacity addition of solar power was estimated to touch record levels of 10.9 GW (+66% over 2016) including utility scale solar (9 GW, +110%), rooftop solar (887 MW, +60%) and wind (4 GW, +11%).

CHAPTER 3

Government Initiatives & Policy Update

The Ministry of New and Renewable Energy (MNRE) has taken several steps to fructify Prime Minister Shri Narendra Modi's dream of a clean energy future for the 'New India'. The largest renewable capacity expansion programme in the world is being taken up by India. The government is aiming to increase share of clean energy through massive thrust in renewables. Core drivers for development and deployment of new and renewable energy in India have been Energy security, Electricity shortages, Energy Access, Climate change etc.

A capacity addition of 27.07 GW of renewable energy has been reported during the last three and half years under Grid Connected Renewable Power, which include 12.87 GW from Solar Power, 11.70 GW from Wind Power, 0.59 from Small Hydro Power and 0.79 from Bio-power. Confident by the growth rate in clean energy sector, the Government of India in its submission to the United Nations Frame Work Convention on Climate Change on Intended Nationally Determined Contribution (INDC) has stated that India will achieve 40% cumulative Electric power capacity from non-fossil fuel based energy resources by 2030 with the help of transfer of technology and low cost International Finance including from Green Climate Fund. As on 30.11.2017, Solar Energy Projects with an aggregate capacity of over 16611.73 MW including 863.92 MW from Solar Roof Top projects has been installed in the country.

The government is playing an active role in promoting the adoption of renewable energy resources by offering various incentives, such as generation-based incentives (GBIs), capital and interest subsidies, viability gap funding, concessional finance, fiscal incentives etc. The National Solar Mission aims to promote the development and use of solar energy for power generation and other uses, with the ultimate objective of making solar energy compete with fossil-based energy options. The objective of the National Solar Mission is to reduce the cost of solar power generation in the country through long-term policy, large scale deployment goals, aggressive R&D and the domestic production of critical raw materials, components and products. Renewable energy is becoming increasingly cost-competitive as compared to fossil fuel-based generation.

In order to achieve the renewable energy target of 175 GW by the year 2022, the major programmes/ schemes on implementation of Solar Park, Solar Roof Top Scheme, Solar Defence Scheme, Solar scheme for CPUs Solar PV power plants on Canal Bank and Canal Tops, Solar Pump, Solar Rooftop etc have been launched during the last two years.

Various policy measures have been initiated and special steps taken in addition to providing financial support to various schemes being implemented by the Ministry of New and Renewable Energy (MNRE) for achieving the target of renewable energy capacity to 175 GW by the year 2022. These include, inter alia, suitable amendments to the Electricity Act and Tariff Policy for strong enforcement of Renewable Purchase Obligation (RPO) and for providing Renewable Generation Obligation (RGO); setting up of exclusive solar parks; development of power transmission network through Green Energy Corridor project; guidelines for procurement of solar and wind power though tariff based competitive bidding process, National Offshore Wind Energy Policy notified, Repowering of Wind Power Projects, Standards for Deployment of Solar Photovoltaic systems/ devices, orders for waiving the Inter State Transmission System charges and losses for interstate sale of solar and wind power for projects to be commissioned by March 2019; identification of large government complexes/ buildings for rooftop projects; provision of roof top solar and 10 percent renewable energy as mandatory under Mission Statement and Guidelines for development of smart cities; amendments in building bye-laws for mandatory provision of roof top solar for new construction or higher Floor Area Ratio; infrastructure status for solar projects; raising tax free solar bonds; providing long tenor loans; making roof top solar as a part of housing loan by banks/ NHB; incorporating measures in Integrated Power Development Scheme (IPDS) for encouraging distribution companies and making net-metering compulsory and raising funds from bilateral and international donors as also the Green Climate Fund to achieve the target.

Initiatives and Achievements of MNRE

Estimated Potential of Renewable Energy

The increased use of indigenous renewable resources is expected to reduce India's dependence on expensive imported fossil fuels. India has an estimated renewable energy potential of about 1096 GW from commercially exploitable sources viz. Wind – 302 GW (at 100-meter mast height); Small Hydro – 21 GW; Bio-energy – 25 GW; and 750 GW solar power, assuming 3% wasteland

Targets

The Government of India has set a target of 175 GW renewable power installed capacity by the end of 2022. This includes 60 GW from wind power, 100 GW from solar power, 10 GW from biomass power and 5 GW from small hydro power.

A target of 14550 MW grid renewable power (wind 4000 MW, solar 10000 MW, small hydro power 200 MW, bio-power 340 MW and waste to power 10 MW), has been set for 2017-18. Besides, under off-grid renewable system, targets of 15 MW eq. waste to energy, 60 MW eq. biomass non-bagasse cogeneration, 7.50 MW eq. biomass gasifiers, 0.5 MW eq. small wind/hybrid systems, 100 MW eq. solar photovoltaic systems, 150/25 Nos. eq. micro hydel and 110,000 nos. family size biogas plants have been set for 2017-18.

Share of Renewable Energy in Total Installed Capacity

Economic growth, increasing prosperity, a growing rate of urbanization and rising per capita energy consumption has increases the energy demand of the country. In order to meet the energy demand, India has total installed power generation capacity of 331.95 GW as on 31.10.2017 from all resources. With 60.98 GW installed renewable power capacity, the renewable power has a share of about 18.37% to the total installed capacity.

Achievements

- **Green Power Capacity Addition**

A total of 11788 MW of grid-connected power generation capacity from renewable energy sources has been added so far this year (January 2017 to November 2017) in the country.

A total of 11319.71 MW of grid-connected power generation capacity from renewable energy sources like solar (5502.38 MW) and wind (5585.98 MW), Small Hydro Power (105.90 MW), Bio-Power (161.95 MW) has been added during 2016-17 in the country against target of 16660 MW. During 2017-18, a total 4809.51 MW capacity has been added till 30.11.2017, making cumulative achievement 62053.73 MW.

Sector-wise highlights of achievements

- Biggest ever Solar Power capacity addition of 5525.98 MW in 2017-18. During 2017-18, a total 4323.1 MW (including 207.92 MW Solar Roof Top) capacity has been added till 30.11.2017, making cumulative achievement 16611.73 MW (including 863.92 MW Solar Roof Top).
- So far,1.42 lakh Solar Pump have been installed in the Country as on 30.11.2017 including 1.31 lakh during last three and half year.
- Solar projects of capacity 23656 MW have been tendered and LoI for 19,340 MW issued.
- Under National Solar Mission, the target for setting up solar capacity increased from
- 20 GW to 100 GW by 2021-22. Target of 10,000 MW, set for 2017-18 which will take the cumulative capacity over 20GW till 31st March 2018.
- As on date,23656 MW has been tendered out, of which LOI issued for
- 19340 MW.
- Capacity of the scheme for "Development of Solar Parks and Ultra Mega Solar Power Projects" has been enhanced from 20,000 MW to 40, 000 MW.35 solar parks of aggregate capacity 20,514 MW have been approved in 21 States.
- Kurnool Solar Park in Andhra Pradesh with 1000 MW capacity has already been commissioned and is operational. With commissioning of 1000 MW capacity at single location, Kurnool Solar Park has emerged as the World's Largest Solar Park.
- 650 MW capacity commissioned in Bhadla Phase-II Solar Park in Rajasthan.
- 250 MW capacity commissioned in Phase –I of Neemuch Mandsaur Solar Park (500 MW) in Madhya Pradesh.
- 3 new solar parks have been approved in this year at Rajasthan (1000 MW), Gujarat (500 MW) and Mizoram (23 MW) after issue of Guidelines for Enhancement of capacity from 20, 000 MW to 40, 000 MW under Solar Park Scheme.

- Solar tariff has declined to lowest level of Rs 2.44 /kWh.
- As on 30.11.2017 over41.80 lakh Solar Lighting Systems, 1.42 lakh Solar Pumps, and power packs of 181.52 MWeq have been installed in the country. Major achievements of 18.47 lakh Solar Lighting Systems, 1.31 lakh. Solar Pumps, Power Packs of 96.39 MWeq have been reported during last three and half years.
- Several schemes namely (i) Defence scheme (ii) Central Public Sector Undertakings (CPSUs) scheme (iii) Bundling scheme (iv) Canal Bank/ Canal Top scheme (v) VGF Scheme (vi) Solar Park scheme (vii) Solar rooftops, have been initiated/launched by the Ministry under National Solar Mission which are under implementation.
- Under Defence scheme against a target of 300 MW, 357.50 MW has been sanctioned; under Central Public Sector Undertakings (CPSUs) scheme against a target of 1000 MW, entire capacity sanctioned; under 3000 MW Bundling scheme, Tranch-I: 3000 MW has been tendered; under 100 MW Canal Bank/ Canal Top scheme, all capacity sanctioned; under 2000 MW & 5000 MW VGF Scheme; and under 20,000 MW Solar Park scheme, 35 Solar parks have been approved in 21 States with aggregate capacity of 20,514 MW.

Solar Rooftop

- Ministry is implementing Grid Connected Rooftop and Small Solar Power Plants Programme which provides for installation of 2100 MW capacity through CFA/ incentive in the residential, social, Government/PSU and Institutional sectors.
- Under the programme, central financial assistance upto 30% of bench mark is being provided for such projects in Residential, Institutional and Social sectors in General Category States and upto 70% of the benchmark cost in Special Category States. For Government sector, achievement linked incentives are being provided. Subsidy/CFA is not applicable for commercial and industrial establishments in private sector.
- So far sanctions for 1767 MWp capacity solar rooftop projects has been issued and around 863.92 MWp capacity has been installed.
- All the 36 State / UT ERCs have now notified net/gross metering regulations and/or tariff orders for rooftop solar projects
- Concessional loans of around 1375 million US dollarsfrom World Bank (WB), Asian Development Bank (ADB) and New Development Bank (NDB) have been made available to State Bank of India (SBI), Punjab National Bank (PNB) and Canara Bank for solar rooftop projects.
- Suryamitra programme has been launched for creation of a qualified technical workforce and over11 thousand persons have been trained under the programme.
- An online platform for expediting project, approval, report submission, and monitoring of RTS projects has been created.
- Initiated geo-tagging of RTS projects, in co-ordination with ISRO, for traceability and transparency.
- Launched mobile app ARUN (Atal Rooftop Solar User Navigator) for ease of access of beneficiaries for request submission and awareness.
- MNRE has allocated Ministry wise expert PSUs for implementation of RTS projects in various Ministries/Departments.
- Published best practices guide and compendium of policies, regulations, technical standards and financing norms for solar power projects.

Amendments in Tariff Policy to promote Renewable Energy

- Enhancement in Solar RPO to 8% by March 2022.
- Introduction of RGO for New coal/lignite based thermal plants after specified date.
- Ensuring affordable renewable power through bundling of renewable power.
- No inter-state transmission charges and losses to be levied for solar and wind power.
- Further, pursuant to the revised tariff policy, the Ministry of Power on 22ndJuly 2016 has notified the long term growth trajectory of RPO for solar and non-solar energy for next 3 years 2016-17, 2017-18 and 2018-19 as under:-

Exhibit 21: Growth Trajectory of RPO

Long term trajectory	2016-17	2017-18	2018-19
Non-solar	8.75%	9.50%	10.25%
Solar	2.75%	4.75%	6.75%
Total	11.50%	14.25%	17.00%

Indian Renewable Energy Development Agency (IREDA)

Indian Renewable Energy Development Agency Limited (IREDA) is a Mini Ratna (Category – I) Government of India Enterprise under the administrative control of Ministry of New and Renewable Energy (MNRE). IREDA is a Public Limited Government Company established as a Non-Banking Financial Institution in 1987 engaged in promoting, developing and extending financial assistance for setting up projects relating to new and renewable sources of energy and energy efficiency/conservation.

