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Solar Parks to Ramp up Solar Projects in the Country, Issues and Challenges: Contribution towards Climate Change

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Abstract : The objective of this paper is to review the basic concepts of solar parks and its new era of development of solar projects in India. The paper describes the most recent approach for development of solar projects in the form of a solar park with growth oriented and easily acceptable facilities to all. Considering the declining prices of solar power vis-a-vis other source of costlier power, leading to growth in solar sector by which it has become more affordable to Solar Project Developers (SPDs) and Distribution Companies (DISCOMs). In solar parks an increased trend in participation in bidding, as they foresee opportunities in solar business with reasonable return on investment. Further, the increased scalability, assured off-take, guaranteed payment, risk free and preserving grid connectivity also created an environment of profitable business. With a strong commitment to increase the renewable sources-based energy capacity to 175 GW by 2022, India has a target to install 100 GW of solar energy capacity out of which 40 GW would be the share of Solar Parks. The another approach in this chapter is to evaluate the determined policy in India on large scale ultra-mega solar projects or solar parks which designed as a package deal, enabling project development time lines to be streamlined by allowing different government as well as private agencies to undertake land acquisition and seek necessary permits, and providing a dedicated common infrastructure in the form of developed land, water availability and access roads, and power transmission systems for setting up solar power generation plants inside the solar park.

Key words: Solar Parks, Renewable Energy in India, National Solar Mission, Solar Development

1. Introduction

National Solar Mission (NSM) is a major initiative by Government of India, to promote ecologically sustainable growth and addressing energy security challenge. The NSM is one of the eight missions of National Action Plan on Climate Change (NAPCC). Recognizing the potential of solar energy to contribute to energy security of the country, the Government of India launched NSM on the 11th January, 2010. The objective of the NSM is to establish India as a global leader in solar energy, by creating the policy conditions for its diffusion across the country as quickly as possible. Implementation of the Mission is envisaged to adopt a 3-phase approach, spanning the period of the 11th Plan and first year of the 12th Plan (up to 2012-13) as Phase-I, the remaining 4 years of the 12th Plan (2013-17) as Phase-II and the 13th Plan (2017-22) as Phase-II. Policy framework under Mission is to create the necessary environment to attract industry and project developers to invest in research, domestic manufacturing and development of solar power generation and thus create the critical mass for a domestic solar industry.

The mission National Solar Mission (NSM) under the brand name “Solar India” set an target of adding 20 GW of Grid connected and 2 GW of Off-grid capacity by 2022.

India, in its Intended Nationally Determined Contributions (INDC), announced to increase share of installed electric power capacity from non-fossil-fuel-based energy resources by 2030 to 40% and to reduce the emission intensity of its GDP from 33 to 35% by 2030. In consideration of above, the Government of India in June 2015 scaled up the target for setting up of grid connected solar power capacity from 20,000 MW to 1,00,000 MW by 2022 under the NSM. The above capacity is proposed to be achieved through deployment of 40,000 MW of rooftop solar projects and 60,000 MW medium& large scale solar projects.

In order to harness the solar potential efficiently and to achieve the objectives of NSM, it was required to develop State level Infrastructure solely dedicated to promote solar power generation. One of the ways of achieving that was development of solar parks in a focused manner across different parts of the country.

The solar park is a large chunk of contagious land developed with all necessary infrastructures like approach & access road, water facility, power evacuation infrastructure, metrological station, telecommunication infrastructure etc. Solar Park also facilitates developers by reducing the number of required approvals. The most important benefit from the solar park for the private developer is the significant time saved. The solar parks facilitate the solar project developers to set up projects in a plug and play model.

2. Solar Energy Status in India:

India’s Power Sector has predominantly been based on fossil power and use mostly domestically produced coal to generate electricity. The country has been rapidly adding generating capacity since Independence largely due to economic growth, rising population, rapid urbanization leading to rise in demand. The utility electricity sector in India has one National Grid with an installed capacity of 330.86 GW as on November, 2017. India is the world's third largest producer and fourth largest consumer of electricity. The gross electricity consumption was 1,122 kWh per capita in the year 2016-17. The per capita electricity consumption is low compared to many countries despite cheaper electricity tariff in India. The contribution of power from renewable energy sources contributes about 17% and that of solar power is more than 4% in the overall energy mix as shown in figure1.

The growth of around 90% has been achieved with capacity addition of 22,256 MW grid renewable power during last three years (2014-15 to 2016-17 as on 31.03.2017), as compared to

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11,746 MW installations during preceding three years (2011-12 to 2013-14).

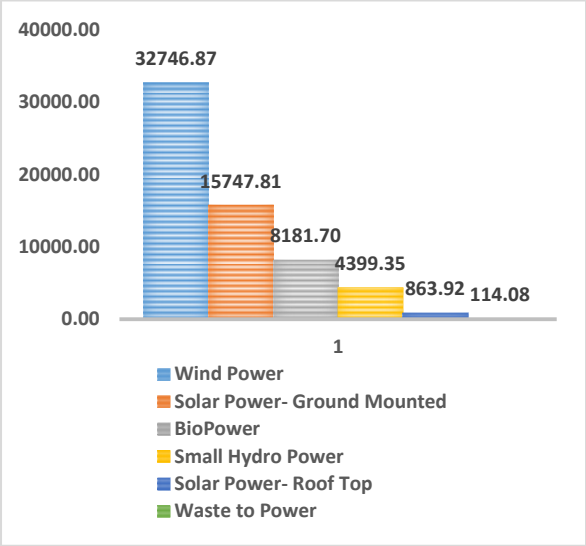

Figure 1: Installed Capacity of Renewable Energy in India as on 30-11-2017 (Source: MNRE/CEA)

The cumulative installed capacity of grid renewable power has reached to 57,244 MW at the end of FY 2016-17, which accounts for 17% of grid renewable power installed capacity from all resources. The aggregate 57,244 MW grid renewable power installed capacity includes 32,280 MW from Wind power, 12,289 MW from Solar power, 4380 MW from Small Hydro Power and 8295 MW from Bio-Power as shown in the figure 2.

