

## Solar Energy Development in India: an Approach towards Sustainability

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### Abstract

The enormous challenges posed by global warming to the world community needs to be looked from various dimensions such as food security, deteriorating water level, and rise in poverty and health impact. With 1.2 billion population to feed and nearly 24% of the population lacking basic energy services, India finds itself in a precarious state to ensure welfare to its citizens as well as to keep in part with the challenges of climate change. Fossil fuels such as coal, crude oil and natural gas constitute around two-third of India's energy portfolio. India has grown from being the world's seventh largest energy consumer in 2000 to the fourth largest one within a decade. Acceleration in industrial sector and shifts in consumer tastes are the two main factors that are likely to push up energy demand in the near future. With peak time energy deficit estimated to be 5.2%, it is time for India to plan for a shift from current pattern of energy generation. Excess dependence on conventional energy is not only a concern to environmental problems but also drains the foreign exchange. Although the country rank low in per capita emissions, it is among the top five emitters of overall greenhouse gas emissions. The energy world underwent a seismic shift in 2015, with Paris Climate Agreement urging signatories in reducing emission intensities and of launching 21<sup>st</sup> century as clean energy economy. Sustainability demands that the country increasingly shifts to renewable sources. Solar energy a clean renewable source with zero emission has got tremendous potential of energy which can be harnessed using various devices. The precipitous drop in solar photovoltaic panel prices has coincided with rising cost of grid power, quickly making solar cost effective and shortening projected timeline to achieve grid parity. This paper intends to look into the a) prospects of solar power generation in mitigating climate change challenges and improving accessibility of energy in rural areas b) regulatory policies for creating an enabling environment for scaling of grid and off-grid solar power installations in the country and c) the current challenges faced by this sector in scaling up the market penetration and solutions for creating a vibrant future solar market in the country.

**KEYWORDS:** Climate Change, Greenhouse Gas, Solar Photovoltaic, Sustainability

### Introduction

While India relieves itself from the slow pace of growth impacted upon by the global recession of 2007-09 and now growing itself at a pace of 7 per cent annually, it is essential that the nation finds accessibility to clean energy sources to contain the impact of Greenhouse Gas (GHG) emissions. As climate change creates an uphill challenge before the developing world including for countries like India in accumulating investments for delivering sustainable living standards and as a model for climate adaptation strategies. India's average annual energy consumption was 0.6 tones of oil equivalent (toe) per capita as compared to global average of 1.8 tonnes of oil equivalent (UNFCC). For India to rise in Human Development Index value of 0.8, India need a per capita oil consumption of 4 tonnes of oil equivalent. As a result of increasing urbanization, the proportion of people living in cities has risen to 70 per

cent and by 2050 will have a corollary effect on raising the demand for power, housing and transport. Demand for grid power in India is likely to rise from 776 Terawatt hours (TWh) in 2012 to 3,870 Terawatt hours (TWh) by 2030. The total emissions in India would rise from 1.6 billion tonnes carbon dioxide equivalent (CO<sub>2</sub>e) in 2005 to 6.5 billion tonnes carbon dioxide equivalent by 2030 (McKinsey Analysis 2009). India occupies the fifth largest power generation worldwide, with total power generation estimated at 307.28 GW. Currently renewable energy, hydropower and nuclear energy together constitute around 30 per cent of the total installed power generation in India. Solar photovoltaic installations have the potentiality of reducing the intensity of greenhouse gas emissions and can turn as a game changing option for India in achieving sustainable development outcomes. The precipitous drop in solar photovoltaic panel prices has coincided with rising cost of grid power, quickly making solar cost effective and shortening projected timeline to achieve grid parity. This paper intends to look into the a) Current state and potentiality of solar energy sector in India b) regulatory and financing policies for creating an enabling environment for scaling of grid and off-grid solar power installations in the country and c) the current challenges faced by this sector in scaling up the market penetration and solutions for creating a vibrant future solar market in the country.

