Development of Solar Parks in India and the Way Forward

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***Abstract*—**In the Nationally Determined Contributions (NDC) as per the Paris Accord on Climate Change, India made a pledge that by 2030, 40% of our installed power generation capacity shall be based on renewables and the emissions intensity of its GDP reduced by 33 % to 35% by 2030 from the 2005 level. Keeping this in view and also keeping in view of commitment to a healthy planet, the Renewable Energy (RE) capacity of 175 GW targeted and will be installed by 2022 in India. The substantial higher capacity target will ensure greater energy security, improved energy access, and enhanced employment opportunities. With the accomplishment of these ambitious targets, India will become one of the largest Green Energy producers in the world, surpassing several developed countries.

The capacity of around 82 GW has already been installed form different sources of renewable energy. The cost of solar and wind power generation has also declined significantly and for new projects, depending upon the location, the cost ranges between Rs. 2.44 per unit and Rs.2.85 per unit of power produced. On a life-cycle basis, the delivered cost of solar and wind power (even after including the normative transmission charges of Rs 1 per unit of power), has become cheaper than the marginal cost of power from thermal power plants. The demand forecast suggests that by the year 2030 a solar and wind power capacity of 500 GW will be required. Now, renewable energy is not only a matter of commitment and faith but also has emerged as a cost-competitive option for meeting the electricity requirement.

With this background, the present paper reviews the current status and role of Solar Parks in the growth of the National Solar Mission & renewable energy sector, Initiatives and especially the development of solar parks in India which are the key factor to set up a new era of the solar industry in India. Further, the challenge faced by Solar Project Developers (SPDs) & Solar Power Park Developers (SPPDs) has been discussed in this article. This includes aspects of the move from Solar Parks to RE Parks to reduce the effect of critical elements of land and transmission system for sustainable growth of RE in India. A case study of operational 1000 MW Kurnool Solar Park is also included in the paper to analyze the variation in generation of energy, system voltage, and the frequency.

Keywords-National Solar Mission; Solar Park; Transmission System; Renewable Energy.

I. INTRODUCTION

National Solar Mission (NSM) is a major initiative by Government of India, to promote ecologically sustainable growth and addressing energy security challenge in India. The NSM is one of the eight missions of National Action Plan on Climate Change (NAPCC). In the Nationally Determined Contributions (NDC) as per the Paris Accord on Climate Change, India made a pledge that by 2030, 40% of our installed power generation capacity shall be based on renewables and to reduce the emissions intensity of its GDP by 33 to 35 percent by 2030 from the 2005 level. Keeping this in view and also keeping in view of commitment to a healthy planet, the renewable energy capacity of 175 GW will be installed by 2022 in India [1] [2]. At the end of August, 2019, the capacity of around 82 GW has already been installed form different sources of renewable energy [7]. The cost of solar and wind power generation has also declined significantly and the renewable energy is not only a matter of commitment and faith but also has emerged as a cost competitive option for meeting the electricity requirement.

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 with the objective 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. 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 [3] [4].

To achieve the targets of 100 GW by 2022, the scheme for Development of Solar Parks and Ultra-Mega Solar Projects has been launched in December 2014. 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.

The concept of solar parks has emerged as a powerful tool for the rapid development of solar power projects under the National Solar Mission of India. Assured availability of land and transmission infrastructure are the major benefits of a solar park apart from 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 also enables States to bring in significant investment from project developers, meet the Solar Renewable Purchase Obligation (RPO) mandate and provide employment opportunities to the local population. 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 [2], [3], [5].