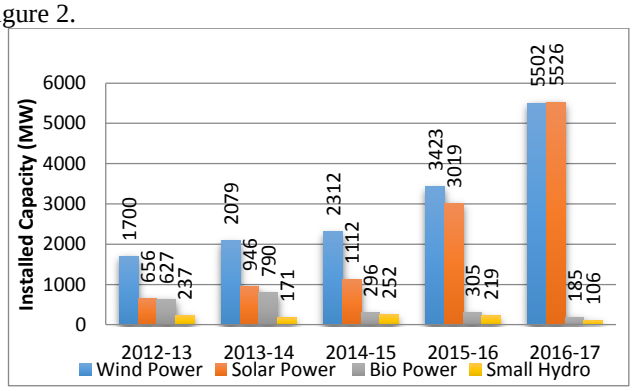

Figure 2: RE sectors wise progress during last 5 years

However, the main challenges being faced in conventional power generation include depleting coal reserves in India, difficulty in procurement of imported coal and long gestation periods of coal-based power plants.

India, with its large population and rapidly growing economy, needs access to clean, cheap and reliable sources of energy. India lies in the high solar insolation region, endowed with huge solar energy potential with most of the country having about 300 days of sunshine per year with the daily solar radiation incident varies from 4 - 6 kWh per square meter of surface area depending upon the location and time of the year.

Government of India has taken up renewable energy as an article of faith and set up an ambitious target of 175 GW installed renewable capacity by 2022. Out of 1,75,000 MW, 1,00,000 MW is proposed to be achieved through solar energy. As on October 2017, around 14,800 MW solar power projects have been installed in the country.

The Government is promoting solar energy through fiscal and promotional incentives, such as capital subsidy, generation-based incentive, accelerated depreciation, viability gap funding (VGF), financing solar rooftop systems as part of home loan, concessional custom duty, exemption from excise duty and foreign direct investment up to 100 per cent under the automatic route, etc.

There is tremendous opportunity for foreign investment in India in solar sector as foreign direct investment is permitted under the automatic route. Reserve Bank of India (RBI) has announced renewables including solar energy as priority sector. This will enable banks to provide loans up to a limit of Rs 150 million to borrower companies of renewable energy. For individual households, the loan limit has been set to Rs 1 million per borrower. Ministry of Finance has accorded in-principle approval for issuance of tax free infrastructure bond of Rs. 5000 crore for funding renewable energy projects. India has taken another initiative to create an International Solar Alliance (ISA). It will be a group of around 120 countries working for development and promotion of solar energy. India as founder member of this alliance has offered to have its secretariat and also committed some financial contribution.

3. Growth of Solar Capacity

Prior to the launch of National Solar Mission, only 11 MW of solar capacity was installed. However, after the launch of the NSM and other State policies encouraging solar energy generation, the solar capacity grew at a rapid pace. Total solar capacity installed of about 1 GW was added upto the 11th Plan Period and about 9 GW were added in 12th Plan Period. In last five years, solar energy sector has grown at a rapid pace. As shown in figure 3 the installed capacity of solar projects has increased from 2,632 MW in 2013-14 to 16,675 MW in 2017-18 .

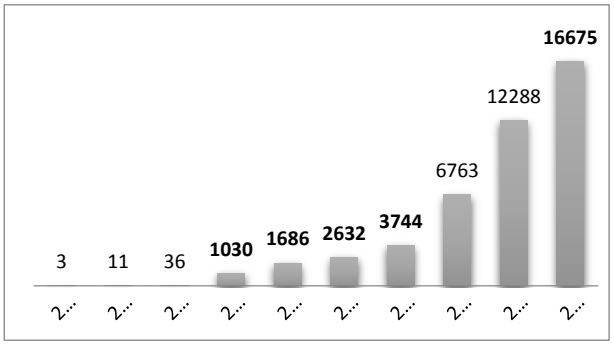

Figure 3: Cumulative Installed capacity (in MW as on 30-11-2017, Source: MNRE/CEA)

Out of the above solar capacity, the 10 states contribute about 90% of the total capacity installed as shown in figure 4.

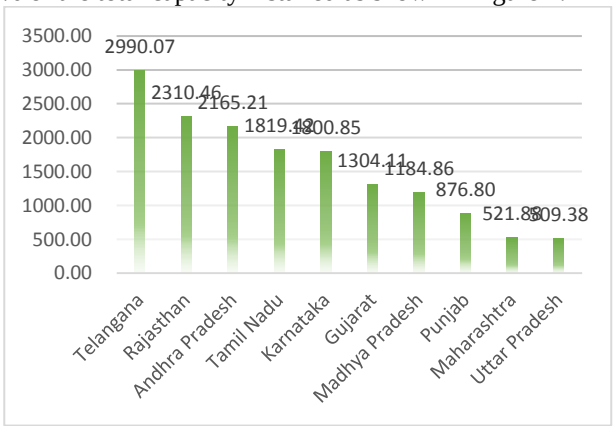

Figure 4: Top ten states in Solar Capacity (in MW)

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4. Solar Manufacturing in India

One of the NSM's objectives is to take global leadership role in solar manufacturing across the value chain of leading edge solar technologies and target a 4-5 GW equivalent installed capacity by 2020. The Mission statement mentions setting up of dedicated polysilicon manufacturing capacities sufficient to cater to produce 2 GW worth of solar cells annually.

In India, most manufacturing capacity was idle or operating at low utilisation rates, primarily because it is uncompetitive due to lack of scale, low-cost financing, and underdeveloped supply chains. Solar manufacturing in India started after the announcement of the NSM. The present cell and module manufacturing capacities in India are given below:

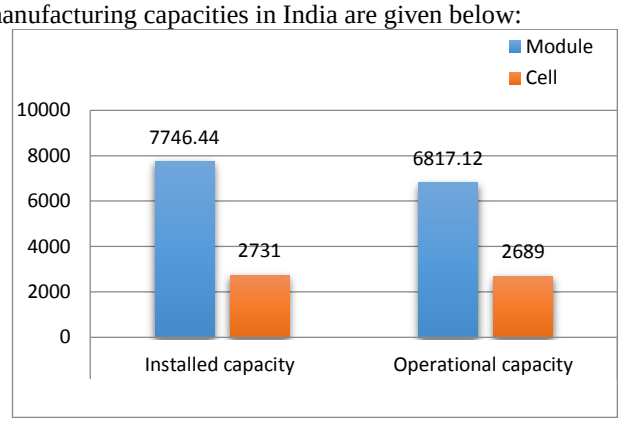

Figure 5: Installed and Operation Capacity of Solar Module & Solar Cell

In respect of installed and operation capacity in India, actual production capacity is quite low as shown in figure 6 that in year 2013 production of module & cell was 743 MW & 171 MW respectively and now in 2016-17 the production is around 2257 MW & 682 MW respectvily.

