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Solar Energy: Advantages and Challenges before India

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ABSTRACT: India, a rapidly growing economy with more than 1 billion people, is facing a huge energy demand. The country stands fifth in the world in the production and consumption of electricity. The electricity production has expanded over the years but we cannot deny the fact that the population of the country is also expanding. The power produced in the country is mostly from coal (53%) and it is predicted that country's coal reserves won't last. More than 72% population living in villages and half of the villages remain without electricity. It's high time that our country should concentrate more on energy efficiency, conservation and renewable energy. To meet this surging demand, solar energy is the best form of energy to fulfill the energy needs of India and bridge the energy demand-supply gap. India has tremendous scope of generating solar energy. The geographical location of the country stands to its benefit for generating solar energy. The reason being India is a tropical country and it receives solar radiation almost throughout the year, which amounts to 3,000 hours of sunshine. This is equal to more than 5,000 trillion kWh. Almost all parts of India receive 4-7 kWh of solar radiation per sq metres. This is equivalent to 2,300–3,200 sunshine hours per year. States like Andhra Pradesh, Bihar, Gujarat, Haryana, Madhya Pradesh, Maharashtra, Orissa, Punjab, Rajasthan, and West Bengal have great potential for tapping solar energy due to their location. Since majority of the population lives in rural areas, there is much scope for solar energy being promoted in these areas. Use of solar energy can reduce the use of firewood and dung cakes by rural household.

KEYWORDS: solar energy, advantages, India, Challenges, household, villages, power, conservation

I. INTRODUCTION

Recently, India achieved the third rank globally for solar installation capacity. Mercom India, a clean energy research organisation, has reported that the installed solar photovoltaic (PV) capacity has reached over 28 GW. However, this accounts for only about 5.5 per cent of the total global cumulative installations. India may have emerged as the third largest market for solar, but a comparison at the global front suggests that India has a long way to go in order to become a solar super power. Mercom noted that in calendar year (CY) India added 8.3 GW of solar capacity. It has observed a 13 per cent dip from the previous year, when the solar PV installation addition was 9.6 GW. The total installations globally accounted 104 GW during which China and the US added 44.3 GW and 10.6 GW respectively.[1]

India has a target of installing 100 GW of solar capacity and is still 72 GW short of it. To achieve this ambitious goal, a ramping up of the yearly targets is the need of the hour. Yet, the challenges are immense. Firstly, to achieve the 100 GW target, India needs to invest \$65 billion in the next four years.

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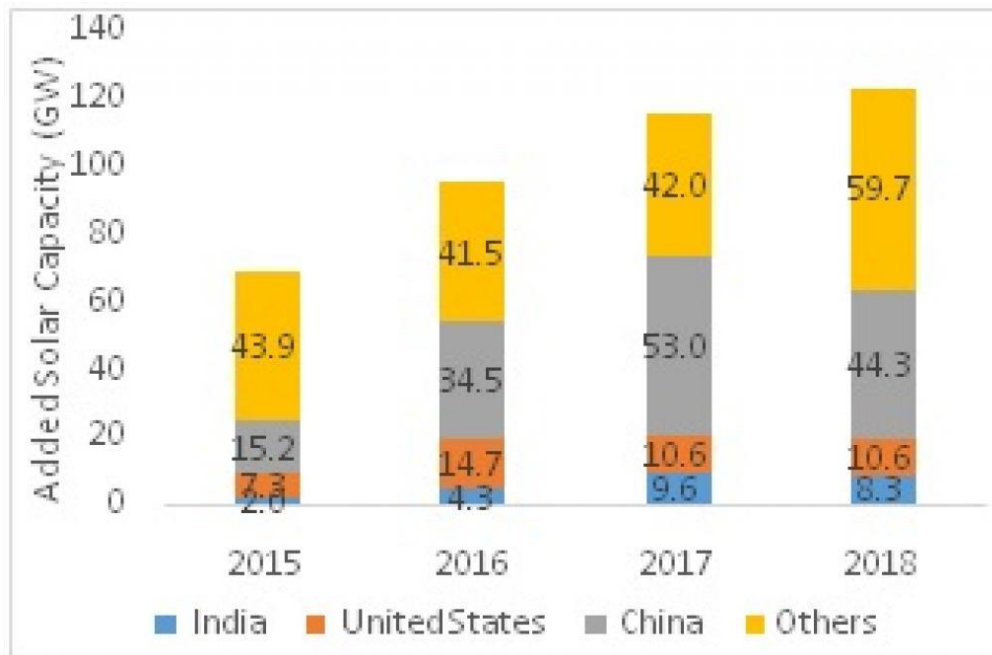
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A major part of it has to be raised within the country, as the renewable sector could so far attract a foreign direct investment (FDI) worth only \$7.5 billion in the last 18 years, according to a report by the India Brand Equity Foundation. Second, the factors causing negative growth of the solar sector in CY— the confusion along the GST and the import duty on solar equipment — are yet to be resolved completely. Thirdly, on the domestic manufacturing front, India fares worse.