II. RENEWABLES IN INDIA

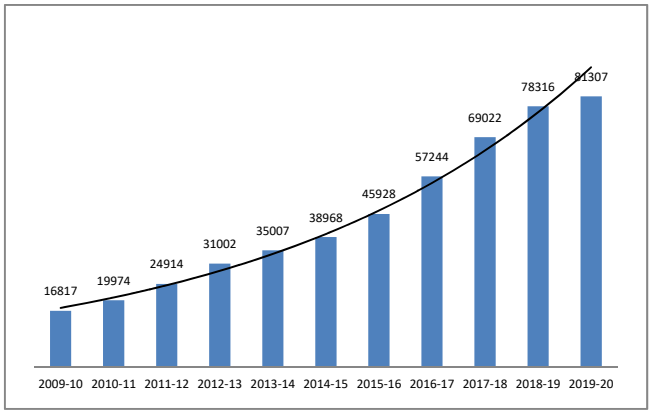


Figure 1: Year wise cumulative progress of RE (as on 31-07-2019, Capacity in MW)

The cumulative installed capacity of grid renewable power has reached to around 82 GW at the end of July, 2019, which accounts for 22% of grid renewable power installed capacity from all resources and that of solar power is more than 8 % in the overall energy mix as shown in figure 2.The year wise growth of RE sector is as shown in the figure 1.

The capacity of RE includes the capacity of 36686.82 MW (45%) from Wind Power, 30071.35 MW (37 %) from Solar Power, 4604.80 MW (6%) from Small Hydro Power and 9944.61MW (12%) from Bio Power including the Waste to Power [6], [7].

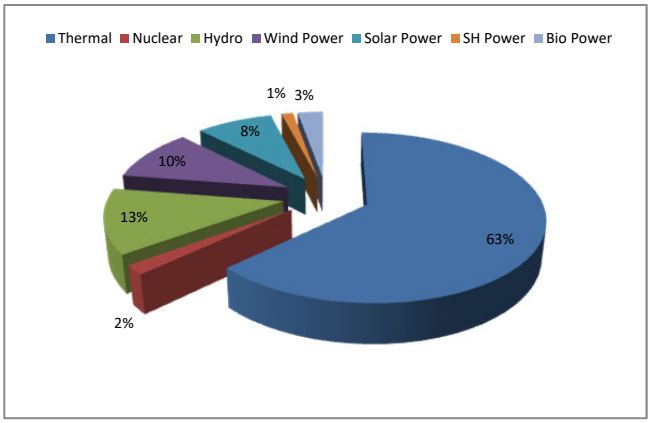


Figure 2: Energy Mix as on 31-07-2019

The year wise progress in solar energy is as shown in the figure 3 and 4.

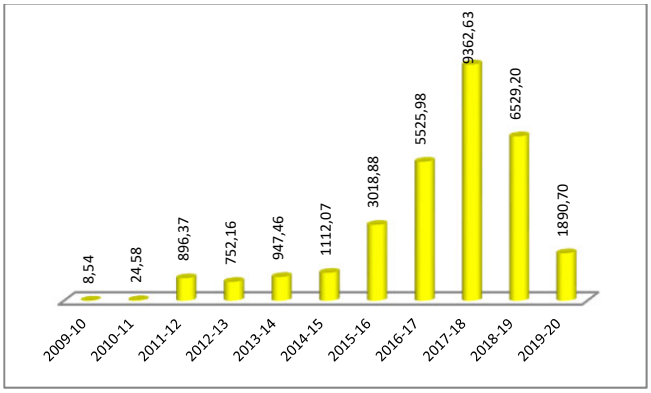


Figure 3: Year wise Capacity Addition in Grid Connected SolarSector of India (as on 31-07-2019, in MW)

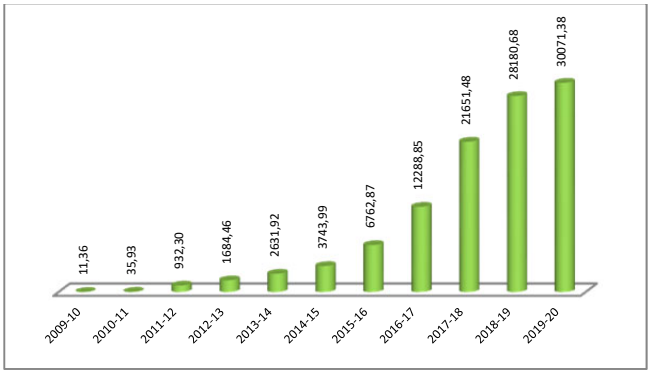


Figure 4: Year wise Cumulative Capacity in Grid Connected Solar Sector of India (as on 31-07-2019, in MW)

III. DEVELOPMENT OF SOLAR PARKS

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.