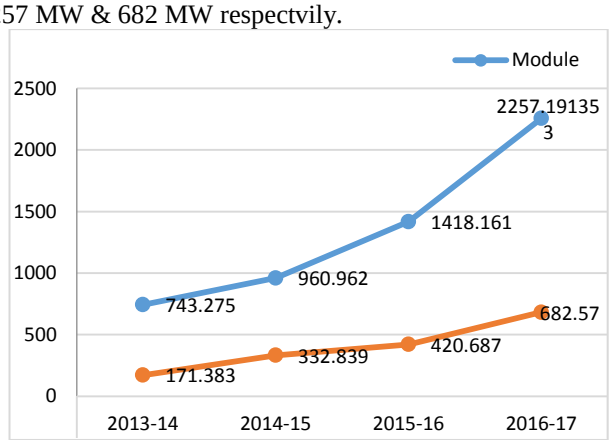

Figure 6: Year wise production of Solar Module and Solar Cell

The solar projects under Phase-1 of National Solar Mission were set up during the period 2010-11 to 2011-12. For the period 2010-11, CERC determined the project cost of solar PV projects as Rs.16.90 Cr. / MW based on the prevalent PV module prices (US$ 2.2/W_p) and the corresponding tariff as Rs.17.91 per kWh. The project cost determined by CERC for the period 2016-17 is Rs. 5.30 Cr./MW based on the PV modules prices of US$0.48/$W_p$. Declining module cost year wise is as shown in the figure 7.The corresponding solar PV tariff is Rs. 5.68 per kWh. The cost of PV modules have since continuously been reducing over the period with advancement of technology as well as with significant improvement in global supply scenario. In view of the falling cost of PV modules, the tariff of solar PV projects have also been declining significantly as in the graphically representation of figure 8 below.

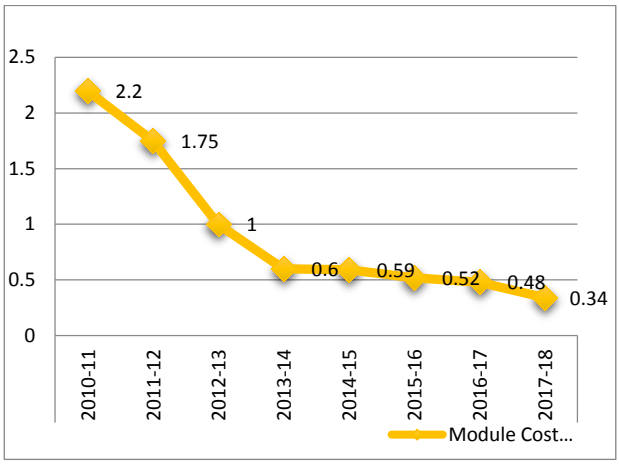

Figure 7: Declining Module Cost

5. Trend of Solar Tariff

Calculation of tariff depends on various factors that include location, solar irradiance in the State, availability of conducive State policy for solar, availability of land, the cost of financing and business environment, willingness of DISCOMS to purchase the solar power, power evacuation infrastructure, etc.

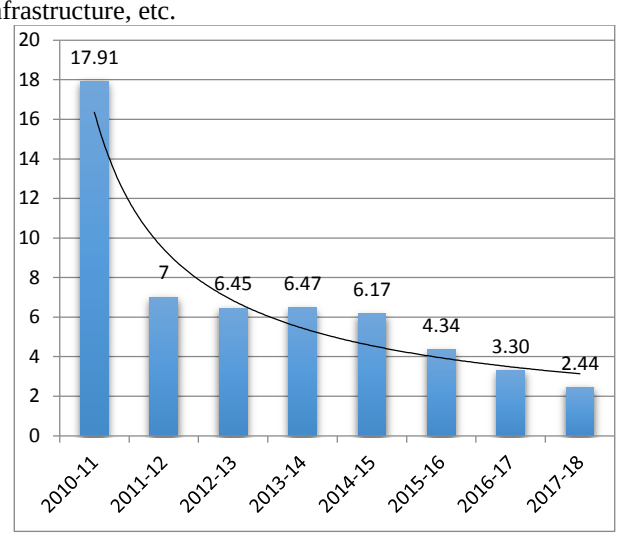

Figure 8: Year-wise lowest solar tariff (in Rs. /kWh)

Pursuant to successful bidding of solar projects under NSM, the solar projects which are being set up under the State Scheme are mostly selected through a process of tariff based competitive bidding and reverse auction. This method of selection has brought down the solar average bid tariff discovered in bidding/auctions significantly from a level of Rs. 17.91 per kWh in December, 2010 to about Rs.2.97 per kWh in February, 2017. Tariff in Indian solar market changed regularly as shown in Figures that the weighted average tariff varies from Rs. 17.91 per unit to Rs. 2.44 per unit. The declining trend of solar power tariff during the period from 2010-11 to 2017-18 is shown below in figure 8 below:

The recent downward trends in solar tariff may be attributed to the factors such as economies of scale, assured availability of land, and power evacuation systems under the solar parks.

6. Concept of solar Park

The concept of solar park was conceived from Charanka Solar Park in Gujarat, and closely followed by the Bhadla Phase-I Solar Park in Rajasthan. Solar power projects can be set up anywhere in the country. To set up solar projects, a solar project developer is required to identify and acquire the

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required land along with all necessary statutory clearances required from the concerned Government, arrange other infrastructure facilities like approach road, water, telecommunication facility etc., develop transmission infrastructure for evacuation of solar power to the nearest grid substation. The above process is required to be followed by every solar project developer for setting up solar projects. It generally takes a longer time for project developers to acquire land, get change of land use and various permissions, etc. which delays the project.

The solar projects scattered in multiple locations lead to higher project cost per MW and higher transmission losses. Total cost of a solar project depends on multiple factors such as solar insolation at a particular site, infrastructure facilities required to be developed, logistics, cost of funding, prevailing prices of solar cells/modules and related policies of the Government.

Solar Parks can be instrumental in overcoming the bottlenecks otherwise faced by independent power producers in a solar PV plant, related to land availability, developing evacuation infrastructure and its funding and other financial challenges. To overcome these challenges, the scheme for Development of Solar Parks has been introduced in December, 2014.