IREDA has been awarded Mini Ratna Status and the authorised capital of IREDA is increased from Rs.1000 Cr. to Rs.6000 Cr.

Green Energy Corridor

Intra-State Transmission System is being implemented by eight renewable rich States (Tamil Nadu, Rajasthan, Karnataka, Andhra Pradesh, Maharashtra, Gujarat, Himachal Pradesh and Madhya Pradesh) withtotal project cost of Rs. 10141 crores, with funding mechanism consisting of 20% State Equity, 40% Government of India Grant (total 4056.67 crores) and 40% KfW loan (500 million EUR). The project includes about approx. 9400 ckm transmission lines and Substations of total capacity of approx. 19000 MVA to be completed by March 2020. The purpose is to evacuate approx. 20,000 MW of large scale renewable power and improvement of the grid in the implementing States.

Projects worth Rs. 6766 crore have been awarded and approx. Rs. 1400 crores have been disbursed to the States from the Government of India share.

Other Initiatives

India is taking a leading role in the International Renewable Community and was a leading country along with France in formation of International Solar Alliance (ISA), an international body of 121 countries lying between Tropic of Cancer and Tropic of Capricorn. 47 countries have signed the Framework Agreement and 18 countries have ratified it within 1 year of opening of Framework for signature. Accordingly, ISA became alegal entity on 6.12.2017, with its headquarters in India.

Bank loans up to a limit of Rs.15 crores will be given to borrowers for purposes like solar based power generators, biomass based power generators, wind power systems, micro-hydel plants and for renewable energy based public utilities viz. Street lighting systems, and remote village electrification. For individual households, the loan limit will be Rs.10 lakh per borrower.

Foreign Direct Investment (FDI) up to 100% is permitted under the automatic route for renewable

energy generation and distribution projects subject to provisions of The Electricity Act, 2003.

In order to achieve the targets, various initiatives have been taken by the Government which interalia include:

I. Announced a cumulative target of 175 GW renewable energy based electric installed capacity of 100 GW solar power installed capacity;

II. Issued guidelines for procurement of solar and wind power through tariff based competitive bidding process;

III. Declared Renewable Purchase Obligation (RPO) up to the year 2018-19;

IV. Declare Renewable Generation Obligation on new coal/lignite based thermal plants;

V. Notified National Offshore Wind Energy Policy;

VI. Notified policy for Repowering of Wind Power Projects;

VII. Notified standards for deployment of solar photovoltaic systems/devices;

VIII. Issued order for waiving the Inter State Transmission System charges and losses for inter-state sale of solar and wind power for projects to be commissioned by March 2019;

IX. Launched Atal Jyoti Yojna for Solar LED Street Lights in five States; and

X. Setting up of exclusive solar parks;

XI. Identification of large government complexes/ buildings for rooftop projects;

XII. Provision of roof top solar and 10 percent renewable energy as mandatory under Mission Statement and Guidelines for development of smart cities;

XIII. Amendments in building bye-laws for mandatory provision of roof top solar for new construction or higher FAR;

XIV. Infrastructure status for solar projects;

XV. Raising tax free solar bonds;

XVI. Making roof top solar a part of housing loan by banks/NHB;

XVII. Raising funds from bilateral and international donors as also from the Green Climate Fund to achieve the target.

CHAPTER 4

Financials of Solar Power Projects in India

Solar and Wind Energy sectors are extremely dynamic in India. Over the traverse of three years more than 16,000 solar home systems have been financed through 2,000 bank branches, especially in rural territories of South India. Launched in 2003, the Indian Solar Loan Program was a four-year association between United Nations Environment Programme (UNEP), the UNEP Risoe Centre, and two of India's largest banks, the Syndicate Bank and the Canara Bank. On 11th January 2010, our former Prime Minister, Dr. Manmohan Singh launched Jawaharlal Nehru National Solar Mission (JNNSM) under the National Action Plan on Climate Change. Through this plan it proposed to produce 1,000 MW of energy by 2013 and up to 20,000 MW grid-based solar power; 2,000 MW of off-grid solar power and covers 20 million square meters with collectors before the finish of the last phase of the mission in 2021-22. Further, Government of India has increased the target of Grid Connected Solar Power Projects from 20,000 MW by the year 2021-22 to 100,000 MW by the year 2021-22 under the JNNSM and it was approved by Cabinet on 17th June 2015. This target will be achieved by the government in three phases.

Exhibit 22: JNNSM Capacity Addition Targets

Application Segment	Target for Phase I (2010-13)	Target for Phase 2 (2013-17)	Target for Phase 3 (2017-22)
Utility Grid Power including roof top	1,000-2,000 MW	4,000-10,000 MW	20,000 MW revised to 100,000 MW in 2015
Off-grid solar applications	200 MW	1000 MW	2000 MW
Solar thermal collectors (e.g. SWHs, solar cooking/cooling, industrial process heat applications)	7 million sq. meters	15 million sq. meters	20 million sq. meters

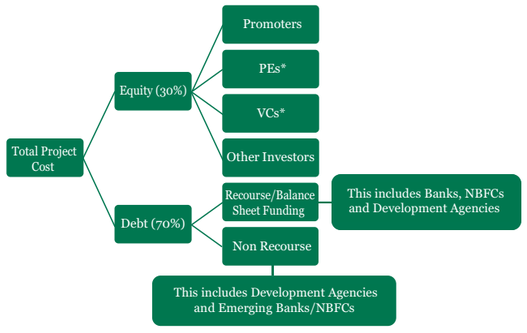
Cost of Setting-up a Solar Power Plant in India

The usual cost of setting up a solar power plant is around Rs 6.0 crores/MW. On general basis 30% of the cost is met by equity funding, and the rest through debt financing. Equity funding either comes from internal resources or from other investors. The EPC (Engineering Procurement Construction) contractors in India generally go for setting up solar plants with a debt-equity mix.

Debt-Equity Financing of Solar Projects

The following charts gives details of the financing options for setting up a solar power plant in India:

Exhibit 23: Segregation of Solar Power Project Cost



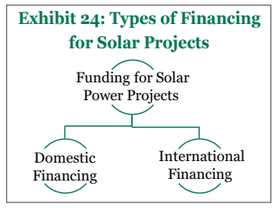
*PE: Private Equity; VC: Venture Capital Financing
Source: Vivaan Solar; LSI Research

The financing of a Solar Power Project usually has a ratio of 70:30 (Debt: Equity). Debt financing is done via two sources- Recourse / Balance Sheet Funding and Non-Recourse Project Financing:

Balance Sheet Based Financing: This option is available mostly for large conglomerates with a healthy balance sheet that can support large projects. Using this option, the large corporate houses get lower interest rates using their existing relations with the banks. However, this model does put a lot of stress on the company's balance sheet and the entire burden of the project has to be borne by the developer.

Non-Recourse Project Financing: This is the financial model followed usually by a Special Purpose Entity. The lending institution provides the debt and has lien on the project's cash flow. However, since this financing model does not provide for recourse to the developers' balance sheet, the lending institution requires concrete agreements with the developer and solid revenue statements from the projects.

Exhibit 24: Types of Financing for Solar Projects



Domestic Financing: The Domestic Financing mainly comes from Banks. The Banks lend at rates between 11-13% while NBFCs lend at slightly higher rates in comparison. The Indian government's renewable energy lending arm (IREDA) lends at lower rates than the banks. IREDA lends to solar power project developers at rates between 10.2-11.4%. The collaterals required against the loans vary between 20% to 100%, usually IREDA has much lower collateral requirements when compared to Banks. The domestic loans are usually for a period of 7-10 years.

Prior to financing a Solar Project, the investor should check for the following:

- Whether the company has a positive cash flow from its operations;
- Whether the company debt is less than 40% of its net worth;
- If the Debt Service Coverage Ratio (DSCR) of the company is greater than 1.5

International Financing: Interest rates for funding of solar projects from international sources is usually lower and between 8-10% though getting an international financier for a solar project is a time-consuming affair. Finding an international financier may take anything between 9-12months and this will delay the starting of the project. Further, even though international rates are lower than the domestic rates, the cost of hedging against currency fluctuations also needs to be factored in.

It is usually easier to get funding from international investors if the components used in setting up the solar project are also imported from the lending country; however, this is now becoming an issue as there are rules and regulations in place by the Government of India to stipulate domestic sourcing of solar components including solar modules, solar cells, etc.

Some of the International Financiers in India are as follows

- International Finance Corporation (IFC), the financing arm of the World Bank is engaged in financing of solar projects in India.
- EXIM Bank is also a good option for getting finances for solar projects in India
- The Asian Development Bank (ADB) has also emerged into a prominent leader to promote the solar projects in India.
- European Investment Bank (EIB) is also interested in financing solar parks in India.

Apart from the sources listed above, many green energy funds are providing equity funding at cheap rates for the development of solar power.

Exhibit 25: Investment Model for 1 MW Solar Plant All over India

Particulars	Unit
Capacity of Power Plant	1.00 MW
Generation Expected per year	Rs 17.50 Lakh Units/MW
Degradation Till 1st 10 years	0.05%
Degradation from 11 to 25 years	0.67%
Debt Percentage	70.00 %
Equity Percentage	30.00 %
Rate of Interest of Indian Bank Loan	13.00 %
Rate of Interest of Foreign Bank Loan	10.00 %
Repayment Period of Indian Loan	11 years
Repayment Period of Foreign Loan	15 years
Percentage of Indian Loan	70%
Average Cost of Sale of Electricity	Rs 6.49 per unit
Cost of Project per MW	Rs 650.00 Lakhs per MW
O & M Cost per MW for 1st year	Rs 8.00 Lakhs per MW
Depreciation	5.28%
Corporate Tax	30.28%
Minimum Alternate Tax	18.38%

Exhibit 26: Project funds for MW

Particulars	Unit
Project Cost	Rs 650.00 Lakhs
Debt	Rs 455.00 Lakhs
Equity	Rs 195.00 Lakhs

Source: MAC Solar Tech; LSI Research

Exhibit 27: Steps to Set-up a Solar Plant in India

DESIGN THE SCOPE OF THE PROJECT

The developer should do a needs assessment and prepare a feasibility report for the project.

LAND / SITE ASSESSMENT AND AQUISITION

The site needs to be assessed with regard to the resource available and the energy needs and load profiling. Land acquisition includes two sub-steps procuring a land lease agreement and conversion of land to industrial land, if and when necessary.

SELECTION OF VENDOR / EPC / INSTALLER

Identify the vendor for executing the installation from MNRE channel partner list. Either a single EPC contractor or multiple EPC contactors may be appointed. The project developer will also sign the technology supply.

LEGAL AND REGULATORY FRAMEWORK

The installer should obtain the approvals and clearances from various departments. The developer must avail the additional benefits and incentives for promoting solar energy in India.