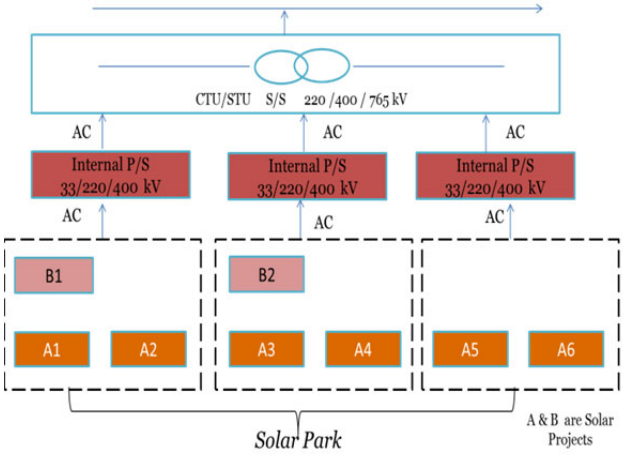


Figure 5: Basic Block Diagram of a solar park

To overcome these challenges, the scheme for Development of Solar Parks has been introduced by Ministry of New & Renewable Energy (MNRE) in December, 2014 to set up at least 25 Solar Parks of aggregate capacity of 20,000 MW. The capacity of the scheme was enhanced from 20,000 MW to 40,000 MW with a plan to set up at least 50 Solar Parks by 2021-22. The capacity of Solar Park will be 500 MW and above. However, smaller parks in States with shortage of non-agricultural lands [8].

Solar Energy Corporation of India (SECI) is the implementing Agency of the Scheme on behalf of MNRE. The Solar Power Park Developers (SPPD) may be selected from any of the Seven (7) Modes of Development of Solar Park [1].

Under the Solar Park Scheme of Government of India, 42 solar parks having an aggregate capacity of 23,404 MW in 17 states have been sanctioned at the end of July 2019. These solar parks are at different stage of development. The capacity of around 6775 MW has been commissioned in 11 solar parks and balance is at different stages of implementation. This will help in achieving the 100 GW target of solar energy which is part of India's 175 GW target of Renewable Energy by 2022. Year wise breakup of 6775 MW is as shown in the figure 6.

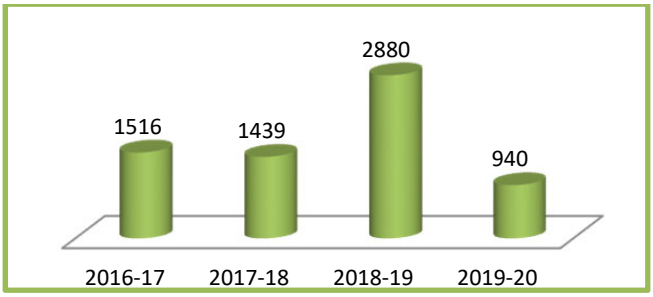


Figure 6: Year wise Capacity Commissioned in different solar parks in India ((as on 31-07-201, in MW)

The park wise capacity commissioned in India is as shown in the figure 7.