A solar park is large contiguous stretch of land with high insolation levels and provides developers an area that is well characterized with proper infrastructure and access to amenities and where the risk of the projects can be minimized. A solar park facilitates assured availability of land and transmission infrastructure facilities for setting up higher capacity of solar projects, reducing the number of approvals required, minimizing time of setting up solar projects thereby provide both economy of scale for cost-reduction and achieving large scale reduction in GHG emissions.

The solar parks provide specialized services to incentivize solar project developers to invest in solar projects in the park. These services while not being unique to the park, are provided in a central, one-stop-shop, single window format, making it easier for investors to implement their projects within the park in a significantly shorter period of time, as compared to projects outside the park which would have to obtain these services individually.

In addition, the park provides road access (both approach roads and smaller access roads to individual plots), water (via a dedicated reservoir located within the premises), boundary fence and security, each of which would have entailed additional costs for the developer outside the park.

Each of these specialized services offer significant benefits to the project developers but come at a premium. Land plots within the solar park are more expensive than outside. But this premium is easily justifiable by these services, which are bundled into the land cost. However, the most important benefit from the park for the project developer is the significant time saved. The centralized, single window nature of the services within the park reduces the time between project conceptualization and operations, translating into economic and real monetary gains for the project developers and the State.

The capacity of the solar park has been kept at 500 MW and above level in order to achieve economy of scale for cost-reduction. However, smaller parks can also be set up in hilly areas where contiguous land may be difficult to acquire in view of the difficult terrain and where there is acute shortage of non-agricultural lands.

A systemic representation of the concept of the solar park is given in figure

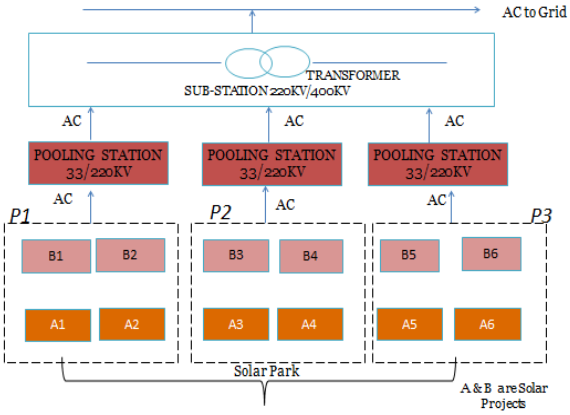

Figure 9: Systemic representation solar park

The solar park is divided into several plots based on the topography & availability of the land and suitability of power evacuation arrangement. Here in above figure, P1, P2 & P3 are the individual plots and A1, A2…B6 are solar projects inside the plots of the solar park.

The power generated from the individual projects pooled to a nearby pooling station. For this each plot is interconnected with pooling stations through 33kV/other suitable voltage underground, over ground or overhead cable. The construction of this line from the solar projects up to the pooling station is the reponsibity of the Solar Project Developers (SPDs).

The Solar Power Park Developer (SPPD) is responsible to set up, internal transmission system to evacuate the power from the solar park. The internal transmission system consists of setting up of the pooling stations (with 33/220 kV or suitable voltage level) inside the solar park and will also draw transmission line to transmit power from pooling station to the nearest sub-station of Central Transmission Utility (CTU) or State Transmission Utility (STU) at 220 KV/400 KV or suitable voltage level.

The solar power from the solar park needs to be evacuated to the existing grid. A grid-substation (220 KV/400 KV or suitable voltage level) right adjacent to the solar park and transmission line to connect with the existing network is therefore, required to be set up either by CTU or STU. Setting up of sub-station nearby the solar park and creation of transmission line to connect with the existing network of CTU/STU is termed as external power evacuation system.

7. Operational Structure:

The State Governments willing to set up solar parks first identify an agency for development of solar park. The agency entrusted with the responsibility of setting up of solar park is termed as Solar Power Park Developer (SPPD). A State Government may select SPPD in any of the following four modes:

Modes for selection of SPPD	
Mode I	The State designated nodal agency, c ould be a State Government Public Sector Undertaking (PSU) or a Specia l Purpose Vehicle (SPV) of the State Government.

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A Joint Venture Company between the State designated nodal agency and SECI wit h 50:50 % equity.		Mode I I
Mode III	The State designates SECI as the nod al agency on behalf of State Governm ent on mutually agreed terms.	
Private entrepreneurs without any equity par ticipation from SECI, but may have equity p articipation from the State Government or it s agencies.		Mode I V

The SPPD is tasked with acquiring the land for the park, cleaning it, leveling it and allocating the plots for individual projects. Apart from this, the SPPD are also entrusted with providing the necessary facilities like approved land for installation of solar projects and required permissions including change of land use etc; road connectivity to each plot of land; water availability for construction as well as running of power plants; flood mitigation measures like flood discharge, internal drainage etc; power during construction; centralized weather monitoring station; telecommunication facilities; power evacuation facility consisting of pooling stations to allow connection of individual solar projects with pooling station through a network of underground/over ground cables or overhead lines; housing facility for basic manpower wherever possible; parking, warehouse etc.

8. Progress and Status

The Scheme for Development of Solar Parks was rolled out in December, 2014 by Government of India. It was planned to set up at least 25 solar parks, each with a capacity of 500 MW and above, thereby targeting around 20, 000 MW of solar power installed capacity; in a span of 5 years commencing from 2014-15. Smaller parks are also allowed in Himalayan region & other hilly States where contiguous land is difficult to acquire in view of difficult terrain and in States where there is acute shortage of non-agricultural land.
Considering the demands for more solar parks in States, the capacity of the solar park scheme is enhanced from 20,000 MW to 40,000 MW in March, 2017. All these solar parks are proposed to be set up by 2019-20.

As on October 2017, 35 solar parks with cumulative capacity of 20,503 MW have been approved in 21 States as shown in figure 10 these solar parks are in different stage of development. In addition to the above recently 500 MW solar park approved for Tamil Nadu by TNEB Ltd.