### **Current state of Solar Development in India**

In the backdrop of widening gap between demand and supply of energy requirements, scarcity of conventional fuels and longer gestation period of installing thermal power plants, solar energy is a reliable, accessible and game changing option before India. India being a tropic country receives an annual solar radiation of 5000 trillion Kilo Watt hour (KWh) and 4-7 KWh per square meter daily. With 250-300 sunny days in a year solar energy can contribute much in mitigating the challenge of global warming and climate variability. The scaling of solar photovoltaic installations can have the impact of raising India's per capita energy consumption, which currently constitute only one-third of world's average constitution. With rising population, limited commissioning of fossil fuel generation plants and high irradiation in Northern and Central parts of India made solar industry an investment hub for international and private investments in the country. Solar power installed capacity has increased from only 3.7 MW in 2005 to about 4060 MW in 2015, with a Compounded Annual Growth Rate (CAGR) of more than 100 per cent over the decade (INDC 2015). As of March 2016, India had a cumulative capacity of 6.6 GW, constituting around 40% of the total renewable resources installed in the country (MNRE).

Solar technologies as solar lanterns, solar water pumps, off solar installations, rooftop photovoltaic installations, solar dryer and solar desalination plants have the potentiality of addressing the power outages in India's rural areas. The deployment of solar lanterns in remote rural areas can enhance the primary enrollment ratio of students & can relieve the burden of state financing in providing kerosene and fuel subsidies to the less privileged classes. Solar energy is a boon for students in faraway villages, facing erratic power supply throughout the year. As per the analysis of World Health Organization, 13 per cent of the total mortality in India, 20 per cent of the heart diseases, lung cancer and lower respiratory infections in India is due to the reliance of traditional cook stoves & three stones fires by the rural households. The health disorders of rural households can be relieved with use of solar cookers instead of the traditional biogas stoves. Solar water pumps in small land holdings can directly enhance financial health of State distribution companies, which give electricity at

subsidized rates to rural farmers employing diesel pumps or tube wells for irrigation (yadev et.al.2016).

### **Regulatory & Financial Polices for Re-energizing India's Solar Energy Sector**

The Electricity Act 2003 was the umbrella legislative framework, adopted for harnessing the potentiality of renewable energy sources in the country. In the context of rising power deficits and of improving energy accessibility in rural areas, Electricity Act 2003 makes it mandatory for respective stakeholders for promoting renewable energy installations on a priority basis. The Rural Electrification Programme of 2006 was the initial step made by the central government in recognizing the viability of solar energy in India. In 2008, the government introduced the first of its fiscal package, Generation Based Incentive scheme, to attract new investments and have the ease of doing business in the sector. Generation Based Incentive (GBI) has been used to support grid connected rooftop Photovoltaic installations, where the central government pays state utilities a set tariff for power purchased from solar developers. As the scheme offered a Feed in Tariff (FiT) of RS. 15/KWh and the generation cost amounts to Rs.18/KWh, scheme turns to be unviable for project developers (CEEW-NRDC 2015).

Realizing the potentiality of solar energy in mitigating the burden of climate change costs, national government outlined the inclusion of National Solar Mission as one of the nine missions under National Action Plan on Climate Change (NAPCC). The mission sets the specific goal of nurturing solar ecosystem in the country and broader goals of reducing photovoltaic generation costs through Research and Development (R&D), developing nation as a solar manufacturing hub and developing India as a destination for international and private investments. The mission envisages a cumulative investment of US \$ 100 billion to be garnered through international private investments, in scaling solar installations to the ambitious target of 20 GW by 2022. The phases of National Solar Mission are outlined in Table 1.