FINANCING

The installer can choose from the different modes of financing available. Financing of a solar power plant in India has been discussed in detail earlier.

DESIGN OF SOLAR PLANT

After finalizing the financing mode, the design of the system needs to be figured out.

TENDERING AND PROCUREMENT

The installers need to look for Contracts and Bids. This step also involves preparation of bidding documents for the selected system.

IMPLEMENTATION AND POST INSTALLATION

This involves Installation & Commissioning of the plant and a third-party Inspection as per the Tender Document.

O & M

Appoint a O&M contractor and enter into a contract.

Source: TERI ENVIS Centre; LSI Research

Renewable Purchase Obligation (RPO) & Renewable Energy Certificate (REC)

Renewable power purchase obligation (RPO) is the single most important policy driving renewable energy installations given the government's aggressive goal of installing 175 GW by 2022 including 100 GW of solar power capacity.

The RPO has been the major driving force in India to promote the renewable energy sector. RPO refers to the 'obligation' of certain entities who have to meet a part of their electricity consumption using electricity from renewable resources. As per January 2017, twenty-five states in India have fallen behind their renewable purchase obligation targets. States are now being requested by MNRE to ensure RPO compliance including through purchase of renewable energy certificates (RECs). REC are the units which are up for sale from renewable energy power producing companies. The companies in order to meet RPO have to purchase REC. The companies do also have the option of producing renewable energy themselves in order to meet the target. One REC is equivalent to 1 MWh of renewable energy.

Amongst the 25 states and union territories that have to fulfil their solar RPO, Manipur, Meghalaya, Sikkim and Puducherry are lagging behind the most.

Exhibit 28: Solar Power Capacity Deficit States as per Actual RPO for 2016-2017

State	Capacity Required to Fulfill Solar RPO (in MW)	Capacity Available as on 31.12.2016 (in MW)	Deficit in Capacity (in MW)	Deficit in Capacity (in %)
Arunachal Pradesh	1.3	0.27	1.04	80.0
Assam	50.05	11.18	38.87	77.7
Bihar	129.48	95.91	33.57	25.9
Chhattisgarh	156.75	135.19	21.56	13.8
Delhi	68.02	38.78	29.24	43.0
Goa	28.16	0.05	28.11	99.8
Haryana	307.69	53.27	254.42	82.7
Himachal Pradesh	17.15	0.33	16.82	98.1
Jammu & Kashmir	158.36	1	157.36	99.4
Jharkhand	226.66	17.51	209.15	92.3
Kerala	35.33	15.86	19.47	55.1
Maharashtra	861.66	430.46	431.2	50.0
Manipur	1.51	0	1.51	100.0
Mizoram	1.14	0.1	1.04	91.2
Meghalaya	5.56	0	5.56	100.0
Nagaland	1.1	0.5	0.6	54.5
Odisha	253.2	77.64	175.56	69.3
Sikim	4.39	0	4.39	100.0
Tripura	47.95	5	42.95	89.6
Uttar Pradesh	573.69	239.26	334.43	58.3
West Bengal	155.46	23.07	132.39	85.2
Chandigarh	12.71	6.81	5.91	46.5
Daman & Diu	18.55	4	14.55	78.4
Dadar & Nagar Haveli	49.56	0	49.56	100.0
Puducherry	24.72	0.03	24.69	99.9
Total	**3,190.15**	**1,156.22**	**2,033.93**	**64**

Source: MNRE; Mercom Capital Group; LSI Research

Since the RPO targets are yet to be met, all states should align their policies with MNRE targets in accordance with regulations issued by regulatory commissions like the Central Electricity Authority (CEA) and Central Electricity Regulatory Commission (CERC). The delay in solar parks is one of the reasons for the failing of RPO targets by the states.

The solar power installations in India has now crossed 10 GW mainly due to RPO. States with high solar potential are tendering more projects. Between 2010-2014, direct purchase of electricity generated from renewable energy sources was the preferred option to meet RPOs, however, this has now changes and trading in RECs has ramped up.

Even though solar power installations in the country has reached 10 GW, this is not enough. India needs to further install 90 GW of solar capacity by 2022 which means that the rate of solar power installation in the country should be 18 GW per year. The RPOs play a big role in ensuring that the overall targets are met. Despite of the State RPOs being defined, twenty-five of the states defaulted and did not meet their targets.

The RPO regulations in India are not very strict which is the reason for unmet targets. There is a lack of enforcement of RPO regulations and penalties are absent when the obligations are left unmet. The RPO deficit is 6.9 GW based on MNRE RPO targets for up to 2016-2017. It is expected that if all the states adhere to the RPO targets set, 17.7 GW of solar power should be added by the end the current financial year (2017-2018).

Solar Industry Post Goods and Service Tax (GST):

On July 1, 2017, India embraced the Goods and Services Tax (GST) legislation. The GST council imposed a 5% GST on solar panels and solar PV cells as against the effective rate of taxation at 0% earlier. The following table states the GST rates for the goods needed for generating solar power:

Exhibit 29: GST rates for Solar Power Generating Goods

Solar Power Generating Goods	GST Rate (%)
Solar Panels	5%w
Solar Battery	28%
Solar Charge Controller	18%
Cables for Connection	28%
Solar Modules	5%
Inverter	12%
Solar Street Lamp	5%
Street Light LED Type	12%
Silicon Sealant	28%
Solar Glass	28%
Aluminium Frame	18%
Ribbon	18%
EVA, Backsheet	18%
Junction Box	18%

Source: Solar Quarter, LSI Research

Imposition of GST has in no doubt led to marginal increase in the project costs. The players who aggressively bid for solar projects assuming that the solar panel rates would fall under the new regime have been facing problems. A lower GST rate would have surely been a boon; however, the current GST will not make a significant dent on the solar sector in the long-run. The reduction in solar tariffs to as low as Rs 2.44 per unit augurs well for the industry as it will offset any increase in project costs due to implementation of GST. However, the companies would need to revisit their procurement strategies to minimize the loss of tax credits.

Taxes on consumption or sale of electricity is kept beyond the purview of GST and hence the electricity generated from solar power will be taxed by the respective State government. It is expected that any increase in cost would be passed through to the buyer which they can claim as input credit of GST, once the same has been paid by the supplier.

In contrast to solar going up from 0% to 5%, the taxes on coal have come down from 11.69% to 5%. The government's intention to put coal at par with solar proves that the country is moving towards grid parity.

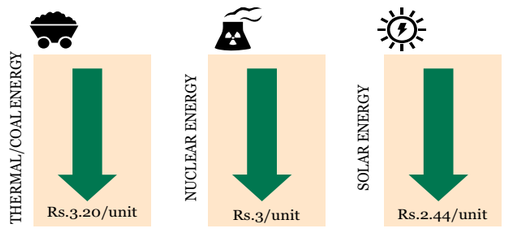
The overall solar project cost has increased by about 12% post GST. The new rates have hit more than 10 GW of ongoing utility scale projects and has posed a threat to their viability. Solar projects involving civil and works contracts will be taxed at 18%. The GST implemented poses doubt on whether the developers will be able to viably set up solar plants and sell electricity at the aggressively falling tariffs, given that their installation costs are set to rise. The GST is expected to impact the solar tariff by around 15-20 paise per unit.

A commercially viable, non-subsidy dependent sector is naturally more sustainable in the long run and therefore GST might not prove to be that big a hindrance eventually. It is however critical for MNRE to set up and play a coordinating role between the central and state regulators to ensure that the process of tariff adjustment is as smooth as possible.

Falling Solar Tariffs & Anti-Dumping Duties on Solar Modules

For the first time in India, the price of solar energy is lower than the price of thermal and nuclear energy:

Exhibit 30: Comparison of Tariffs of Different Power Sources



Source: The Quint, LSI Research

This is good news, but not yet for the consumers and the Indian solar equipment manufactures. This is because solar energy constitutes merely 3% of the total electricity needs of the consumers. About 85% of the consumers electricity needs are still met by non-renewable energy sources. On the other hand, China has over supplied the market with cheap equipment thereby putting Indian manufacturers at the spot. However, the scenario has changed post the anti-dumping duty imposed by India.

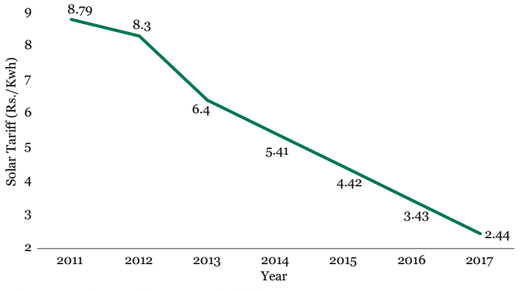
The solar tariff fell to the record low of Rs. 2.44 per unit in May for the Bhadla Phase-III Solar Park in Rajasthan. ACME Solars was the lowest bidder and aims to generate 7,500 MW of solar energy by the year 2019.

Trend in India's Falling Solar Tariffs

The solar power tariffs in India have fallen in nominal terms from INR 15 /Kwh in 2009 to INR 2.44/ Kwh in 2017, due to decline in module prices and improvements in capacity utilization factor. The declining tariffs have attracted good investments but have raised concerns over the long-term sustainability of the projects.

The decline in prices is good news for project developers and power purchasers in India as it would bolster demand and ease financial concerns of developers and lenders. On the other hand, steep price declines pose critical threat to the financial health of module suppliers. This because at low tariffs, the modules are imported from China as they are available at much cheaper rates. There is a possibility of dislocation in the domestic module manufacturing industry, especially after the introduction of the anti-dumping duty on Chinese imports. And if this occurs, it will spell trouble for project bidders who are already factoring in expected price falls in their financial models.

Exhibit 31: India's Falling Solar Power Tariff (Rs./Kwh), 2011-2017



Source: Solar Quarter, LSI Research

The Anti-Dumping Duty on Chinese Solar Modules and Cells

The initiative of Indian Govt. towards the solar project is quite recent. The National Solar Mission was launched just seven years back, in 2010, with a target of adding 20 GW by 2022.

According to various reliable reports on solar projects, India's solar cell manufacturing capacity stands at 1,753 MW and solar PV module manufacturing capacity at 6,913 MW. Whereas, nearly 4,000 MW of module manufacturing capacity is entirely dependent on imported solar cells.

Solar Modules account for nearly 60% of a solar power project's total cost. The cost of manufacturing solar modules in India has always found higher when compared globally. The Indian solar industry is widely occupied with Chinese imports and the Chinese companies own almost 85% of India's solar module demand. Indian project developers favour Chinese module manufacturers as these are approximately 10% cheaper than domestic modules. The local solar module market in India is dominated by Trina Solar (25.7% market share), Hanwha (10.5%) and Risen (7.6%), with domestic manufacturers' accounting for only 10.6% in the market share. Chinese modules are 8-10% cheaper than those made in India. The Chinese modules cost $0.33-$0.36 cents/per Watt, while domestic modules cost $0.35-$0.40 cents/per Watt. In FY 2016-17, 89% of solar modules used in India were imported from China and other countries.