Figure 10: Solar Parks in India

The land of around 1,11,000 acres have been identified & 66,000 acres of land have been acquired in various solar parks. 100% land have been acquired for 9 solar parks namely Radhnesada solar park in Gujarat, Bhadla Ph-II, Bhadla-III Solar Park & Bhadla IV solar parks in Rajasthan, Ananthapur-II & Kurnool solar parks in Andhra Pradesh and solar parks in Meghalaya, Uttarakhand and Uttar Pradesh. Further more than 90% of required land have been acquired in five solar parks namely Ananthapur-I & Kadapa solar parks in Andhra Pradesh, Pavagada solar park in Karnataka, Rewa solar park in MP, Aamguri solar park in Assam as shown in the figure 12.

Power Purchase Agreement (PPAs) have been signed for around 4545 MW of solar projects inside various solar parks; out of which 2230 MW of have been commissioned. Further, tenders for additional 2500 MW have been issued for which PPAs are yet to be signed.
Solar Projects inside the five solar parks have already been commissioned as shown in the figure 11.

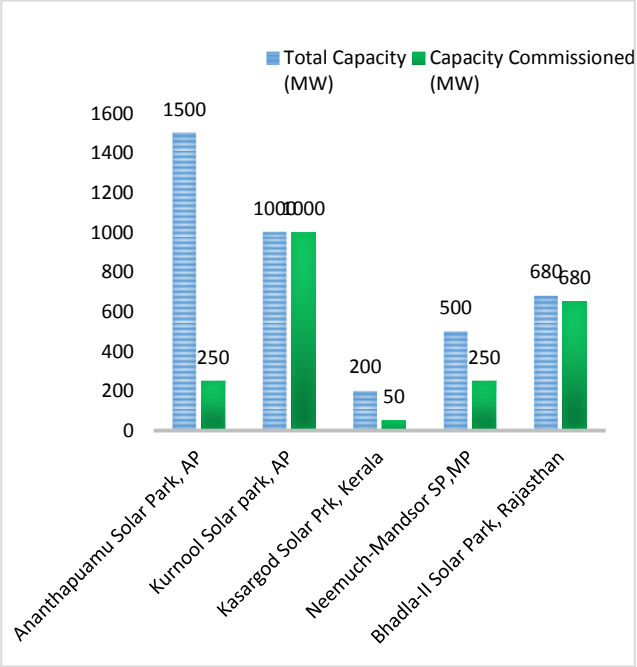

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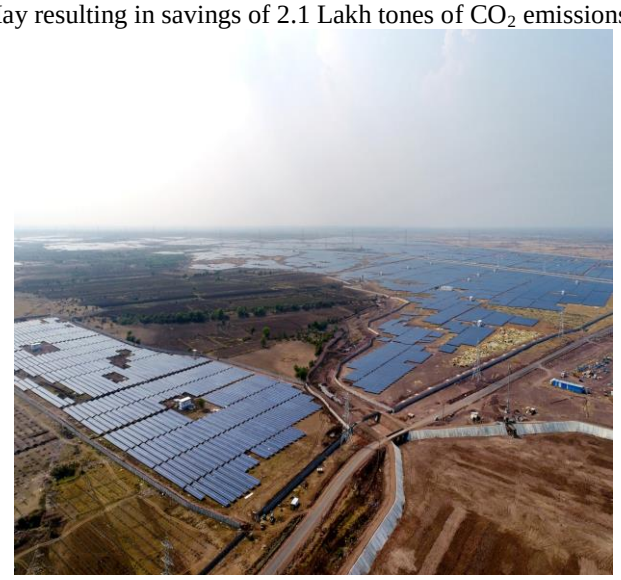
Figure 11: Solar projects commissioned inside various solar parks

9. Remarkable Case Studies

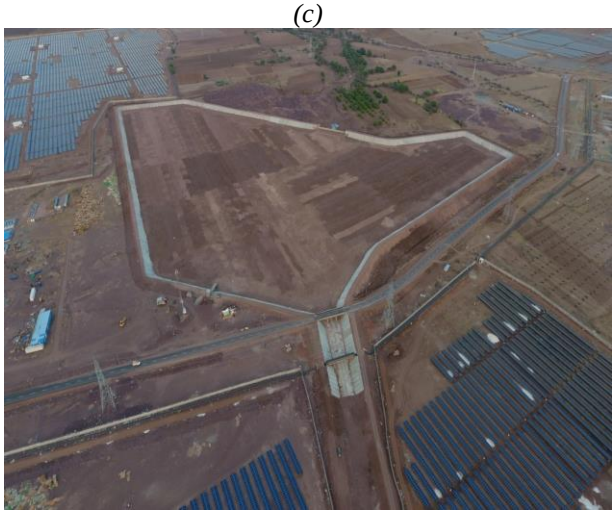
Kurnool Solar Park (1000 MW) in Andhra Pradesh: The Kurnool Solar Park of capacity 1000 MW has already been commissioned and is operational since March, 2017. Around 240 MU of clean energy is generated from this park till end of May resulting in savings of 2.1 Lakh tones of CO_2 emissions.



(a)

(b)

(c)



(d)

Figure 13 Kurnool Solar Park in AP (a) Kurnool Solar Park (1000 MW commissioned) (b) Anantpuramu Phase –I solar park (250 MW commissioned) (c) Pooling substation of NP Kunta site and Kurnool site and (d) ground level water reservoir with rain water harvesting at Kurnool

With commissioning of 1000 MW capacity at single location, Kurnool Solar Park has emerged as the World's Largest Solar Park after Longyangxia Dam Solar Park of capacity 850 MW in China which was commissioned in the year 2016.

Pavagada Solar Park (2000 MW) in Karnataka: The Pavagada Solar Park in Karnataka (2,000 MW), would be the largest solar park of it's kind after Tengger Desert Solar Park of capacity 1500 MW in Zhongwei, Ningxia of China which is under construction and also known as the "Great Wall of Solar" in China. Pavagada Solar Park in Karnataka has the potential to be the largest solar park in the world once completed. Here, 200 MW solar photovoltaic projects along with 15 minutes energy storage facility through battery for peak smoothening is also proposed to be set up by Solar Energy Corporation of India (SECI).