Solar Technology	Phase I (2010-2013)	Phase II (2013-2017)	Phase III (2017-2022)
Grid connected/rooftop	1,000 MW-2,000 MW	4,000 MW-10,000 MW	20,000 MW
Off Grid Solar Applications	200 MW	1,000 MW	2,000 MW
Solar Hot water Collectors	7 Million Square meters	15 Million Square meters	20 Million Square meters

Source: National Solar Mission Document

Table 1 National Solar Mission Targets 2010-2022

The mission underscores the vision of India to emerge as a global manufacturing hub, getting accessible financing options to solar developers and achieving grid parity with fossil fuel generation The Mission sets the target of achieving 20 GW of grid connected Photovoltaic installations and 2 GW of grid installations by 2022 (CII 2012). The success of National Solar Mission depends on the coordination of national and state level policy makers at strategic level and all the other stakeholders ( project developers, manufactures and financiers) at the project level for nurturing a nascent industry in the energy sector.

## Financing mechanism deployed under the framework of National Solar Mission

Anchored by the reverse bidding auction process, Indian government introduced many financing mechanism to support early solar projects during the first phase of the National Solar Mission (NSM). Phase I of NSM have seen many innovative financing mechanisms as preferential feed in tariff system, payment security mechanism in the context of potential default by participating companies and of bundling solar power with unallocated coal (CEEW-NRDC 2015). The Phase I of NSM saw the resurgence of multilateral investors (Asian Development Bank, US Export –Import Bank, KfW Development Bank of Germany) in offering low cost debt finance to project developers and in improving investor's confidence in the domestic sector. The Batch II of NSM has the credibility of achieving grid parity with conventional power plants by quoting the lowest bid through reverse auction mechanism. With the multilateral financial institutions exploring other developing countries offering lower generation costs, the impact of narrowing down the resultant investment gap falls on the domestic financial institutions. A few Indian banks provided project financing loans at a lending rate of 11 to 13 per cent as compared with 9 to 10 per cent annual rates from multilateral institutions. (CEEW-NRDC 2015).

Faced with the unexpected delays in projects get commissioned by the developers, Ministry of New and Renewable Energy issued NSM Phase II Batch I guidelines, only at the end of 2013. Phase II started with significant changes, with the introduction of Viability Gap Funding (VGF) instead of preferential tariff of Phase I and Solar Energy Corporation of India (SECI) as the implementing authority for Batch I instead of NVVN. Financiers, developers and most stakeholders view India's economic slowdown in 2013 & 2014 and the associated currency depreciation and inflation as the reasons for reduced outflows of Foreign Direct Investment in India. Meanwhile international funding bodies as World Bank have expressed their interest in investing in Phase II of solar growth momentum, other big investors of Phase I are reluctant in investing in India's energy sector. The specification of NSM Phase I and Phase II are outlined in the following table (Table 2).

**Table 2: Phase I & II Batch Specifications under National Solar Mission**

Batch Specification	Phase I		Phase II	
	Batch I	Batch II	Batch I	Batch II
Project size for developers to enter the market	5MW	20MW	10MW	50 MW
Implementing Authority	NVVN <sup>a</sup>	NVVN	SECI <sup>b</sup>	NVVN
Bid Allocation Mechanism	Bid for the lowest Preferential Tariff	Bid for the lowest Preferential Tariff	Bid for the lowest amount of Viability Gap Funding	Bid for the lowest Preferential Tariff
Number of Project developers Awarded	36 qualified projects	22 qualified projects	36 qualified projects	Not in operation

a-NTPC Vidyut Vypar Nigam Limited b- Solar Energy Corporation of India

Source: Ministry of New and Renewable Energy, Mission document

Table 1 National Solar Mission Targets 2010-2022

The following are the main finance mechanism employed under NSM for developing a vibrant solar energy sector in India.