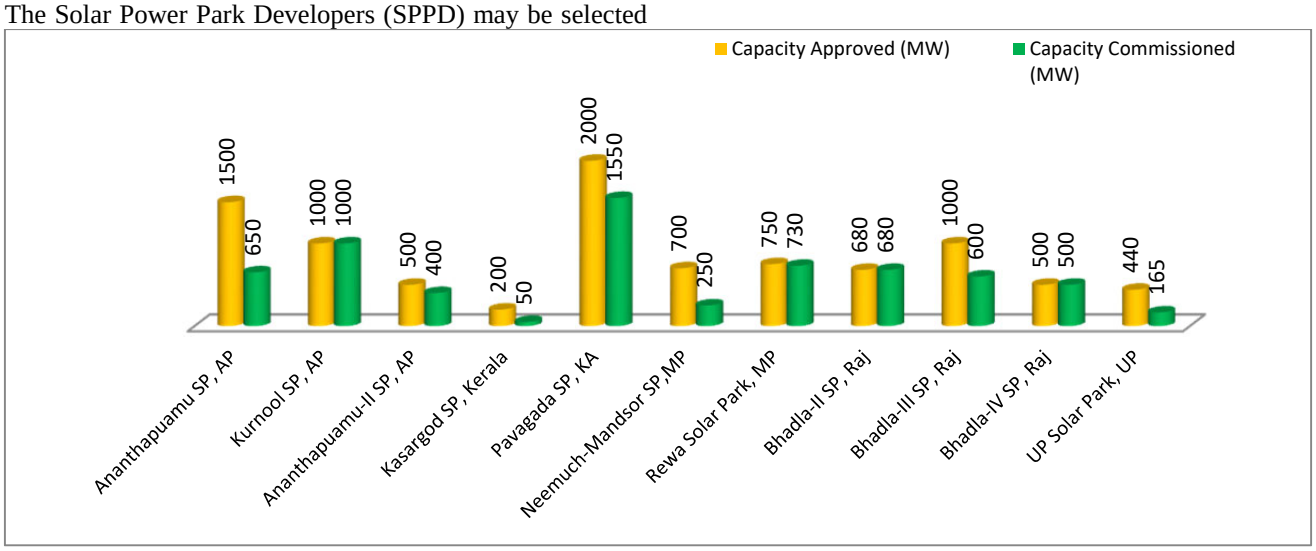


Figure 7: Park wise capacity commissioned

IV. Analysis of 1000 MW Kurnool Solar Park in Andhra Pradesh

The Kurnool Solar Park of capacity 1000 MW was approved by Government of India in 2014 under the solar park scheme. The park is being developed by Andhra Pradesh Solar Power Corporation Pvt. Ltd. (APSPCL); A Joint Venture Company of Solar Energy Corporation of India (SECI) Ltd, Andhra Pradesh Generation Company (APGENCO) and NREDCAP in the Kurnool District of Andhra Pradesh. For development of the solar park land of around 5568.96 acres has been acquired in a record period of 9 months without disturbing a single dwelling house. About 91% of land is Government and assigned land and not suitable for cultivation. All the activities starting from issue of tender notice to commissioning of solar park was completed within a record period of 24 months and is the largest Solar Power Park in the World at a single location at the time of commissioning in 2017.

For evacuation of power from the solar park 4Nos. 33/220kV internal Pooling Substations and 220/400kV external Grid Substation were established. The EPC Contractors for both internal and external evacuation system were finalized well before selection of solar power

developers by NTPC so as to match the commissioning schedule of solar projects.

A. Initiatives taken by APSPCL:

Land Acquisition: To avoid delay in acquisition of land, APSPCL has taken advance possession of government and assigned land from Revenue Authorities pending finalization of lease/ alienation by Government of Andhra Pradesh. Further, negotiation committee consisting of revenue and APSPCL officials was appointed by government to fix the compensation payable to land owners by negotiation and to speed up the land acquisition process. Private and assigned lands were taken through mutual consent by making payment of negotiated price towards compensation.

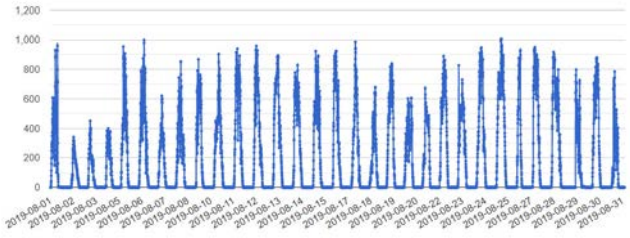
Grid Connectivity: In order to avoid delay in obtaining LTA and Connectivity from CTU /STU by Solar Power Developers, APSPCL has applied for LTA and Connectivity from CTU/STU. APSPCL is the first nodal agency which took initiative in getting approval from MNRE for establishment of internal evacuation system and amending the CERC regulation so that Solar Power Park Developer (SPPD) can apply for LTA and Connectivity for a Solar Park even before Solar Power Developers are identified.

Rain Water Harvesting: APSPCL has provided rain water harvests within the Solar Park to meet huge water requirement for cleaning of solar PV modules.