Various efforts by the Solar Energy Corporation of India (SECI) to attract bids for the development of the Inter-state Transmission System (ISTS) connected Solar Photovoltaic (PV) Power Plant has been in vain. Despite these efforts, the Indian manufacturing sector has yet to kick-start. Therefore, the capacity addition will be done at the expense of imports. Solar cells and PV modules worth about \$20 billion need to be imported in the next four years. India needs a more comprehensive approach in order to achieve the targets of 2022 and beyond. Alternate demand has to be

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generated through open-access platforms in the situation when discoms are violating the Power Purchase Agreements.[2]

Advantages:

- Solar power is pollution-free and causes no greenhouse gases to be emitted after installation
- Reduced dependence on foreign oil and fossil fuels
- Renewable clean power that is available every day of the year, even cloudy days produce some power
- Return on investment unlike paying for utility bills
- Virtually no maintenance as solar panels last over 30 years
- Creates jobs by employing solar panel manufacturers, solar installers, etc. and in turn helps the economy
- Excess power can be sold back to the power company if the grid is tied
- Ability to live grid free if all power generated provides enough for the home/building
- Can be installed virtually anywhere; in a field to on a building
- Use batteries to store extra power for use at night
- Solar can be used to heat water, power homes and buildings, even power cars
- Safer than traditional electric current
- Efficiency is always improving so the same size solar that is available today will become more efficient tomorrow
- Aesthetics are improving making the solar more versatile compared to older models; i.e. printing, flexible, solar shingles, etc.
- Federal grants, tax incentives, and rebate programs are available to help with initial costs
- No trenching is needed since the solar can be close to or at the place of installation

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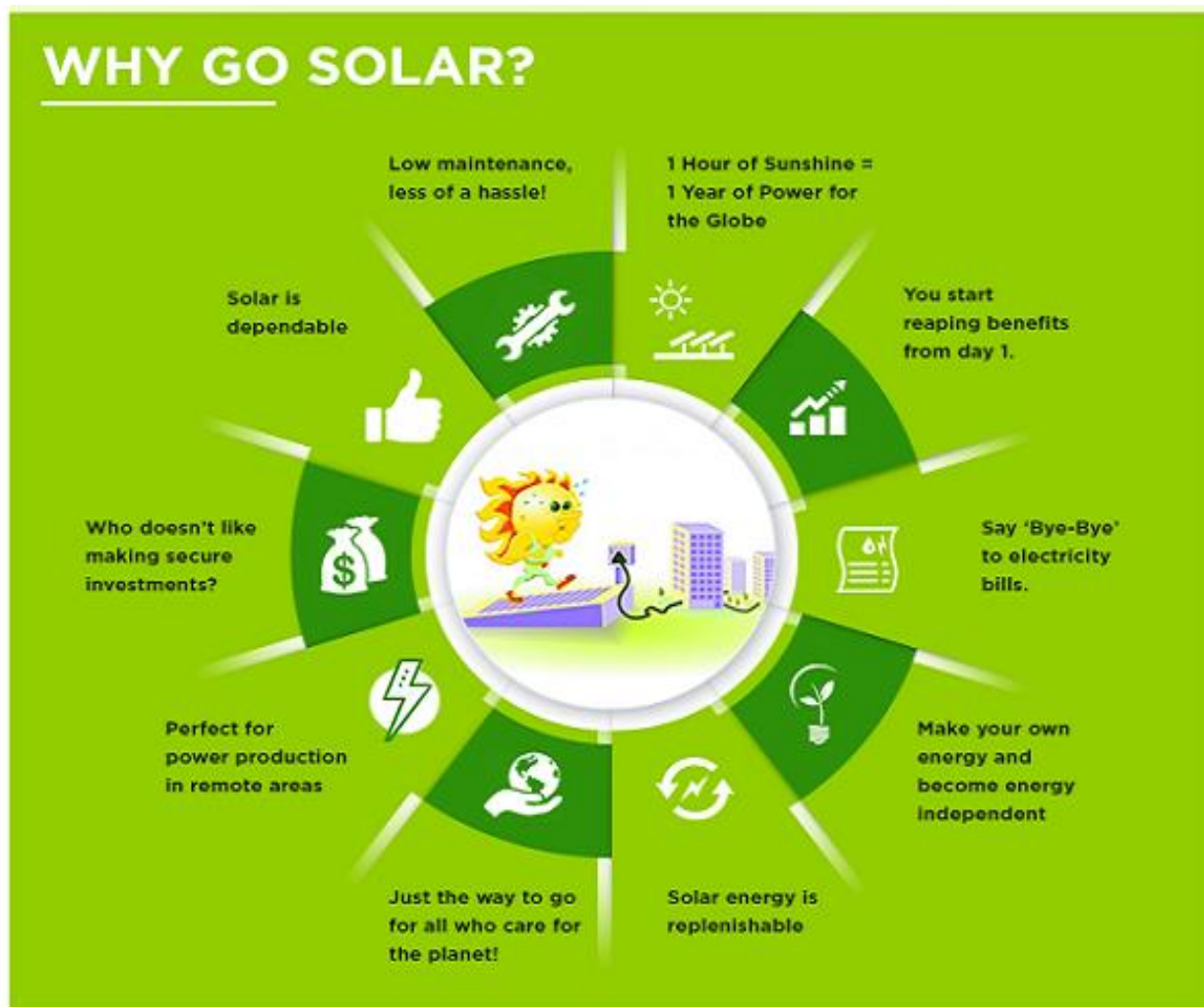
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II. DISCUSSION