- 1) Feed in Tariff (FiT) – It is the preferential tariff offered for solar power sold to utilities by the developers. During Phase I, through reverse bidding auction mechanism, India government set a tariff of Rs.17.91/KWh for project developers. Outside the ambit of NSM, the state government set their preferential tariff for developers in their respective jurisdictions. Phase II OF NSM witnessed the restoration of Feed in Tariff only in Batch II of the mission (CEEW-NRDC 2015).
- 2) Renewable Purchase Obligations (RPO) - Renewable Purchase Obligation is a financial mechanism in driving the growth of solar photovoltaic installations in the country. According to the Electricity Act 2003 and amendment to National Tariff Policy, State Electricity Regulatory Commissions were required to determine a percentage of power which has to be procured from renewable sources. By March 2022, National Tariff Policy made it mandatory for State Electricity Regulatory Commission to purchase 8 per cent of electricity from solar energy (Sharma 2016). With state distribution companies entangled with heavy debt burden, effectiveness of State Electricity Regulatory Commission’s in enforcement of RPO was met with failure. RPO continues in Phase I and Phase II of NSM.
- 3) Renewable Energy Certificate (REC)- REC is a market based trading instrument that enable the obligated entities to purchase renewable sources as per their RPO requirements. I f distribution companies, open access consumers and captive consumers have failed to produce their share of renewable energy; they can purchase REC for their obligations (Sharma 2016). Like other debt instruments traded in financial market, REC is also traded in India Energy Exchange or Power Exchange Limited. The Central Electricity Regulatory Commission fixes the floor and forbearance for trading of REC in the exchange (Table 3)

Price	Solar REC (Rs./MWh)
Forbearance	5,800
Floor	3,500

Source: Central Electricity Regulatory Commission

Table 3: Floor and Forbearance price fixed by CERC (w.e.f. 01.01.2015- 31.03.2017)

- 4) Viability Gap Funding- Phase II Batch I of NSM depends on lowest bid price through Viability Gap Funding to make the solar projects more economically viable. The VGF mechanism allowed developers to seek financing for their projects upfront and allowed the government to provide more initial support instead of spreading it over the 25 year contract term (as in Phase I). Since the VGF covers only a small part of financing required for the projects, developers theoretically need to generate power efficiently and consistently in order to achieve an acceptable return on investment from the project over its projected 25 years at the set tariff (CEEW-NRDC 2015). Phase II Batch I tender of solar projects, witnessed a three times oversubscription of bids.

SECI allocated projects to developers qualifying the least amount of VGF (Table4).

Specifications of the Tender	VGF Bid amount Open category	VGF Amount Bid for "Domestic Content Requirement Category"
Lowest Bid	Rs. 17.5 lakh (\$ 28,162) per MW	Rs.1.35 crore (\$ 217,251) per MW
Highest Bid	Rs.1.35 crore (\$ 217,251) per MW	Rs.2.45 crore (\$ 394, 271 per MW.

Source: CEEW-NRDC

Table 4: Selected VGF Bids for Phase 2 Batch I's Tender

These are the main financing mechanism employed under National Solar Mission in driving the scale of Solar Photovoltaic installations. Apart from these policies, Multilateral financing sources and International Solar Alliance (a grouping of 121 solar rich countries) are also striving for technological and product innovations in this sector.

### Challenges to Solar Energy Sector in India

Despite the support from regulatory level frameworks, solar is faced with technological and financial constraints, making its pace of growth in slow mode.