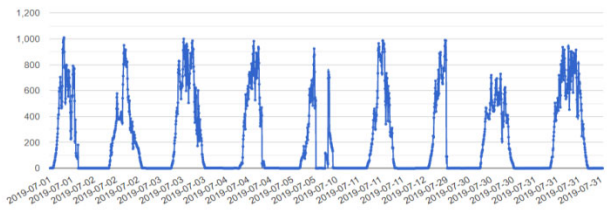
Local Area Development: An amount of Rs. 10 Cr. is collected every year from Solar Power Developers for a period of 5 years and total amount of Rs. 50 Cr. is spent towards local area development in 5 years.

B. Analysis of Energy Generation and the System voltage

In the Kurnool Solar Park in Andhra Pradesh, the total energy generated at the end of July 2019 is around 4917.171 MU since inception. Due to generation of solar energy in the park Carbon Emission Reductions of around 44, 25,454 tons of Co2 achieved so far. Form the figure shown at (a), (b), (c), (d) & (e) we can see the change in the generation due to changes in temperature, irradiation and other effects. The month wise and in a particular day, the variation in energy generated in the solar park is as shown in the figure 8.



(a)



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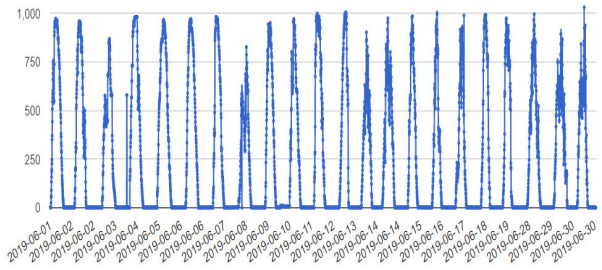

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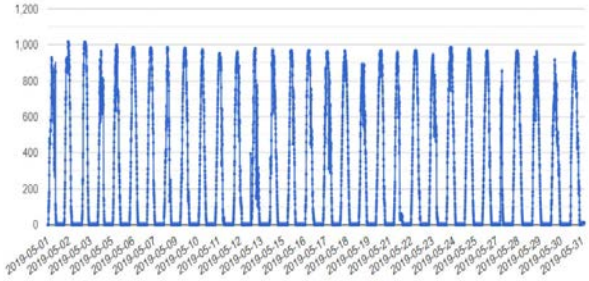

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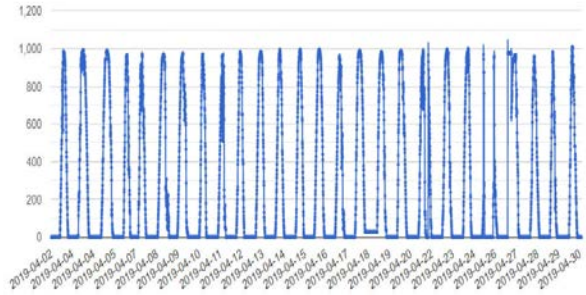
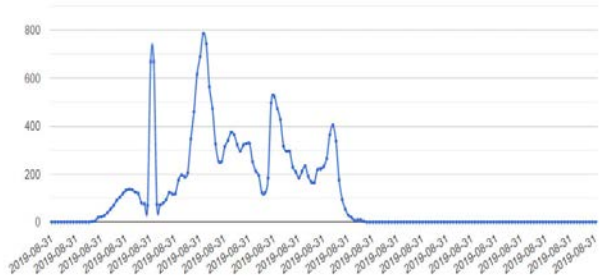
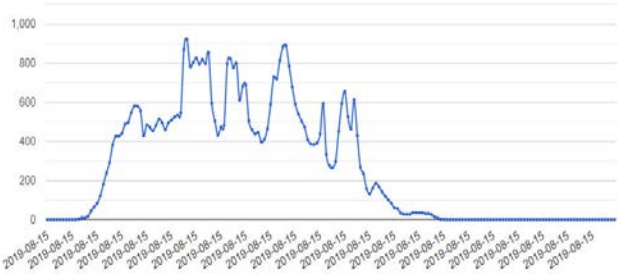


(e)