Need of solar energy

- Energy security:



- India energy demands is largely fulfilled by non-renewable source of energy.
- The scarcity of these fossil resources stresses the need for renewable energy sources.
- Abundance of solar energy can fulfill India clean energy demands.
- India is dependent on imports to fulfill its energy demands, thereby incurring huge expenditure and uncertainty with regards to energy security.

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▪ Economic development:

- India being a developing economy needs proper electricity for industrial growth and agriculture.
- India also needs self sufficiency and minimal cost in power generation, assured regular supply, which will boost industries and economy.[3]



▪ Social development:

- The problem of power cuts and unavailability of electricity especially in rural area, leads to improper human development.
- Mostly energy demands are fulfilled by subsidised kerosene, leading to loss for exchequer.

▪ Environment concern:

- India's large part of energy demand is fulfilled by thermal energy largely dependent on fossil fuels.
- It also causes environment pollution
- Solar energy is clean form of energy resource, which can be a substitute.

Technology

- **Solar Photovoltaic:** Solar photovoltaic (SPV) cells convert solar radiation (sunlight) into electricity. A solar cell is a semi-conducting device made of silicon and/or other materials, which, when exposed to sunlight, generates electricity.
- **Solar thermal:** Solar Thermal Power systems, also known as Concentrating Solar Power systems, use concentrated solar radiation as a high temperature energy source to produce electricity using thermal route.

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Types

- **Solar for grid connected electricity:**
 - Grid interactive solar energy is derived from solar photovoltaic cells and concentrated solar power Plants on a large scale.
- **Solar for off-grid solutions:**
 - While, the areas with easier grid access are utilizing grid connectivity, the places where utility power is scant or too expensive to bring, have no choice but to opt for their own generation.
 - They generate power from a diverse range of small local generators using both fossil fuels (diesel, gas) and locally available renewable energy technologies (solar PV, wind, small hydro, biomass, etc.) with or without its own storage (batteries). This is known as off-grid electricity.

Challenges in adoption

- India's solar story is largely built over **imported products**.
- India's **domestic content requirement** clause is facing legal challenge at WTO.
- India is facing challenge to balance **Prioritising domestic goals and WTO commitments**.
- The **dumping** of products is leading to profit erosion of local manufacturers.
- Indian domestic manufacturers aren't technically and economically strong to compete with Chinese companies.
- China's strong manufacturing base is giving stiff challenge to domestic manufacturer.
- **Land availability** in India for solar plant is less due to high population density.
- India's **solar waste** is estimated to be around 1.8 million also needs to be tackled.