Solar Projects in India in 2018

The Indian solar power sector is off to a good start in 2018. After months of a dry pipeline, the industry now has over 4,000 megawatts (MW) of projects that it can bid for and execute across the country. In the first week of this year alone, the central government-run **Solar Energy Corporation of India (SECI)** has tendered out over 1,200 MW of projects, including 750 MW in Andhra Pradesh, 200 MW in Karnataka, and 275 MW in Uttar Pradesh. The recovery began in December 2017, when around 3,000 MW worth of projects were auctioned and tendered by the SECI and various state governments, including 1,300 MW in Maharashtra, 860 MW by Karnataka, and around 750 MW by the SECI.

The prices of manufacturing different solar products are quite expensive in India, due to these following reasons:

- **No economies of scale advantage:** The average scale and size of an Indian solar module manufacturing factory is one-fifth the size of a typical Asian factory.
- **Insufficient Government Support:** Until recently, government support provided to solar module producers in India was insufficient. Unlike India, other countries had provided massive loans, tax holidays, subsidized utility services, provided easy access to land technological support. Also, the GST implemented in this sector has increased the overall cost of manufacturing solar modules in India.
- **Poor technology and access to finance:** The Indian cell and module makers mostly have outdated technology and depend on imports of raw materials. The Indian module manufacturers also have limited access to cheap loans and operate below capacity. The interest rate for solar panel manufacturers is just 2-3% in China compared to 11-13% in India.

While the country maintains a huge and ambitious target to achieve the 175 GW target by 2022, then in the backdrop imposition of an Anti-Dumping Duty (ADD) on imports of solar cells and modules from China, Malaysia and Taiwan has also occurred. This action actually makes the country's manufacturing capacity somehow uncompetitive.

Details regarding the Anti-dumping duty imposition

In July 2017, India opened a probe into whether Chinese solar equipment makers were hurting the domestic industry by dumping inventories and driving down prices to unfair levels. According to the **Indian Solar Manufacturers Association (ISMA)**, the prices of the goods dumped by China were almost undercut by 40%.

In August 2017, the Indian Finance Ministry imposed an antidumping duty on tempered glass used in solar photovoltaic and thermal products originating in or exported from China. The solar glass imported from China was found to be below its associated normal value.

After that, the year 2018 has obviously started on a trembling note as because India's **Director General of Safeguards (DGS)** has proposed a provisional duty of 70% for a period of 200 days on solar cells and modules. It has issued its recommendations in a preliminary report, completed within just a month of submission of the petition by five Indian manufacturers including Mundra Solar, Indosolar, Jupiter Solar, Websol Energy and Helios (formerly, Moser Baer).

The duty is proposed to be levied on imports from all countries except developing countries other than China and Malaysia. The decision has come as a major shock and risks causing factors in the solar sector when the target of the government is to produce 175 GW solar target within March 2022.

Impact of Anti-Dumping Duties

How much will solar module prices increase by if anti-dumping duties are enforced?

Anti-dumping duties can increase imported module prices by approx. $ 0.04-0.05/Wp. Modules from Indian cell suppliers such as Adani, Websol and Indosolar will be $ 0.01-0.02 lower than Chinese suppliers.

Impact on Solar Module Manufacturers

The anti-dumping duty was introduced to protect the domestic solar module and cell manufacturers. However, the long-term effect on the Indian cell manufacturers is unclear. The duty has resulted in rising solar costs as the Indian modules are much more expensive. And this rise in solar costs has caused a shrinkage in demand for solar cells which has adversely impacted not only the small local entrepreneurs but also the large domestic module manufacturers.

The domestic manufacturers have been struggling because of their inability to compete on price with Chinese manufacturers. Most of them have sub-scale capacities, high cost base and are completely reliant on imported technology and raw materials. Imposition of ADD(Anti-Dumping Duty) or provisional duty exceeding 10% shall enable them to price at profitable levels and increase production.

Also, earlier the Indian module manufacturers were exporting 80% of their operational capacity but with the anti-dumping duties in place, their exports might suffer from retaliatory pressure in the global markets.

In order to make India's solar market globally competitive, the domestic solar cell and module manufacturers will have to take the first step. The domestic players will have to become cost competitive. Better efforts at increasing domestic manufacturing capacity will have to be made. The Indian government is really trying to keep the power tariffs under control, however, this is not possible without an optimum domestic manufacturing ecosystem.

Impact on Solar Project Developers

The possibility of anti-dumping duty on imported solar cells is worrying developers as it will increase the price of imported solar modules while locally-made modules are unlikely to become cheaper than the current prices of imported modules.

Many of the developers might downsize or exit from the market. The investor and banker confidence will also experience a setback. It is expected that up to 1 GW of solar projects could be scrapped.

Impact on solar projects which are in pipeline

As on September 30, 2017, India's total utility scale solar project pipeline, comprising projects allocated to project developers and EPC contractors, stood at 10,842 MW. All these projects face threat of provisional or anti-dumping duty depending on when the decision is announced. The anti-dumping duty will raise the risk of side-tracking pipeline projects of over 10,000 MW.

As per MNRE, India's total installed solar cell and module manufacturing capacity was 3.2 GW and 8.5 GW respectively as of May 31, 2017, but the operational capacity was only 1.7 GW and 5.5 GW for cells and modules respectively. As against this, actual production in 2016-17 was only 0.7 GW and 1.7 GW respectively.

Industry players point out that the only way to prevent recently awarded solar project from making losses, in case India decides to impose the anti-dumping duty, is exempting these projects from its effect. However, so far there is no clarity on this from the policy-makers.

Impact on Consumers and the Economy

In order to neutralise the impact of anti-dumping duties, the government will have to increase its subsidies and expenditure, otherwise the cost of solar power to the end consumer would increase drastically. The motive of establishing solar power as a major source of energy in the power mix would fail if the cost to consumers is high. The goal of reducing dependency on imported coal will be much more difficult to achieve and India would no longer be able to become a leader in the solar market space. Furthermore, as the demand for solar power will face a downward pressure, existing solar jobs will be lost in the long-run.

Apart from harming the solar industry, these anti-dumping duties will have an overall negative effect on the economy. India's power supply gap would prevail as millions of un-electrified households won't get access to a solar solution.

There is uncertainty as to whether imposition of anti-dumping policies will really benefit the sector and the economy. Till date, there is no evidence from other countries of such duties resulting in any long-lasting benefits for domestic manufacturers.

With GST in place, the overall cost of producing solar power has increased. This increase was expected to be offset by the falling tariffs in the long run. The antidumping duty has however, caused a threat to falling tariffs as now the solar project developers do not have access to cheap Chinese solar modules and cells. The project developers are being forced to source their module requirements from the local module manufacturers at higher prices. GST coupled with the antidumping duty will serve to be significantly disruptive for the entire Indian Solar Industry, including the solar module manufacturers and the solar project developers.

Role of Government

The government should consider giving price incentives, subsidized credit, and other such financial incentives to module manufacturers in India. This will make them competitive. If an anti-dumping duty is imposed it would make many investors and banks jittery about project viability, and that will not be good if we must reach 100 GW by 2022 and beyond.

When the govt. has taken the decision in the favour of the local solar cells, panel and product manufacturers then in that respect it should provide proper subsidies to the different types of solar products and should also take the initiative to raise the level of expenditure for various solar projects of the country. This step will not only help the project developers or the solar product manufacturers to stabilise themselves under such situation of pressure but will also encourage them to drag their projects in the superior levels.

CHAPTER 5

LSI Case Studies

Case Study 1:

Industry Convergence Boosting Demand for Solar Power

Rise of Startups in India

Over the last couple of years, the Indian startup ecosystem has displayed a momentous rise, pushing the country to the position of world's third-largest startup base. While Healthcare, Telecommunications and Consumer Goods are among the front runners in this startup race, the Technology sector has definitely managed to steal the show by scoring 43% of the countries startups. According to The National Association of Software and Services Companies' (NASSCOM) Startup Report, the Indian Technology sector alone houses around 5,200 startups, which will likely increase to 11,500 by 2020.

Demand for Third-party Data Centres

However, owing to their B2B business structure and lack of appropriate IT-infrastructure in India, these startups are often faced with cyber security risks. Moreover, these companies may encounter severe challenges if and when an accident causes damage to key equipment in their data centres. Consequently, these factors have stimulated a huge demand for third-party data centres in India as they guarantee high operational efficiency and scalable infrastructure with zero capital investment. Companies belonging to the Banking, Financial services and Insurance (BFSI) sector have also played a part in creating demand for local data centres as they are adverse to the idea of hosting their data in data centres located outside the country due to confidentiality and security reasons.

At present, the data centre market in India is valued at $2.2 billion, which is expected to reach $4.5 billion by 2018. As per predictions, investments in data centres will reach as high as $7 billion by 2020, making India the second largest market for data centres in the Asia Pacific region. Recently, US tech giant Oracle announced its plans to set up a local data centre to expand its cloud services. IBM has already set up two data centres in India (Mumbai and Chennai) while NTT Communications has three (Mumbai, Bangalore and Noida).

Impact of Data-Centres on Environment

Nevertheless, a major drawback of these data centres is the huge amount of energy consumed in order to operate and subsequently cool the servers. Data centres across the world consume around 3% of globally generated power and account for approximately 2% of greenhouse gas emissions, leaving behind a carbon footprint almost equivalent to the airline industry. This has brought them under severe scrutiny of environmental groups. As a result, the IT Industry has been making a conscious effort to reduce their carbon footprint by adopting green innovations.

Data Centres' Green Efforts

A feasible solution at hand for reducing carbon footprint of these data centres is the usage of renewable energy. Utilising renewable energy can not only help reduce data centres' overall emission by 98 percent, when combined with other strategies, but also effectively bring down their expenses. Some of the world's renowned Tech giants have already commenced on this path of green revolution by introducing their data centres to renewable energy. Google is the world's largest corporate buyer of renewable energy and intends to meet its target of 100% renewable power usage by this year. Apple has already reached this mark as all its data centres are 100% powered by clean energy while Microsoft's data centres are 100% carbon neutral with a 50% renewable energy target in place for 2018.

The Indian data centres are likely to soon follow suit, given the exponential growth expected in the country's cloud market, in the absence of reliable and adequate power grid infrastructure. Apparently, India has a target of 175GW of renewable energy by 2022, which makes an attractive market for leveraging this trend in the growth of data centres. In fact, Indian data centres' inclination towards adding renewable energy to the mix is already in the rise. NxtGen has built India's largest carrier-neutral data centre at Bidadi which partially draws power from solar panels. The solar plant will mitigate 57,54,427 kg of carbon dioxide over its project life, making it India's first green data centre. In 2014, IBM India started using solar power and water cooling for air conditioning in its Bengaluru data centre, cutting greenhouse emissions by nearly 40%. It uses a 50-kW solar photovoltaic system that provides electricity to the data servers.