Rewa Solar Park (750) in Madhya Pradesh: Rewa Solar Park in Madhya Pradesh brought a revaluation in tariff of solar power in Indian market by achieving the lowest ever levelized tariff of Rs. 3.30/kWh through competitive bidding of 750 MW. The tariff so discovered depends inter alia on multiple factors like the long-term and concessional debt from World

Bank, three level payment security mechanism through Letter of Credit, Payment Security Fund, State Guarantee, power purchase tied directly with end procurers like Madhya Pradesh Power Management Corporation Ltd. (MPPMCL) and Delhi Metro Railway Corporation (DMRC) etc.The tariff of Rewa Project is not unviable; rather it is low on account of its better project structure, bankability, balanced risk allocation, pre-identified available land, the readiness of internal and external evaluation structure, and a soft loan from the World Bank.

The projects (three units each of 250 MW) were awarded to the three successful bidders. The tariff of Rs. 2.97, Rs. 2.974, and Rs. 2.979 per kWh discovered for the three 250 MW units each of Rewa park is the first-year tariff with 5 paise per year increase for 15 years. The levelized tariff for 25 years of Rewa Solar Park projects would be around Rs. 3.30/kWh.

Kadapa Solar Park (1000 MW) in Andhra Pradesh: The Kadapa Solar Park in Andhra Pradesh (1,000 MW) being developed by APSPCL has also set a new record after the success of Rewa Solar Park as the tariff discovered for 250 MW project is Rs. 3.15 a unit.

Bhadla Phase IV Solar Park (500 MW) in Rajasthan: In Bhadla Phase-IV Solar Park at Bhadla, Jodhpur, Rajasthan being developed by JVC of State Government of Rajasthan and M/s Adani Renewable, the lowest tariff discovered is Rs. 2.62 per unit for 250 MW by SECI under the VGF scheme.

Figure 14: 680 MW Solar Park Bhadla Ph-II in Rajasthan

Bhadla Phase III Solar Park (1000 MW) in Rajasthan: The Bhadla Phase III Solar Park in Rajasthan is being developed by a JVC of State Government of Rajasthan and IL&FS. SECI invited the bids for 500 MW solar projects inside Bhadla-III solar park and the lowest tariff discovered for 200 MW is Rs. 2.44 per unit followed by Rs. 2.46 per unit for 300 MW under the VGF scheme.

10. Issues & Challenges

The concept of solar parks has indeed emerged as a powerful tool for the rapid development of solar power projects in India. Assured availability of land and transmission infrastructure are the major benefits of a solar park. The recent downward trends in solar tariff may be attributed to the factors like economies of scale, assured availability of land and power evacuation systems under solar park.

The Solar Park Scheme aims to provide a huge impetus to solar energy generation by acting as a flagship demonstration facility to encourage project developers and investors, prompting additional projects of similar nature, triggering economies of scale for cost-reductions, technical improvements and achieving large scale reductions in GHG emissions. It would enable States to bring in significant investment from project developers, meet its Solar Renewable Purchase Obligation (RPO) mandate and provide employment opportunities to local population.

However, the development of solar parks has various issues and challenges as given below:

(i) Land: Land is a very critical input for development of solar park. The requirement of land is approximately 4-5 acres for the setting up of solar parks. Land for the setting up of solar park is generally identified by the State/UT Government unless the SPPD has its own land. It is the responsibility of the State Government to help in making the land available if the SPPD selected by the State Government needs help. States are encouraged to identify sites receiving good solar radiation and sites which are closer to CTU, preferably locations with spare transmission capacities and water availability. However, private entrepreneurs selected by the State Government as SPPD are allowed arrange their own land for setting up the solar park. Land are generally taken on long term lease from Government as well as private sources. In such cases, the State Governments are required to ensure that the land is free from any dispute. The park provides opportunity for all technologies in a technologically agnostic fashion.

In order to provide for such a large tract of contiguous land with appropriate insolation levels, the state governments are advised to prioritize the use of government waste / non-agricultural land in order to speed up the acquisition process. The inexpensive land are preferred in order to keep the land cost as low as possible and attract the developers. The land owned by the State Government is given priority and efforts are made to acquire private land as minimum as possible. If land cannot be made available in one location, then land in few locations in close vicinity are also taken.

The acquisition of land for solar park is one of the biggest challenges. Various state governments have announced favorable land policies that have been instrumental in reducing this hassle. Some of the cases of acquisition of land are hereunder:

In Rajasthan, the State Government under its Solar Policy, 2016 has announced availability of land to the developers at lowest cost. There are six solar parks in Rajasthan and in all the cases; the State Government has made the required land available to the park developers. Most of the lands allotted for solar parks are Government land and there was no land conversion charge whereas the stump duty was 5-6% of the value of the land.

In **Andhra Pradesh**, there are four solar parks being developed by AP Solar Power Corporation Pvt. Ltd. (APSPCL), a joint venture company of Solar Energy Corporation India (SECI), Andhra Pradesh Power Generation Corporation (APGENCO) and New & Renewable Energy Development Corporation of Andhra Pradesh Ltd. (NREDCAP). In all the cases, the park developer tried to select government land. However, there are also assigned and patta land. A negotiation committee comprising of local revenue authorities is constituted by the government of Andhra Pradesh for direct negotiation with farmers to finalise the compensation payable to different categories of land to enable speedy acquisition of land.

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For acquisition of government land, assigned land and patta land following process is being followed in Andhra Pradesh as shown in the figure 16.

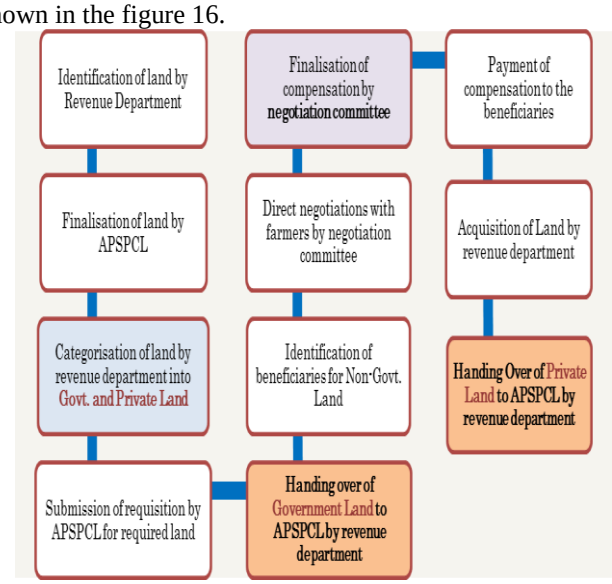

Figure 16: Land acquisition process in Andhra Pradesh

APSPCL, the Solar Power Park Developer in Andhra Pradesh is facing various issues in acquisition of land for the solar parks. APSPCL has selected the land, maximum of which belongs to the State Government. The State Government usually assigns certain Government lands to land less poor by giving assignment. The Government can take back these assigned lands for its own use by paying suitable compensation on par with the patta lands. Before paying compensation to these assigned lands, the revenue department calls land owners/farmers for original assignment and other relevant records for verification. The issue arises when the farmers fail to submit the records for claiming compensation. The revenue department denies compensation to these farmers who fail to submit he records. These farmers regularly come to site and stop the works.