Figure 8: (a), (b), (c), (d), (e), Month wise variation in generation of energy in Kurnool Solar Park (1000 MW) of Andhra Pradesh (India)



(a)



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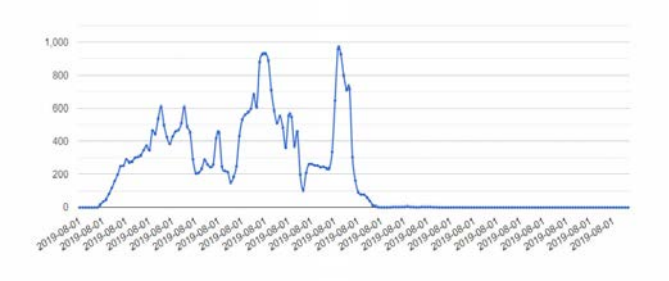

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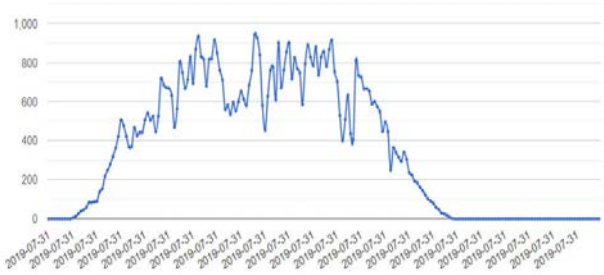

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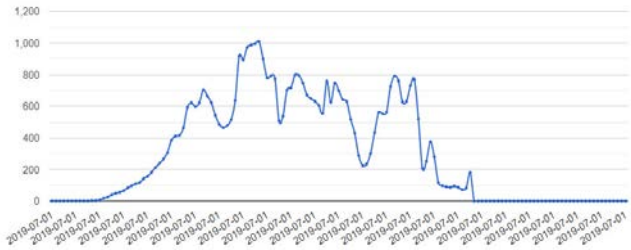

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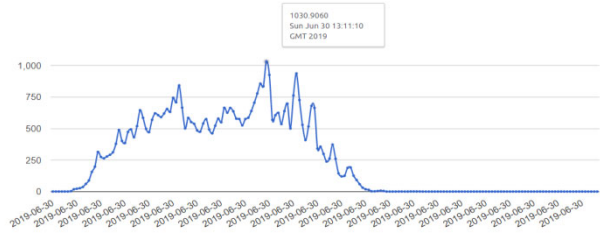

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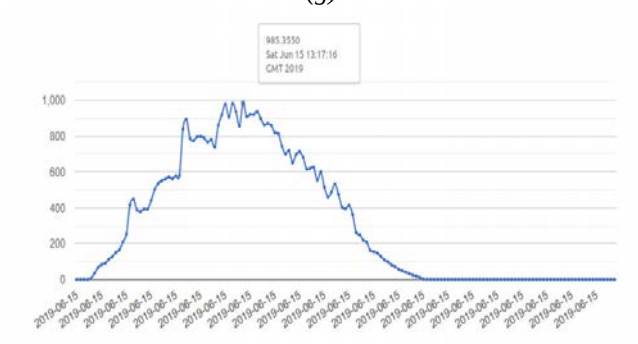

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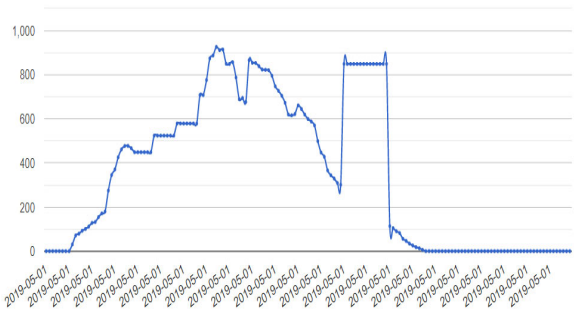

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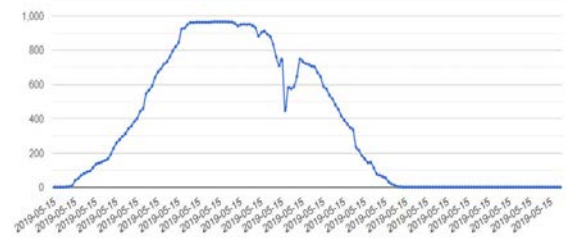