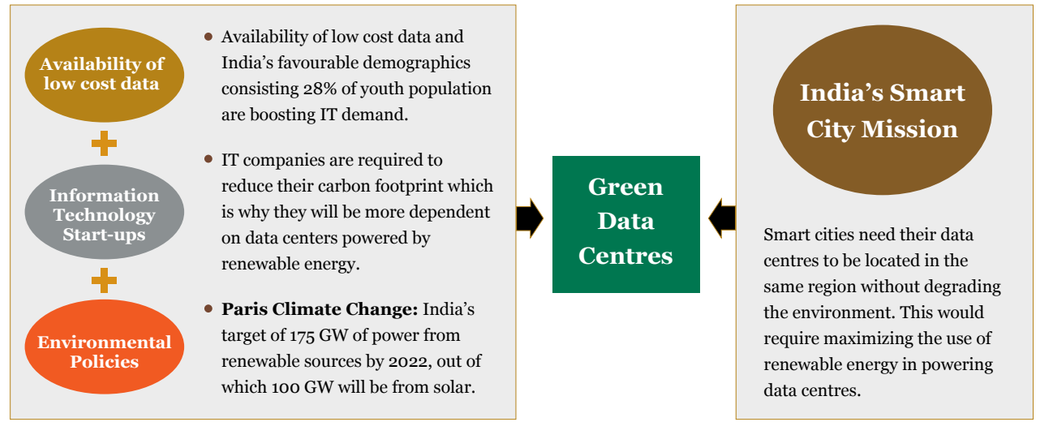
Smart Cities Initiative to Further Spur RE Demand

The Indian government, under the leadership of our current Prime Minister, had announced a flagship program Smart Cities, an initiative undertaken to develop 100 smart cities by 2024. These Smart Cities will run on smart technologies, viz. smart grid, smart phones and different tracking devices, all of which will generate large amounts of data, in turn creating further demand for data centres.

Two of the core infrastructure elements in a smart city would include robust IT connectivity and digitalization along with assured electricity supply but within a clean and sustainable environment. As power is one of the major components of these smart cities, there is a need to develop alternative energy sources to make them financially and ecologically viable. As a result, developing India's capability in the new and renewable energy space is a key requirement to ensure success of the Smart Cities project.

The government is promoting various energy sources such as wind, solar, hydro, and nuclear at full throttle while introducing new technologies to harness power from renewable energy. The target of generating 20 GW through solar power has been enhanced to five times at 100 GW by 2022. The total installed capacity crossed the 5 GW mark recently and there is a clear line of sight to get to 20 GW in the next 18 months.

Exhibit 32: Future Demand Generating Factors for Green Energy in India



Source: LSI Research

Challenges Faced by Indian RE Market

Nevertheless, the government's path will be laced with several challenges when it comes to implementation. Smart Cities will be mostly dominated by high-rise buildings with very less rooftop space which will likely result in space crunch during installation of solar modules. Besides, accumulation of dust on solar panels and high per unit cost of energy are some of the unique challenges the renewable energy industry in India faces. A major hindrance is the high initial cost of installation. While development of a coal-based power plant requires around Rs 4 crore per MW, wind-based and solar-based plants require investments of Rs 6 crore per MW and Rs 18 crore per MW, respectively.

Conclusion

Despite the challenges faced by the Indian Renewable Energy market, depending on fossil fuel energy resources can no longer be an option as they will be exhausted within a generation or two given the present global economic growth rate. Therefore, the future of our energy needs lie in renewable energy resources, the use of which should be encouraged by introducing new policies and regulatory mechanisms. Given the vast potential of renewables in India all that is required are comprehensive policies and an investor friendly regime for the nation to be amongst one the global leaders in clean and green energy.

Case Study 2:

Is Solar Energy Facing the Veblen Effect in India?

Over the past 7 years, Solar Power tariff in India has plummeted to unprecedented lows, from Rs.17.91 per unit in 2010 to Rs.2.44 in May, 2017. This remarkable price drop would naturally lead one to think that Solar Power must have garnered substantial demand in the country by now. Unfortunately, the story of Solar Energy in India is quite the contrary. Demand for this particular Renewable Energy has only diminished with reducing prices. So does that make Solar Power a Veblen Good in India?

What Exactly is a Veblen Good?

Veblen Good is a term used to define products for which demand increases with rising price and falls along with price drop, which is an apparent contradiction of the law of demand. For instance, the latest iPhone is an absolute must have, no matter the price, but as soon as a newer model comes out and the older one becomes less expensive, the desire to own it, too, subsides.

The Curious Case of Solar Power Price Drop

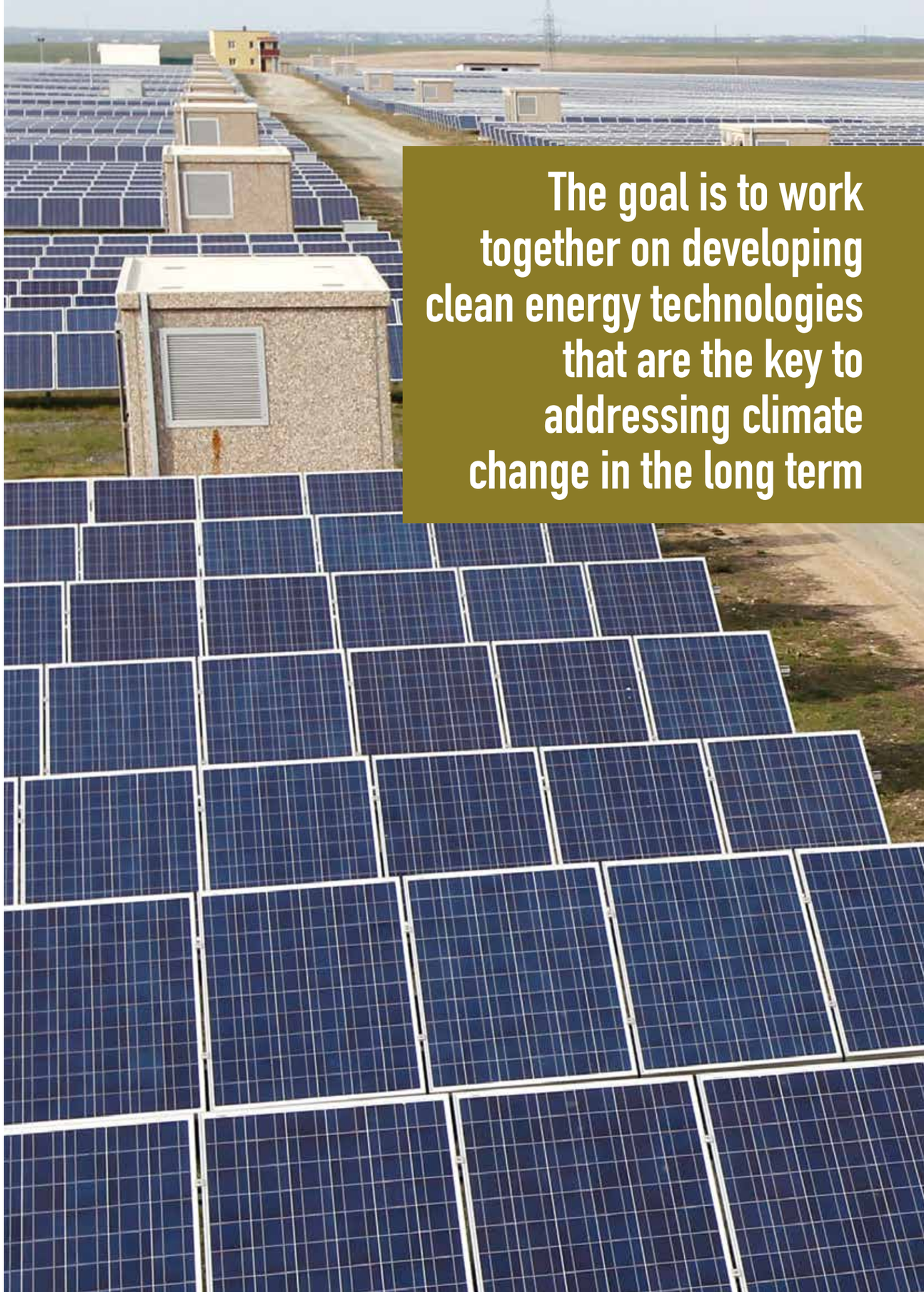
If not demand, then what exactly is the reason behind such rapid drop in Solar Energy prices? Some experts believe that this insane cut in prices might have been driven by cheaper finance and growing investor confidence in India's pledge to dramatically increase its solar power capacity, with the target set at 100 gigawatt(GW) by 2022. On the other hand, according to the Indian Solar Manufacturers Association cheap imports from China is the reason behind Solar Power tariffs hitting record lows. The prices of Solar Panels have crashed to $0.32 per kWh from $0.50 per kWh in three years, owing to global over-capacity and dumping by China.

The Demand Scenario

Now that Solar Power is much cheaper than Coal Power, the notion for India should naturally be propagating utilisation of this clean, environment-friendly energy. However, that does seem to be the case at all. Low unit price of Solar Energy has created significant uncertainty in the transaction space. Investors are becoming increasingly cautious about buying solar assets with firm offtake agreements struck at higher tariffs. Utilities remain another issue as they are refusing to sign new power purchase agreements unless prices are revised downwards to bid prices.

The Veblen Effect

While the current scenario in the Indian Solar Power Industry points towards this very valuable Renewable Energy source becoming a Veblen Good, it might yet not be the time to draw a trenchant conclusion. The Indian government is already adopting several reforms to revive Solar Energy activities, one of which is offering a 30 percent subsidy for setting up new plants while expanding existing ones. Heavy equipment required to set up projects shall also be exempt from customs duty. Moreover, an anti-dumping duty investigation on solar equipment from China, Taiwan and Malaysia is also underway. And then there always remains the fact that fossil fuels will only last us a generation or two, which makes renewable energy our sole resort.



The goal is to work together on developing clean energy technologies that are the key to addressing climate change in the long term

CHAPTER 6

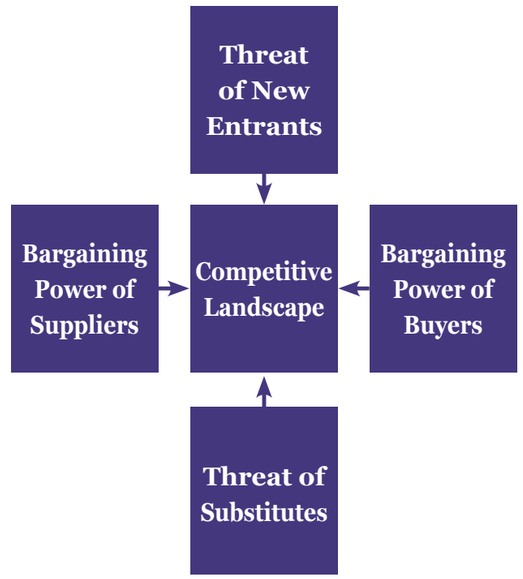
The Solar Power Ecosystem and Competitive Landscape

Porter's Five Force Analysis

Conducting a Porter's Analysis will shed light on the three main market players for the Indian Solar Industry:

1. Solar Photovoltaic Cell and Module Manufacturers; 2. Solar Project Developers; and 3. The Final Consumers. The Porter's Analysis will help in understanding the competitive landscape for the Indian Solar Industry better.

Exhibit 33: Michael Porter's Five Force Model



Source: LSI Research

Threat of New Entrants

The solar power industry like any other power industry is capital intensive and involves large costs for research and development. This nature of the industry makes entry of new firms difficult. Existing companies enjoy economies of scale which is a hindrance for new companies in the sector. The established industry giants are able to maintain their control of market share.

Furthermore, regulatory approvals and land remains a major problem in the sector. This further adds to the barriers to entry of new firms. However, it is expected that in the future, the threat of new entrants might increase as soon as grid parity is reached. Also, with falling solar tariffs and increasing support from the government, this sector is becoming attractive overall.