Further while granting assignment to land less poor, the Government stipulates condition to the farmers to bring the land in to the cultivation within three years. If the farmers don't bring the land into cultivation within three years, the assignment granted to the farmers will be cancelled and the farmer is not eligible for any compensation. These types of farmers also come to site and stop the works. Some of the farmers approach court seeking compensation for these types of lands. Some farmers deny claiming compensation and want to retain his assigned land for his livelihood. In some cases, it is not possible to delete this land from acquisition if the land is in the middle of acquired land. In such cases the farmers approach courts and comes to site and stops the works.

In **Karnataka**, 2000 MW solar park is being developed by Karnataka Solar Power Development Corporation Ltd. (KSPDCL); a joint venture company of Karnataka Renewable Energy Development Ltd. (KREDL) & SECI. The uniqueness in land acquisition for the Pavagada solar park in Karnataka is that the entire land of 13000 acres is private land and taken on lease for a period of 28 years which is first of its kind in World with ownership of land vesting with land owners, as acquiring of land is a major hurdle in implementation of any project. The land owners will be getting land lease charges of Rs. 21,000/acre/annum with 5% escalation once in every two years on the base rate. Pavagada is one of the most backward Taluks in the state of Karnataka. The area is dry and due to lack of water for irrigation, the farmers are suffering due to lack of source of employment. Establishment of solar park in this area will create local employment to the public in a large extent and will improve the revenue to the Government.

In states like **Madhya Pradesh, Uttar Pradesh**, the land is mostly Government owned and there is as such no problem in acquisition of land.

In **Haryana**, a solar park of capacity 500 MW is being developed by Saur Urja Nigam Haryana Ltd (SUN Haryana). Sun Haryana is facing challenges in acquisition of land as the panchayat land lease policy of Government of Haryana does not allow sub-leasing of land. However, sub-leasing of land to SPDs is required for setting up of solar projects.

In **Maharashtra**, there are three solar parks each of capacity 500 MW. Out of these three solar parks, two solar parks are being developed by private entrepreneurs. Both the private entrepreneurs are facing challenges in acquisition of land. Further, incidence of stamp duty for non-agricultural lands is much higher than the duty payable for agricultural land. In order to address this, issue the government decided to exempt industries covered under the industrial policy from payment of stamp duty. However, solar parks and solar projects are not included as an industry as per this policy. The land conversion charges and stamp duty charges which are under the ambit of the State Governments. Incidence of stamp duty would escalate the cost of solar parks exorbitantly.

(ii) Financing: Significant investment is required to be made for development of solar parks which include acquisition of land, get the land developed and provide necessary infrastructure like road connectivity, transmission infrastructure etc. Further, investment is also required to be made in the operation & maintenance of solar parks, employing staff and other activities like marketing etc. The entire cost of development including cost involved in acquisition of land forms the total cost of the project.

Under the Solar Park Scheme, the Government of India provides Central Financial Assistance (CFA) of up to Rs. 20.00 lakh per MW or 30% of the project cost including grid-connectivity cost, whichever is lower, for development of the solar park. While CFA covers only part of the park cost, the remaining amount is being taken from the Solar Project Developers (SPDs) as one-time upfront charges and recurring O&M charges, when they enter the park to set up solar projects. This financial model is being adopted in most of the solar parks. Few cases are given as under:

In **Andhra Pradesh, A**PSPCL is meeting their financial requirement for development of solar parks partly by Central grant (Rs. 12.00 Lakh/MW) and the balance fund is met by collecting one-time solar power development expenses (around Rs.40 Lakh/MW) from the solar power developers (SPDs). Further, O&M charges (Rs.2.50 to 3.00 lakh/MW) are also collected annually from the SPDs to meet the yearly expenditure to be incurred towards maintenance of solar power park.

In **Karnataka,** KSPDCL is meeting their financial requirement for development of solar parks partly by Central grant (Rs. 12.00 Lakh/MW) and the balance fund is met by collecting one-time solar power development expenses (around Rs.28 Lakh/MW) from the solar power developers (SPDs). Further, O&M charges (Rs.2.50 to 3.00 lakh/MW) are also collected annually from the SPDs to meet the yearly expenditure to be incurred towards maintenance of solar power park.

In **Bhadla Phase-II solar park of Rajasthan**, Rajasthan Solarpark Development Company Limited (RSDCL) is meeting their financial requirement for development of solar parks partly by Central grant (Rs. 12.00 Lakh/MW) and the balance fund is met by collecting one-time solar power development expenses of Rs. 6.00 Lakh/hectare. Further, O&M charges (Rs. 30,000/- per annum per hectare) are also collected annually from the SPDs to meet the yearly expenditure to be incurred towards maintenance of solar power park.

The onetime charges put an upfront burden on the selected SPDs. In order to reduce this burden, Ministry of New and Renewable Energy is tying up with different bi-lateral and multi-lateral financing agencies for long tenure and concessional loan for development of solar parks. The long tenure and concessional financing from bi-lateral and multi-lateral financing agencies would be utilized in development of the internal infrastructure, such as, internal transmission system, water access, road connectivity, communication network, etc. of the solar parks. With low cost financing, the solar power generated in the solar parks is expected to be cheaper.

The **Rewa Solar Park in Madhya Pradesh** is one of the solar parks availing World Bank loan for development of park infrastructure. The World Bank loan has a component called Clean Technology Fund (CTF), the USD interest rate of which is 0.25% per annum fixed over the life of the loan. The door-to door tenor of IBRD financing is 24 years and that of the CTF could be 40 years. The Rewa solar park is financed by combination of the following three components:

a) Central Financial Assistance (CFA) from Government of India under the scheme for "Development of Solar parks and Ultra Mega Solar Power Projects" @ Rs. 12 Lakh/MW or 30% of the cost of development of internal infrastructure of solar park, whichever is lower. It may be treated as part of equity of the SPPDs;

b) SPPD's internal resources (equity of the SPPDs or land contribution) and annual park charges / user fee to be charged from the selected SPDs. However, collection of upfront charges by the SPPDs from the SPDs is not allowed for the financial assistance received from the World Bank and Central Grants received from MNRE.

c) Financial assistance from World Bank.