Government initiatives

- **Ministry of new and renewable energy** is the nodal agency to tackle India's renewable energy issues.
- **National Solar Mission** is a major initiative of the Government of India and State Governments to promote ecologically sustainable growth while addressing India's energy security challenge.
- **The Indian Renewable Energy Development Agency (IREDA)** is a Non-Banking Financial Institution under the administrative control of this Ministry for providing term loans for renewable energy and energy efficiency projects.
- **National institute of solar energy** is created as autonomous institution under MoNRE is apex body for R&D.[4]
- Establishment of **solar parks and ultra major solar power project** and enhancing grid connectivity infrastructure.
- Promotion of **canal bank and canal tank solar infrastructure**.

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- Sustainable rooftop implementation of **Solar transfiguration of India (SRISTI)** scheme to promote rooftop solar power projects in india.
- **Suryamitra** programme to prepare qualified workforce.
- **Renewable purchase obligation** for large energy consumer customers.
- National green energy programme and **green energy corridor**.

Potential

For a developing country like India, where electricity for every home was once considered a dream is now close to reality. The government initiative of **'power for all'** is changing the socio-economic structure of the country.

- The sector also has immense **potential to create new jobs**; 1 GW of Solar manufacturing facility generates approximately 4000 direct and indirect jobs.
- In addition solar deployment, operation and maintenance creates additional recurring jobs in the sector.
- Advancements are underway for storage, which has the potential to revolutionise this sector globally, till then **dependence on fossils can be reduced** by gradually increasing the share of renewables.
- India is expected to be **8% of global solar capacity by 2035**. With the future potential capacity of 363 Gigawatts (GW), India can be a global leader in term of encashing energy sector advantages.

International initiatives

- India's commitment as part of **INDC at Paris climate deal** to reduce the emissions intensity of its GDP by **33 to 35% from 2005 level**.
- To achieve about **40 per cent cumulative electric power** installed capacity from non-fossil fuel based energy resources , with the help of transfer of technology and low cost international finance, including from Green Climate Fund.
- The establishment of International Solar Alliance (ISA) of more than 122 countries initiated by India, most of them being sunshine countries, which lie either completely or partly between the Tropic of Cancer and the Tropic of Capricorn to promote solar energy.
- To mobilize more than US \$ 1000 billion of investments needed for massive deployment of solar energy, and pave the way for future technologies adapted to the needs.[5]

Way Forward

- Strong financial measures are required to finance the solar projects, innovative steps like **green bonds, institutional loans and clean energy fund** can play a crucial role.
- Promotion of research and development in renewable energy sector, especially in storage technology.
- Proper mechanism should be provided to tackle China's dumping of solar equipments.
- Framework to avoid unnecessary delays in policy decision making and implementation.
- India needs a **Solar Waste Management and Manufacturing Standards Policy**.

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III. RESULTS

The Rural Electrification Program of 2006 was the first step by the Indian Government in recognizing the importance of solar power. It gave guidelines for the implementation of off-grid solar applications. However, at this early stage, only 33.8MW (as on 14-2-2012) of capacity was installed through this policy. This primarily included solar lanterns, solar pumps, home lighting systems, street lighting systems and solar home systems. In 2007, as a next step, India introduced the Semiconductor Policy to encourage the electronic and IT industries. This included the Silicon and PV manufacturing industry as well. New manufacturers like Titan Energy Systems, Indo Solar Limited and KSK Surya Photovoltaic Venture Private Limited took advantage of the Special Incentive Scheme included in this policy and constructed plants for PV modules. This move helped the manufacturing industry to grow, but a majority of the production was still being exported. There were no PV projects being developed in India at that stage. There was also a need for a policy to incorporate solar power into the grid. The Generation Based Incentive (GBI) scheme, announced in January 2008 was the first step by the government to promote grid connected solar power plants. The scheme for the first time defined a feed-in tariff (FIT) for solar power (a maximum of Rs. 15/kWh). Since the generation cost of solar power was then still around Rs. 18/kWh, the tariff offered was unviable. Also, under the GBI scheme, a developer could not install more than 5MW of solar power in India, which limited the returns from scale. One of the main drawbacks of the GBI scheme was that it failed to incorporate the state utilities and the government in the project development, leaving problems like land acquisitions and grid availability unaddressed. As a result, despite the GBI scheme, installed capacity in India grew only marginally to 6MW by 2009. In June 2008, the Indian government announced the National Action Plan for Climate Change (NAPCC). A part of that plan was the National Solar Mission (NSM). The NSM guidelines indicated that the government had improved on the shortcomings of the GBI scheme. It aimed to develop a solar industry, which was commercially driven and based on a strong domestic industry. The extra cost of generation of solar power was being borne by the federal government under the GBI scheme.[4,5]