Threat Level- Moderate

Bargaining Power of Buyers

Though the prices are not regulated for industrial customers, for retail consumers the government sometimes interferes to regulate prices. In general, the bargaining power of consumers is moderate in the renewable energy development market. Solar products are mainly differentiated based on cost/KW of efficiency, and thus, low product differentiation in this industry makes the buyer discriminant as the switching costs are low. However, if a customer enters into a Power Purchase Agreement, a loan option, or lease option for solar, then these agreements can be for 20-30 years and the switching costs for these customers are extremely high.

Threat Level- Medium

Threat of Substitutes

Solar power does not have any substitutes, however the electricity produced via solar power can be substituted for the electricity generated from fossil-fuels. Conventional sources of energy are the closest substitutes and the market in general is dominated by them.

Even though there is a solar power can be substituted with thermal power electricity, the RPOs regulations make the substitution difficult. Also, with the falling solar tariffs falling, grid parity will be reached very soon.

Threat Level- Low

Bargaining Power of Suppliers

Some parts of the supply chain such as polysilicon manufacturing have no domestic players and are high risk investments, given the high capex involved and the significant global competition particularly from China. Some other parts such as modules have relatively low risk from a capex standpoint, but have significant competition from numerous domestic companies as well as Chinese companies that offer similar products at far lower prices. Chinese modules are 10-20% cheaper than those made in India.

Further, the anti-dumping law introduced by the government and with the import duties in place, the domestic project developers are left with no choice. They now have to source their module requirements domestically despite of the high prices. This policy has given strengthened the bargaining power of suppliers in India.

Threat Level- High

Competitive Landscape

The overall industrial rivalry is not intense due to the oligopoly structure in the segment. In India, the projected demand is already above the supply levels. The intensity of rivalry from the direct competition i.e. companies dealing in solar equipment and solar power, is low but from the indirect competition i.e. companies dealing in conventional residential pump it is very high.

Competitive rivalry is expected to increase in the future due to government encouraging private players to enter the sector. The government subsidies and benefits are attracting many firms to the industry.

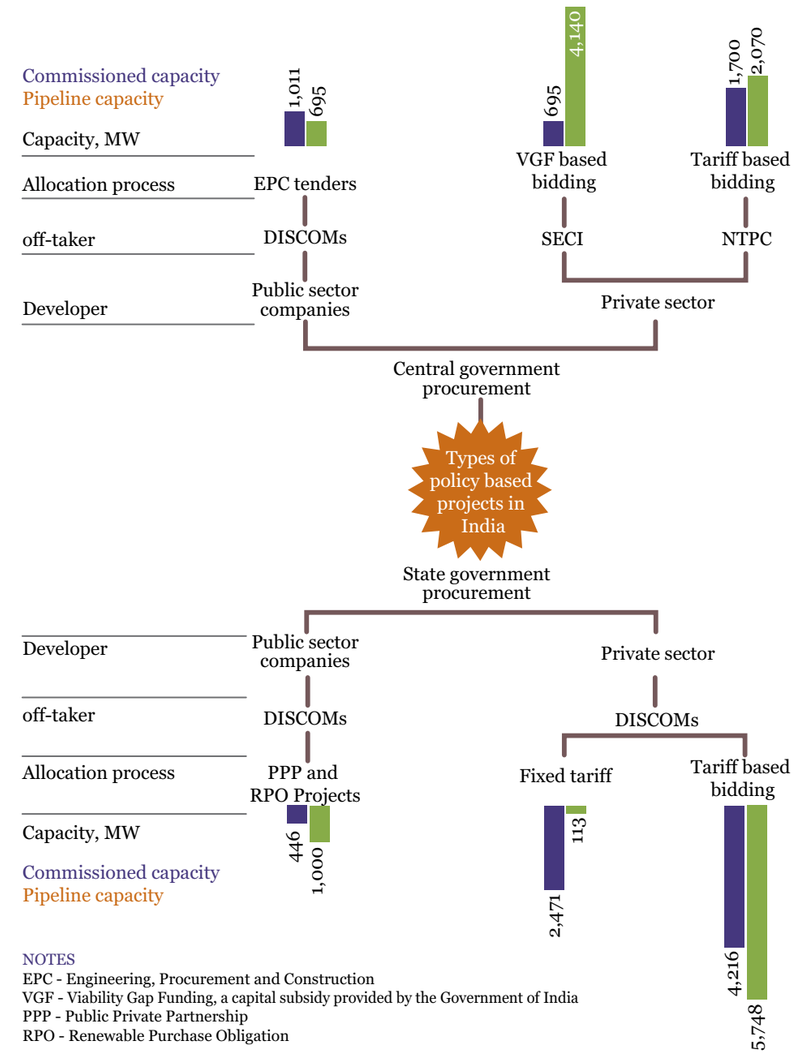
Threat Level- Medium

Overall Industry Attractiveness

The 'Make in India' concept for solar is filled with both opportunities and challenges. The threats for companies in the renewable energy industry are substantial, and barriers to entry would make it hard to simply get in the door of most of the available sections in the industry. The high threat levels make the overall industry attractiveness fairly low.

The challenge with this conclusion is that the customer base for solar is growing every single year so it would logically make sense to join an industry with an expanding customer base. However, the warning signs here show that there is a tremendous amount of adversity in the industry that would make success very difficult to achieve and sustain.

Exhibit 34: Types of Policy-based Projects



Source: Bridge to India, India Solar Handbook, 2017

Project development landscape

As the Indian solar market grows and project sizes increase, international developers and private equity funded IPPs are playing a greater role.

Exhibit 35: Commissioned capacity as of March 31,2017

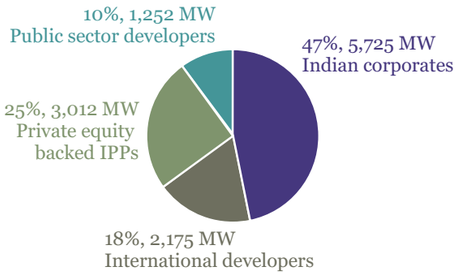
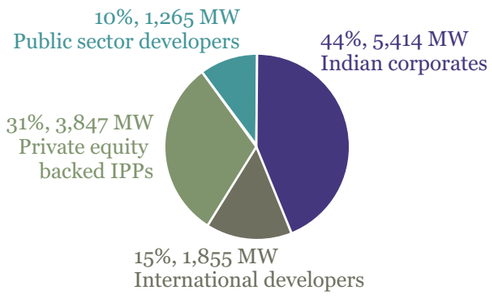


Exhibit 36: Capacity Under Development as of March 31, 2017



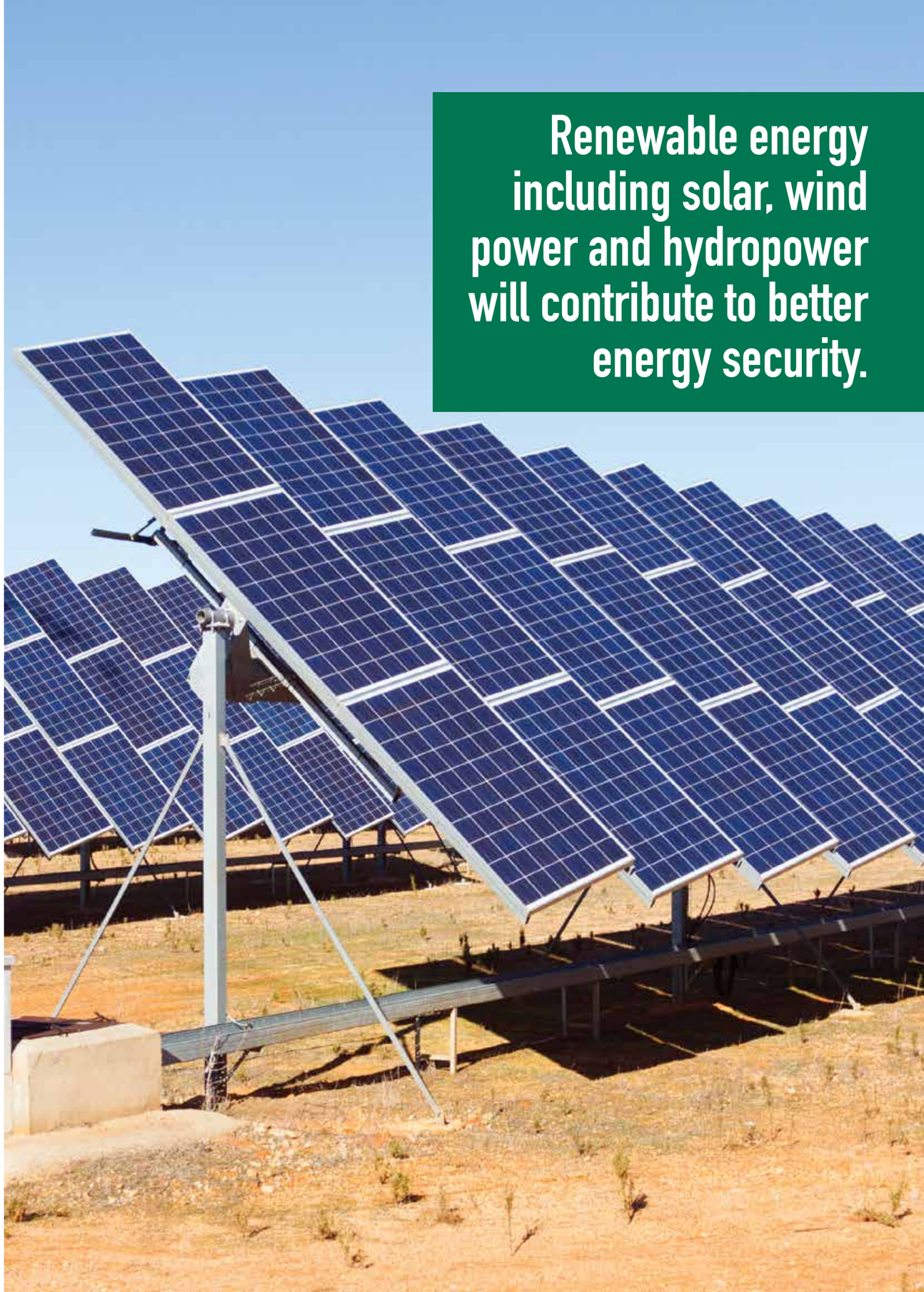
Source: Bridge to India, India Solar Handbook, 2017

Renewable energy projects of close to 6650 MW will be tendered in February 2018, taking the total for 2017-18 past 10,000 MW – a record in a financial year.

Recent studies have shown that India has achieved a milestone 20GW in cumulative solar installations, though the MNRE record maintains that the solar capacity in India is at 16 GW. The top state for solar installation in Telengana, followed by Karnataka, Andhra Pradesh and Rajasthan.

According to a recent update, 1,456 Mw of solar projects were tendered and 1,232 MW auctioned in the third quarter of 2017. It is a marked reduction from what had been seen in the second quarter of 2017, when 3,408 MW was tendered and 2,505 MW auctioned. According to the annual plan of the Ministry 3 GW were to be tendered in December 2017, followed by 3 GW in January and 5 GW in February and 6 GW in March. According to the plan 30 GW each will be tendered in 2018-19 and 2019-20. However, it is expected that several regulatory changes would affect the renewable energy landscape in the coming financial year.