However, the financial assistance from World Bank would be limited to 50% of the total cost of development of internal infrastructure of the Solar Park.

(iii) Grid Integration of Solar Parks: In case of large scale renewable generation, particularly for large scale solar parks, it is not possible to absorb the energy locally. The scenario is more prominent especially during the period of high solar generation wherein electricity demand is not at peak level. Transmission system is required to be planned for integrating such large scale solar power parks with the State grid as well as with the inter-state/national grid. Integrated planning approach would ensure that solar generation does not have to be backed down during solar maximized scenario or other than peak demand period and local grid network must be stable even when solar generation is not available during night time. This integration provides reliability of transmission and power supply to the whole system. Owing to intermittent nature of solar energy, it requires support from the grid. The transmission capacity requirement for grid integration of solar parks shall also depend upon quantum of power to be transmitted/integrated. Once all the solar parks are commissioned, solar projects of aggregate capacity 40 GW would be connected to the grid.

To evolve plan for grid integration of large scale solar/wind generation capacities, POWERGRID has been entrusted by Ministry of Power (MOP) to formulate Grid Integration Plan for envisaged renewable capacity addition by 2022 as Green Energy Corridors-II. The scope of Green Energy Corridors-II includes identification of transmission scheme, its implementation, financing strategy etc. The power evacuation arrangement for the identified solar parks approved under Pahse-I of the Solar Park Scheme envisaged through Intra state & Interstate evacuation is evolved as Green Energy Corridors-II (Part-A). The report on Green Energy Corridor-II covers the plan for grid integration of solar parks at inter-state level and intra-state level.

POWERGRID has carried out studies to identify transmission infrastructure requirement for solar parks in various states. To carry out the studies, inputs like existing generation data, information regarding details of solar parks i.e. location, quantum and time frame in various states, pocket wise RE & conventional generation capacity addition program in time frame of 2016-17 & 2018-19 has been considered. Information about existing and planned transmission system including various transmission corridors High Capacity Corridors/Green Energy corridors, wind and solar generation pattern, network topology etc. has been taken into account in studies. In order to facilitate transfer of power from envisaged solar parks, inter-state & intra-state transmission scheme is evolved with total estimated cost of Rs 12,786 crore.

(iv) Difference in Gestation period of Solar Generation and Transmission: Gestation period of solar projects is very less (12-18 months) vis-a-vis transmission development (24-36 months) for integration with the grid. Further, the capacity utilization factor for solar generation is low resulting into high transmission tariff. In view of the above, Transmission development for solar generation faces two critical issues i.e. matching implementation period (Generation vis-a-vis Transmission) as well as transmission tariff.

As per the prevailing regulation in India, inter-state transmission system for generation project is evolved based on Long Term Access/Connectivity application by the applicant. However, keeping in view of short gestation period of RE, transmission development need to be done much ahead of generation without considering LTA/Connectivity application. However, location of the generation project and its quantum needs to be firmed up in advance so that transmission system planning can lead the generation and its implementation may match with solar generation development.

An approach should also be developed to build the transmission for High potential RE zones in anticipation of subsequent RE development rather than waiting for RE project to first come up with their requirements i.e. Transmission to lead generation approach.

(v) Forecasting of Solar Generation: Solar generation forecasting & its real time monitoring are important tools to address variability & uncertainty aspect of its grid integration. State-of-the-art forecasting helps grid operator to manage power system balance for economic, reliable & secured operation of the grid even in high RE penetration regime.

In this direction, establishment of Renewable Energy Management Centers (REMC) co-located with SLDCs/RLDC/NLDC in RE resources rich states was

proposed as part of Green Energy Corridor-I. REMC shall be responsible for forecasting of RE generation in their jurisdiction for different time horizons, real time tracking of RE generation and close co-ordination with their SLDC/RLDC for smooth grid operation. It is proposed that the envisaged solar parks shall be integrated with these REMCs also for monitoring, scheduling & forecasting purpose.

(vi) Ancillary Services: Ancillary Services, defined as: "those services necessary to support the transmission of electric power from seller to purchaser given the obligations of control areas and transmitting utilities within those control areas to maintain reliable operations of the interconnected transmission system." The two most important ones are the

a) Reserves of generation to support falls of generation and with the goal to maintain the frequency and interchanges in the case of loss of some generation.
b) Maintain the voltage profile in the system

High Renewable penetration scenario necessitates increased balancing and system flexibility requirements. In such scenarios, to ensure the reliability of the power system and quality of electricity, additional services viz. Ancillary services may be needed by the system operator to achieve system balancing in real time. The Detailed Procedure for Ancillary Services Operations for Inter-state has been approved by CERC in March, 2016. The Ancillary Services have been rolled out for implementation in April 2016. Similar framework needs to be implemented in the states also.

11. Conclusion

The concept of solar parks has indeed emerged as a powerful tool for the rapid development of solar power projects in India. Assured availability of land and transmission infrastructure are the major benefits of a solar park. The recent downward trends in solar tariff may be attributed to the factors like economies of scale, assured availability of land and power evacuation systems under the Solar Park Scheme. The issues/challenges can be resolved by concerted efforts of all stake holders. The major benefits of solar parks are

- 50,000 MW of solar projects can be set up in 50 proposed solar parks in various States/ UTs of the country.
- Availability of solar power at competitively low tariffs. Total capacity when operational, will generate 64 billion units of green energy/electricity per year @1.6 million unit per MW.
- Achievement of 40,000 MW solar capacities would contribute to long term energy security of country and ecological security by reduction in carbon emissions and carbon footprint, as well as generate large direct & indirect employment opportunities in solar and allied industries like glass, metals, heavy industrial equipment etc.
- Installation of 40,000 MW of solar will lead to abatement of around 56 million tons of CO_2 per year over its life cycle.
- Creation of solar parks has attracted foreign players to invest in solar projects in India. More investment opportunities will enhance income.
- The solar parks will also provide productive use of abundant wastelands which in turn facilitate development of the surrounding areas.

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