- 1) Solar tariffs have plummeted by 33% in the last two years. The laxity of state governments in compiling with guidelines of Ministry of New and Renewable Energy and Central Electricity Regulatory Commission, account for loss of investor confidence in this sector. Until May 2014, only four states (Gujarat, Andhra Pradesh, Uttarkhand and Tamil Nadu) have finalized net metering policies. With state distribution companies facing a cumulative loss of US \$50 billion, they are precarious condition in meeting mandatory Renewable Purchase Obligation and incentivizing actual generation (Bridge to India 2014).
- 2) India's solar market is faced with low quality grid integration and availability. The Indian power grid suffers from high losses, frequent technical failures and lack of monitoring and maintenance. It is the reverse of the vision of "Smart Grid". Grid stability is essential so as to absorb the volatile renewable power and for meeting the rising demand in pace with the supply of power. Apart from the financial loss, state distribution companies refrain from utilities reluctant grid investors and non- bankable Purchasing Power Agreements (PPA's) (Bridge to India).
- 3) Solar in particular and renewable in general is influenced by lack of policy uncertainty. The government has announced reduction of its key financial incentive 'Accelerated Depreciation' from 80% to 35% in 2012. Under Accelerated Depreciation scheme, a company can claim 80% accelerated depreciation in the first year of installation under section 80 IC of the Indian Income Tax. With making significant reduction under this scheme, commercial project developers remain reluctant in investing in utility scale solar projects (Bridge to India).

- 4) Solar sector is faced by viable debt financing sources. The solar sector being faced by high upfront capital cost (Rs.10-12 crore per MW) and uncertainty of the future prospect of the sector restrict banks and other financial institutions from lending to solar projects. Further high domestic interest rates (11%-13%) charged by the domestic banks made rooftop solar projects in a slow pace of growth. The target of India achieving 20 GW of rooftop has waned for lack of clarity on lending norms and no concessional financing options for solar project developers (CII 2012).
- 5) The state distribution companies have not been effective in the enforcement of Renewable Purchase Obligations, acting as limitation in the scaling of solar installations in the country.
- 6) Solar energy has the potential to create employment potentiality in the country. Globally, USA, Germany and china lead in the employment potentiality to its citizens. The maintenance works in solar products can be done only with the scaling of employability in the sector.
- 7) Two-thirds of the total cost of generation of solar power is attributed to Balance of system (inverter and other components for installation) cost. This act as a major barrier in the growth of utility scale solar projects.

#### **Possible Solutions of overcoming the challenges**

- 1) Establish Priority Sector Lending for Solar Power- To increase affordable domestic financing, the RBI, along with leading agencies including the Ministries of Power, Coal, and Finance should explore the possibility of priority sector lending for off –grid energy projects.
- 2) Ensure timely implementation of Solar Policies- Both the national and state programs must continue to advance market momentum through timely programme implementation, with timelines for issuing guidelines, guidance, auctions and payments.
- 3) Deploy VGF within one year- The central government must ensure effective implementation of the VGF for the Phase 2 , Batch I Projects, with payment within the first year.
- 4) Increase transparency of Solar Market Information- The central government, states and financiers as part of solar market ecosystem must continue to increase transparency and provide information on the progress of solar projects.
- 5) Enforce RPO mandates: In the absence of well functioning of REC market, solar industry is missing a key opportunity to attract additional investors. The Central Electricity Regulatory Commission must strictly issue guidelines for the implementation RPO norms in India.
- 6) Create a domestic manufacturing capability in India: Currently, India's installation of solar projects is driven by imports from USA & Germany. By developing a manufacturing base in the domestic sector, India can reduce the import burden on solar projects. By 2030, India target to develop a manufacturing base of 2-3 GW in the domestic sector.

#### **Conclusion**

It is acclaimed from the discussion that demand of power is surging and regulatory agencies are struggling to grow in pace of supplying power. In this

scenario, it is inevitable that renewable sources (solar, wind and small hydro) have lot of potentiality in delivering the end needs of the states. But the sector is faced with global uncertainties, complexities in domestic regulatory institutional guidelines, making its targets mentioned in Mission document waned. The central electricity regulatory commission should have a effective monitoring mechanism in assessing the potential of state governments in amending laws and financing options to the sectors. Further, Reserve Bank of India have the priority sector lending (that banks should garner 40% of their total credit to critical sectoral finance) should be made available to solar project developers. Lastly public perception of this green energy source should be promoted through promotional activities of federal and state government bodies. If the bottlenecks are eased for doing business in this sector, by 2030, India should have the potentiality of carbon emissions and thus making compliance with the international norms.

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