India's government has begun to acknowledge the importance of solar energy to the country's economic growth. Prime Minister Manmohan Singh, who has said solar energy will transform rural India, launched a National Solar Mission in 2010. Initial growth has been dramatic, albeit from a tiny base. From less than 12 MW in 2009, solar-power generation in the country grew to 190 MW in 2011. By March 2013, it is expected to grow fivefold to 1,000 MW, but the country has a long way to go to reach its goal of increasing solar-power generation to 20 gigawatts. Across India, there are still thousands of villages with plenty of sun but not enough power.

With the cost of solar photovoltaic cells falling — prices dropped by 50% last year and are now a quarter of what they were in 2008 — renewable-energy advocates say India is ripe for a solar-power revolution. And it could use it. More than 40% of the countryside is still not connected to the national power grid, and a 2010 report by the National Renewable Energy Laboratory in the U.S. said power demand in India trails supply by 12.7%. Closing this gap “will be critical for India to achieve its growth targets,” the report said. Failure to meet that unsatisfied demand could hamper India's growth, the World Economic Forum (WEF) said in a recent report.

IV. IMPLICATIONS

The Jawaharlal Nehru National Solar Mission aims at development and deployment of solar energy technologies in the country to achieve parity with grid power tariff. The National Solar Mission is a major initiative of the Government of India and State Governments to promote ecologically sustainable growth while addressing India's energy security challenge. It will also constitute a major contribution by India to the global effort to meet the challenges of climate change. The objective of the National Solar Mission 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. The aim would be to protect Government from subsidy exposure in case expected cost reduction does not materialize or is more rapid than expected. The immediate aim of the Mission is to focus on setting up an enabling environment for solar technology penetration in the country both at a centralized and decentralized level. The main features of the National Solar Mission [3,4] are:

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1. Make India a global leader in solar energy and the mission envisages an installed solar generation capacity of 20,000 MW , 1,00,000 MW , and of 2,00,000 MW .
2. The total expected investment required for the 30-year period will run is from Rs. 85,000 crore to Rs. 105,000 crore.
3. However the target is to achieve tariff parity with conventional grid power and achieve an installed capacity of 20 gigawatts (Gw) .
4. 4-5GW of installed solar manufacturing capacity by 2017.

GUJARAT SOLAR POWER POLICY -2009 Gujarat is the first state to launch its own solar policy in 2009. The Gujarat solar policy was in place a year before the NSM was announced. The initial target is to achieve 500 MW of installed capacity by the end of this period. Gujarat Energy Development Agency (GEDA) and Gujarat Power Corporation Limited (GPCL) have been appointed as nodal agencies for the facilitation and implementation of the policy. Gujarat Solar Power Policy is the only policy, which has awarded projects with a fixed FiT, on a first-come-first serve basis. This has resulted in the allocation of a number of projects to in-experienced or unknown developers. After the NSM policy was formalized in December 2009, developers moved away from Gujarat towards the NSM. In the first phase of the Gujarat policy, only 396.5 MW worth of PPAs were signed out of 716 MW allotments, leading to a conversion rate of 55% (PPAs signed as a percentage of projects allotted). The tremendous interest from developers for NSM led to the competitive bidding for projects and a subsequent fall in tariffs. The fall in the NSM tariff below the levelized tariff in Gujarat suddenly made the Gujarat policy very attractive again to developers. Further, a significantly higher feed-in-tariff in the first 12 years in Gujarat matches investor's timelines, as they would look to cover the cost of debt during this period. To ensure developer commitment, Gujarat's solar policy for the second phase has been amended to include a deposit that would be encashed, if the developers fail to sign the PPAs. Larger available project sizes and the relative ease of land acquisition has led to larger developers getting serious about the Gujarat policy and signing PPAs and starting the implementation of projects. Gujarat has significantly improved the credibility of its solar program from the first to the second phase[4]