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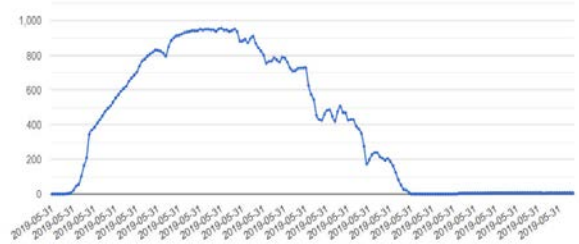

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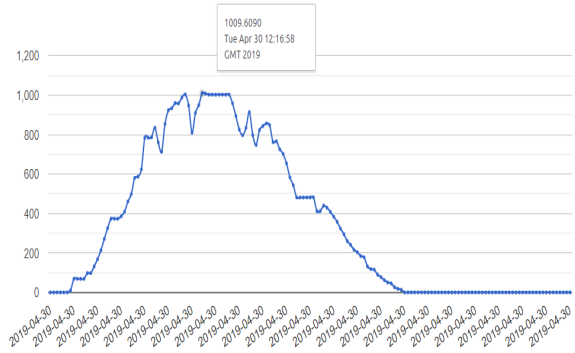

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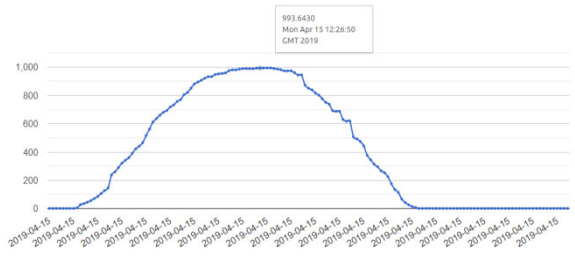


(n)

Figure 9: (a)-(n) Variation in generation in a particular day of the different months

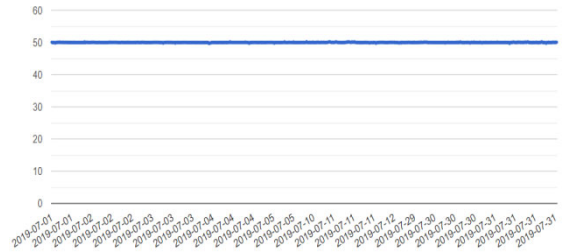
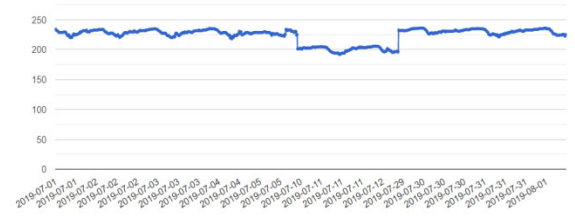
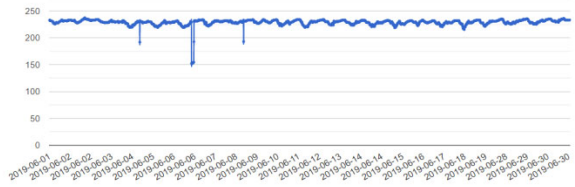


Figure 10: Frequency in the July 2019 in Kurnool Solar Park



(a)



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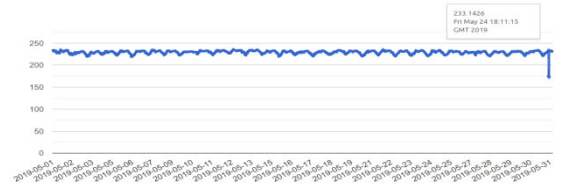

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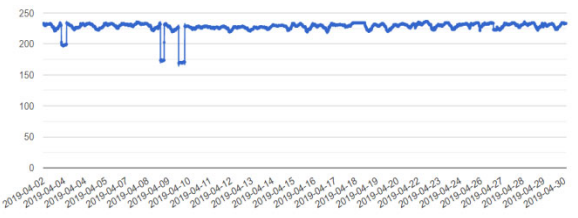

(d)

Figure 11: Variation in system voltage

V. MOVES FROM SOLAR PARK TO RENEWABLE ENERGY PARKS

In order to address the two most critical elements such as land and power evacuation infrastructure for solar parks, a new mode (Mode 7) has been introduced in the exiting solar park scheme for development of Renewable Energy Parks (Solar or Wind or Hybrid or other RE parks) through Solar Energy Corporation of India Ltd. (SECI).