It took eight long years to reach a cumulative solar installation capacity of 20 GW and hopefully the pace will pick up. Private solar companies in India have gained vital experiences over the years and are looking to the government to create an environment conducive and remove the policy uncertainties currently acting as the roadblocks for the industry's growth trajectory.



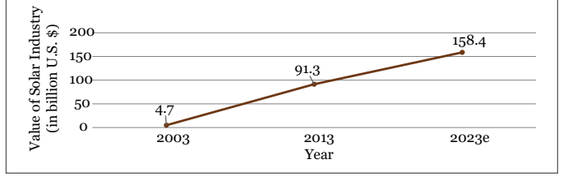
CHAPTER 7

Global Comparison and Future Outlook

Solar power was the fastest-growing source of new energy worldwide last year, which is simply capable to start a new era in the sector of renewable energy. Renewable energy accounted for two-thirds of new power added to the world's grids in 2016.

Over the next 14 years, India is actually on the phase to become the world's fourth-largest consumer of renewable energy, after China, United States and European Union. This is believed that the renewable energy will account for 40% (two-fifths) of power generation in India by 2030, if global renewable energy supplies double.

Exhibit 37: Value of the Global Solar Power Market from 2003 to 2023



Source: www.statista.com

This graph represents the value of the global solar power market in 2003 and 2013 and also a forecast for 2023. The global solar power market is expected to be valued around 160 billion U.S. dollars by that time.

Global Solar Report (2016)

In the year 2016, wind, solar, biomass and waste-to-energy, geothermal, small hydro and marine sources added 138.5GW, up from 127.5GW in the previous year.

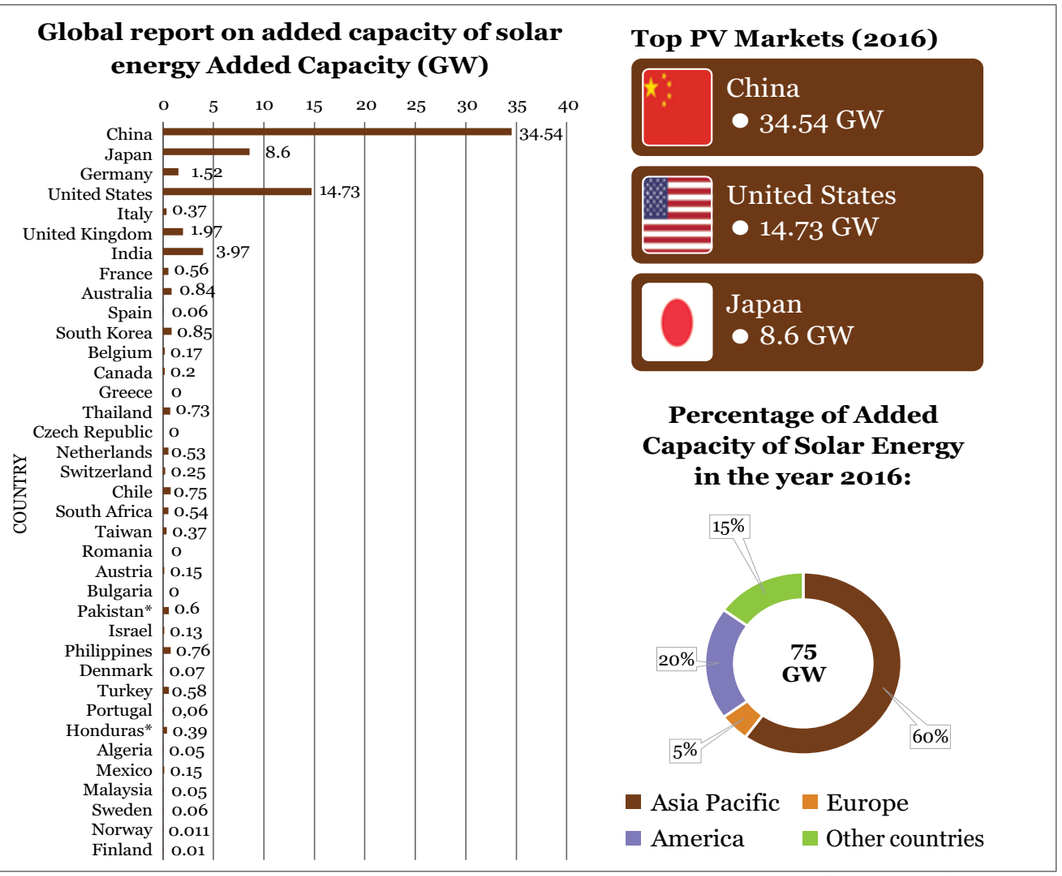
The most promising fact was a series of winning bids for solar, in auctions around the world, at tariffs which were found really low only a few years ago. The records set last year were $29.10/MWh for solar in Chile. Low announced prices for solar and wind were recorded in a variety of places, including India, the United Arab Emirates, & Mexico.

New investment in solar in 2016 totalled $113.7 billion, down 34% from the all-time high in 2015, due in large part to sharp cost reductions.

This was another record year, largely as a result of booming solar PV deployment in China and around the world, driven by sharp cost reductions and policy support.

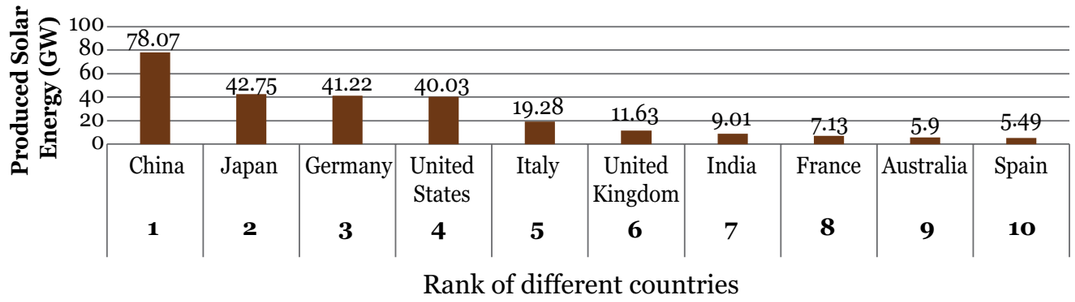
India saw the construction of the Ramanathapuram solar complex in Tamil Nadu, billed as the world's largest ever PV project at some 648MW.

Exhibit 38: Global solar market in the year 2016 at a glance:



Source: www.iea-pvps.org

Exhibit 39: Top Ten countries for Cumulative Installed Capacity of Solar Energy Till 2016



Source: www.iea-pvps.org

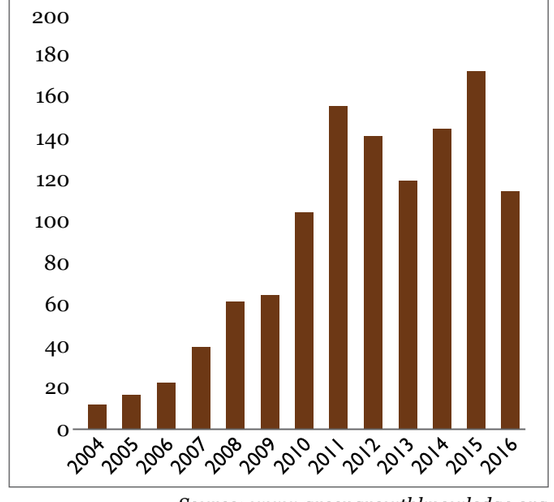
Key findings of Global Solar Market in 2016:

- 303 GW has been installed all over the world by the end of 2016.
- New installations of around 75 GW took place in the year 2016.
- China has established itself as the world's 1st PV market.
- The largest increments in 2016 were recorded in China (34.5 GW) and the US (14.7 GW), together accounting for two-thirds of the growth in global solar capacity. Japan provided the third largest addition (8.6 GW). China also leads in terms of cumulative installed capacity (78.1 GW), with more than a quarter of the global total. Japan (42.8 GW) moved past Germany (41.3 GW) to take second place, with the US (40.3 GW) now close behind Germany.

Investment in solar project by different economies:

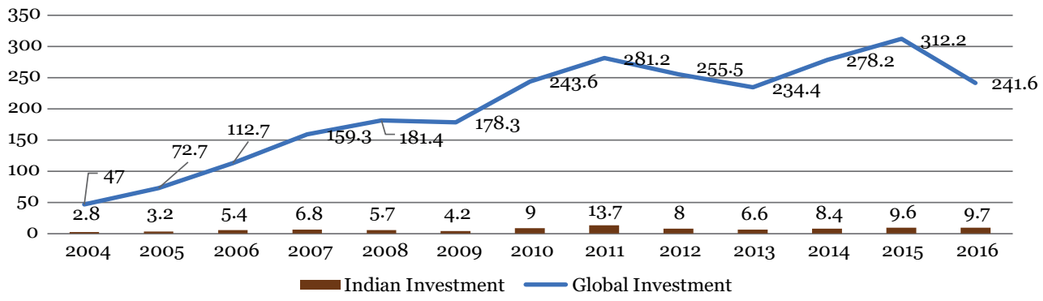
- According to some new annual figures of established report, the global investment in solar reached about $161 billion in the year 2017. That total is an increase of 18 percent over the previous year, and represents almost half of the total global investment in renewable energy and energy-smart technologies of $334 billion.
- The impact of lower costs for wind and solar was felt everywhere.
- Dollar investment in developed economies fell by 14% to $125 billion in 2016, some 52% of the world total, with a 10% decline in the US, a 3% increase in Europe, and a 56% drop in Japan.
- The 'big three' developing economies of China, India and Brazil saw a combined 28% setback in dollar investment to $94.7 billion. China was down by almost a third, Brazil 4% lower and India held steady.

Exhibit 40: Global Investment in Solar Sector, 2004-2016 (in $ billion)



Source: www.greengrowthknowledge.org

Exhibit 41: Investment in Renewable Energy from 2004 to 2016 (in $ billion)



Source: www.greengrowthknowledge.org

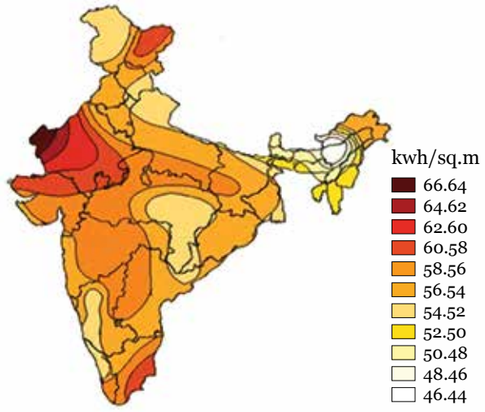
Outlook

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. Even if a tenth of this potential can be utilised, it could mark the end of India's power problems. 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."

The geographical position of India makes it a sunlight rich country due to its convenient location near the Equator, and that's why this is blessed with about 5,000 TWh of solar insolation every year.