INDIA'S FIRST SOLAR PARK On December 29th 2010, India's first solar park was inaugurated at Charanaka in Patan district of northern Gujarat. So far, land has been allotted in the solar park for projects worth 176MW to 16 companies from the first and second phases. The total capacity of the solar park is 500MW with 30,000 sq. m per MW land allotted to Solar Thermal and 20,000 sq. m per MW of land allotted to PV projects. The solar park has been financed with over Rs. 12 billion by financial institutions like the International Finance Corporation (IFC), the Asian Development Bank (ADB) and the Infrastructure Development Finance Corporation (IDFC). The park tackles land procurement, water availability and grid connectivity issues and offers a "single-window" clearance process. Sixteen companies, including SunEdison Energy India (25MW), Alex Astral Power (25MW), Roha Energy (25MW), GMR Gujarat Solar (25MW), Kiran Energy (20MW), Emami Cement (10MW) and Azure Power (5MW) have been allotted projects worth a total of 176MW in the park. They have all signed PPAs with the state government.

KARNATAKA SOLAR POWER POLICY (2011-16) Karnataka, a south-western state of India, announced its solar policy on July 1, 2011. Under the solar policy 2011-16, the Karnataka Government proposes to promote solar power as part of renewable energy generation policy in the state. 1. It targets 350 MW worth of projects till 2016. 2 .200 MW is to be developed for direct sale to the distribution companies in the state (40 MW to be added each year) 3. 100 MW under REC Mechanism 4. 50 MW for bundling of power with thermal power from outside the state at rates to be determined by the State Government subject to approval of KERC. The minimum capacity of solar PV projects is 3 MW and maximum capacity of 10 MW, while for Solar Thermal the minimum is 5MW with no cap on maximum. The quantum of power to be procured by ESCOMs from solar resources under purchase obligation is 0.25% of the total consumption and the shortfall in procurement of solar energy by the ESCOMs can be made good by purchase of solar specific RECs. Though the state has come up with its own policy, it will continue to support programs like the NSM.

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The state has set a combined target of 126 MW of solar power to be developed by 2013-14 through NSM and its own solar policy

RAJASTHAN SOLAR POWER POLICY - 2011 On April 19th 2011, Government of Rajasthan issued Rajasthan Solar Energy Policy, 2011 to promote solar energy in the state. The policy aims to help Rajasthan, develop as a global hub of solar power for 10000-12000 MW capacity over the next 10 to 12 years to meet energy requirements of Rajasthan and other states of India. 1. It targets a minimum of 550MW of grid connected solar power in Phase 1 (up to 2013). 2. Projects will be awarded through a process of competitive bidding. 3. PV projects will be worth 300MW, out of which 100MW are reserved for project developers and 200MW for panel manufacturers. 4. The minimum and maximum sizes for PV projects are 5MW and 10MW. 5. Module manufacturers that set up their manufacturing plant in Rajasthan can bid for either 10MW or 20MW worth of PV projects based on their manufacturing capacity. 6. A further 50MW will be allocated for rooftop PV (1MW each) and other small solar power plants. 7. The DISCOMS in Rajasthan will provide PPAs for the projects. In addition, projects worth 100MW (50MW PV and 50MW CSP) are targeted for bundled solar power. In such projects, the developer can sell conventional power and solar power in a ratio of 4:1 at the weighted average tariff to the distribution utilities in Rajasthan. Varied project sizes will attract small as well as large developers looking to invest in projects of different scale.[5]

V. CONCLUSIONS

Present Study led us to three major conclusions:

India's solar market could be worth billions of dollars over the next decade:- India's solar potential is real enough, and the support environment is improving fast enough, to forecast a \$6 billion to \$7 billion capital-equipment market and close to \$4 billion in annual revenues for grid-connected solar generators over the next decade.

Project execution, financing, and localization are crucial:-A frugal cost base will be at the core of successful Indian solar ventures. As the number of projects and players increases, procurement effectiveness will become a requirement. Longer-term value will come from efficiently executed projects, low-cost (and often innovative) financing, and localization.

Local players will dominate the downstream solar industry:-In contrast to the global nature of the upstream industry (solar modules), we expect local, or at least well-localized players to dominate the downstream side in the initial years; this includes project development, installation, and distribution. Given sufficient time to fine-tune their business models, global players entering India for the first time will be able to prosper. Entering and learning the ropes early will be important for both local and global players. While some players have already begun preparing, most have yet to place a bet on solar, given the uncertainties within the sector. Success in solar energy will require a long-term commitment and a sound understanding of local dynamics.[6]

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