With the assistance of the State Government, SECI will make land available to successful bidders for setting up RE power projects. For this, the State Governments would be paid a facilitation charge of Rs 0.02/unit for power to be generated in these parks. This facilitation charge would be paid by the RE project developers, in addition to any land cost in terms of outright sale or lease rent. The outlines of the RE park is as shown in the figure.

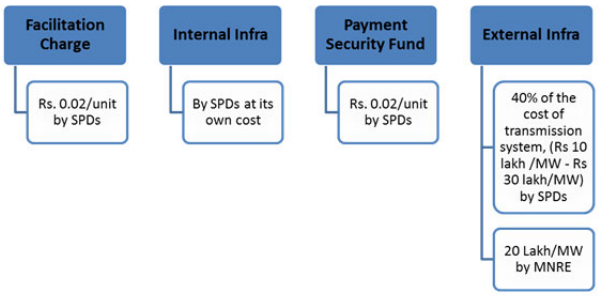

Figure 12: Outlines of RE Park under Mode-7

VI. CHALLENGES& THE WAY FORWARD

The advantages of solar energy are that the grid parity is realized in near future, lower transmission losses, environmental benefits, energy sustainability, lower gestation period, offset of day time peak load etc. As the targets of 100 GW solar in India is to be achieved by 2022, while all efforts are being made to achieve this target through the various central & state schemes, the participation and cooperation of the Central, States and private sector are essential to achieve the above target. However, in solar sector at the end of July 2019, the capacity of only 30 GW has been commissioned.

With respect to the challenges in solar parks, the major challenges are availability of clear land as well as the required transmission system for power evacuation from solar parks. Further, on the solar project development, the challenges regarding the delay in the payments by DISCOMs have serious impact on viability of the solar projects. The Solar Power Developers need to be given adequate assurance to maximize development of solar power capacity in the State and they will lose confidence if Government entities want to make changes to contracts/PPAs already signed. Honor the contractual agreement signed or the sanctity of Power Purchase Agreements (PPA) is highly concerned with developers.

The other major issues are non-allocation of waste lands by the States; Inadequate transmission capacity for futuregrowth in the Sector; Dumping of Chinese PV Module causing injury to Indian Domestic Manufacturers; Frequent changes in RfS like Tariff Cap, Payment Terms &

condition, Security; Frequent bid cancelations and Delay in adoption of tariff by the regulators.

In India, in the coming years to achieve the more GW capacity, the conducive policies may attract the investment capital. Waste land in all States to be identified & land bank data may be established to better implementation of the schemes and to faster move of the industry. Policy may be formulated for allocation of waste land for RE projects; Allow exemption for Non-Agricultural conversion / Deemed Conversion of land for RE Projects (no fees to be paid); RE Projects may be exempted from taking approval for land ceiling limits; States to formulate policy on time bound approval for land for RE projects; State Governments to allow 100% exemption from payment of registration fees & stamp duty on land for setting up of RE Projects; and States to speed up digitization of land / revenue records are the major points where Government can help the developer for expediting the projects.

The issue of load restriction also faced by Solar Power Developers,load limitation is significantly impacting the profitability of projects as such additional generation was factored in financial models while bidding. Therefore, the regulator/government should allow variation of $\pm$ x % deviation from name plate capacity so that the restriction may be resolved.

A consistent, stable policy with long term should be there with a clear visibility in biding plan on annual & quarterly basis. Strict adherence to Standard Bidding Guidelines (SBD) by States and Centre with no upper tariffcap on bidding as the process of reverence auction and bidding are in very transparent and competitive environment. Further, honor of the tariff discovered through transparent E-Reverse Auction should be regularly monitored that will enhance global investorconfidence in India.

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