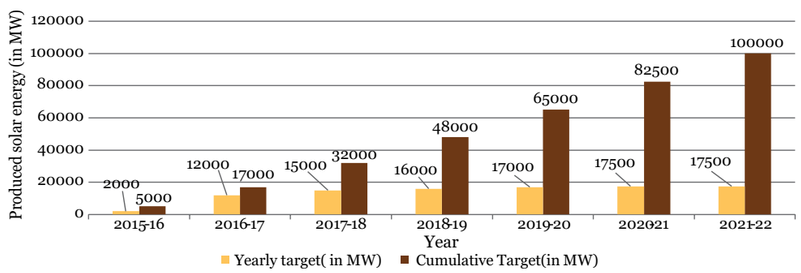
Exhibit 42: Solar Insolation Profile of India



Source: indianpowersector.com

The ministry has fixed the target of 100 GW for solar power project by the year 2022 under National Solar Mission.

Exhibit 43: Yearly & Cumulative Target for Solar Power Project in India from 2016-2022

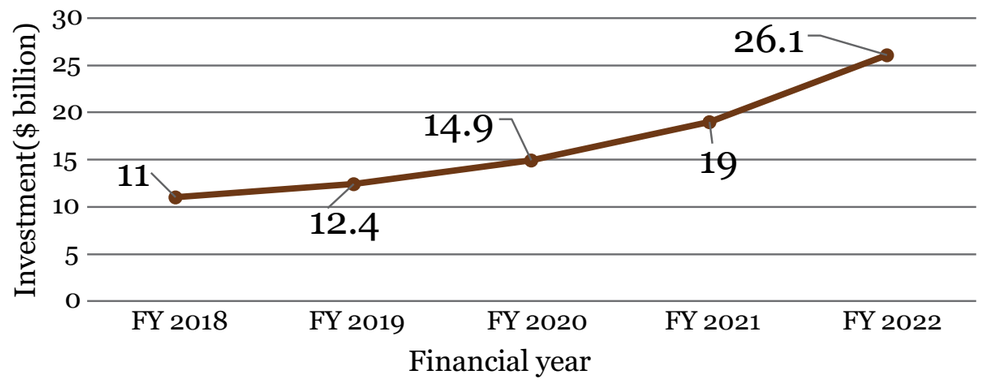


Source: www.mnre.gov.in

This has been estimated that India would need $83 billion between FY2018-FY2022 to meet its 175GW target.

Utility-scale renewable energy aspirations of 135GW will require $19 billion less than the previous estimates.

Exhibit 44: Investment Required to Achieve 175 GW Renewable Energy Target by FY2022



Source: data.bloomberglp.com

Budget 2018 for solar sector:

This year the budget has also allocated ₹2.17 billion to the state-owned **Solar Energy Corporation of India (SECI)** under the internal and external budgetary resources. The finance minister has announced that the government will undertake necessary measures to encourage state governments to put in place a mechanism that would ensure that their surplus solar power is purchased by distribution companies (DISCOMs).

Key highlights from the Budget 2018-19 regarding the renewable and solar sector:

- The government will encourage state governments to put in place a mechanism that their surplus solar power is purchased by the distribution companies or licensees at reasonably remunerative rates.
- Customs duty on solar tempered glass or solar tempered (anti-reflective coated) glass for manufacture of solar cells /panels/modules reduced to zero percent from the earlier rate of 5 percent.
- Income tax for Micro Small and Medium Enterprise (MSME) companies with annual revenues of up to ₹5 billion has been reduced to 25%, which is expected to benefit smaller renewable companies.
- Solar Energy Corporation of India (SECI) has been allocated ₹2.17 billion under IEBR.
- Ministry of New and Renewable Energy (MNRE) has been allocated ₹99 billion under internal and extra budgetary resources (IEBR).
- The tariff rate of customs duty for Lithium-ion batteries is being increased from 10% to 20%. The effective rate of import duty on Lithium-ion batteries (other than Lithium-ion batteries for cellular mobile phones) will, however, remain unchanged at 10%.

Major Initiatives taken by Ministry for Solar projects in India:

Solar Power

Under National Solar Mission, the target for setting up solar capacity increased from 20 GW to 100 GW by 2021-22. Target of 10,000 MW, set for 2017-18 which will take the cumulative capacity over 20GW by 31st March 2018.

Capacity of the scheme for "Development of Solar Parks and Ultra Mega Solar Power Projects" has been enhanced from 20,000 MW to 40, 000 MW.35 solar parks of aggregate capacity 20,514 MW have been approved in 21 States.

Several schemes namely (i) Defence scheme (ii) Central Public-Sector Undertakings (CPSUs) scheme (iii) Canal Bank/ Canal Top scheme (iv) VGF Scheme (v) Solar Park scheme etc. have been launched by the Ministry under NSM which are under implementation.

Solar Rooftop - Ministry is implementing Grid Connected Rooftop and Small Solar Power Plants Programme which provides for installation of 2100 MW capacity through CFA/ incentive in the residential, social, Government/ PSU and Institutional sectors.

So far sanctions for 1767 MWp capacity solar rooftop projects has been issued and around 863.92 MWp capacity has been installed.

All the 36 State / UT ERCs have now notified net/gross metering regulations and/or tariff orders for rooftop solar projects

Concessional loans of around 1375 million US dollars from World Bank (WB), Asian Development Bank (ADB) and New Development Bank (NDB) have been made available to State Bank of India (SBI), Punjab National Bank (PNB) and Canara Bank for solar rooftop projects.

Suryamitra programme has been launched for creation of a qualified technical workforce and over 11 thousand persons have been trained under the programme.

Along with several other initiatives, launched mobile app ARUN (Atal Rooftop Solar User Navigator) for ease of access of beneficiaries for request submission and awareness.

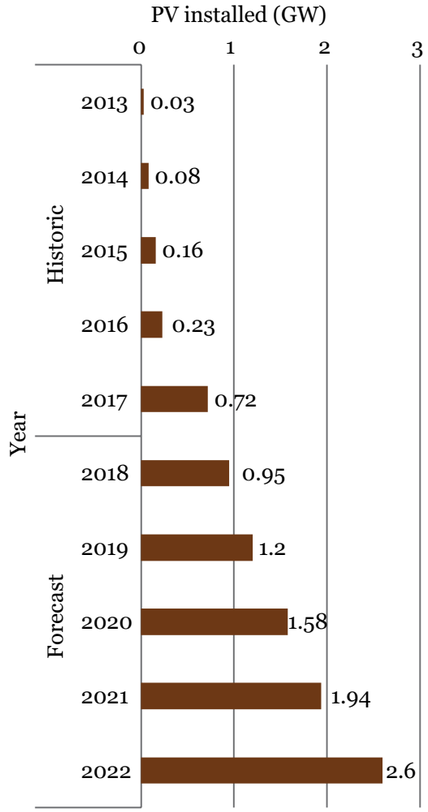
MNRE has allocated Ministry wise expert PSUs for implementation of RTS projects in various Ministries/ Departments.

Investment for achieving the targeted level of solar energy:

- India is encouraging development of renewable energy projects to provide clean energy at cheap and reasonable prices to its 1.3 billion people. Rooftop solar continues to be the fastest growing sub-sector, and needs to grow faster still to reach the ambitious 40GW target for 2022, which presents a $23 billion investment opportunity.
- The majority of the capacity in the 2022 target – a total of 135GW – is utility-scale (wind farms and solar parks, in particular).
- Rooftop solar in India will grow inevitably with or without the support of power distribution utilities. Total rooftop PV capacity at the end of FY2017 in India totalled 1.3GW. More capacity was added in the last financial year than in the previous four years combined.
- This is expected that India will reach 9.5GW of rooftop PV capacity by FY2022 – seven times of its current total.

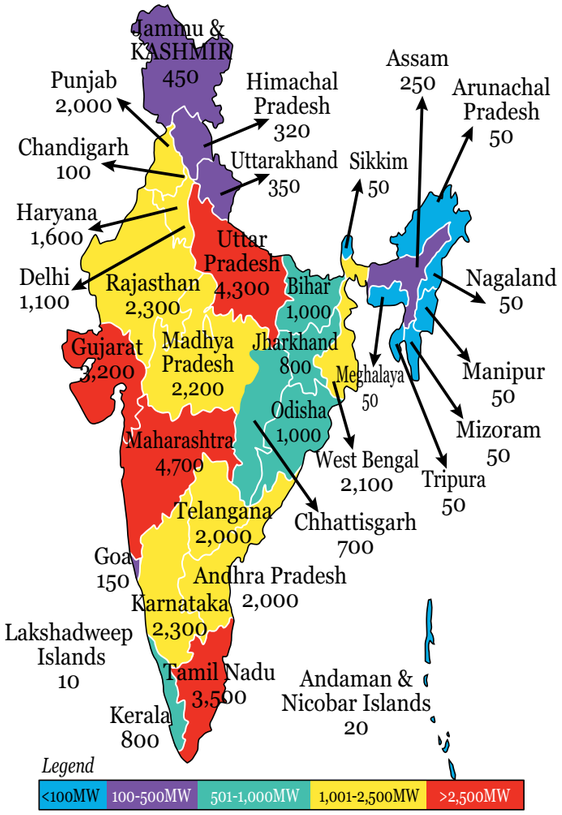
Annual rooftop PV installations in India and forecasts:

Exhibit 45: Annual Rooftop PV Installations in India & Forecasts



Source: data.bloomberglp.com

Rooftop PV installation targets in Indian States for March 2022



Source: data.bloomberglp.com

Investment for different solar projects:

Exhibit 46: Year wise Target of Cost Differential Envisaged for RE Segments

Segment	2015-16 (INR Crores)	2016-17 (INR Crores)	2017-18 (INR Crores)	2018-19 (INR Crores)	2019-20 (INR Crores)	2020-21 (INR Crores)	2021-22 (INR Crores)
Grid connected solar	2,523 - 5,087	4,726 - 12,512	2,346 - 10,034	497-5637	0-2,627	0-710	0-74
Rooftop PV (residen-tial/in situational)	60	1,440	1,500	1,800	2,100	2,400	2,700
Off-grid/ mini-grid segment	54	8,181	12,330	20,430	40,995	–	–

Source: www.niti.gov.in

- India's installed solar power capacity reached 14,771.69 as of September 2017. A total of 2,247 megawatts (MW) was installed in the third quarter of 2017, from 1,947 MW in the second quarter of 2017. The cumulative installed capacity reached 7,149 MW in the first nine months of 2017, covering more than one-third of total new power capacity addition in 2017.
- Average cost of debt for renewable energy projects in India has come down. However, at 9-11%, debt is still among the most expensive in Asian countries.
- With the aim of giving a motivation to renewable energy, the State Bank of India (SBI) and the World Bank have decided to sanction credit worth Rs. 2,317 crore (US$ 356.82 million) to seven corporates towards solar rooftop projects to generate a total of 575 megawatt (MW) of solar energy.
- The Department of Economic Affairs, Government of India, signed a guarantee agreement for IBRD/CTF loan worth US$ 98 million and grant agreement for US$ 2 million with the World Bank for 'shared infrastructure for solar parks project'.

Disclaimer: *This report is based on publicly available data and other sources that we consider reliable. While every effort is made to maintain the accuracy and completeness of information contained, we do not represent that it is accurate or complete and do not take liability for errors or omission. LSI Financial Services Pvt. Ltd. shall not be liable for any direct or indirect damages that may arise due to any act of omission on the part of the user due to any reliance placed or guidance taken from any portion of this report.*

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