

POWERING AHEAD WITH RENEWEABLES IN COST EFFECTIVE WAY 'NTPC PROSPECTIVE'

Author's:

H.S. Bagga, Senior Manager (Inspection Services)

Vikas Khare, AGM (Inspection services)

Main Author

H.S. Bagga, Senior Manager (Inspection)

B. E (Mech. Engg), PDGBA (Finance)

1.0 SUMMARY

The past decade and half has been a period of immense growth, innovation and evolution for the Indian power sector. From a luxury product just a few decades ago, electricity has turned into a necessity for every household.

The Indian power system is the fifth largest in the world and among the most complex. With installed capacity of 309 GW and an annual electricity production of 1,108 billion units (BU), it is among the top five power consumers across the globe, and the demand is expected to touch 1,900 BU by 2020. While almost 61% of the power generated is from coal, India is looking to alter the generation mix in the years to come, focusing on a low-carbon growth strategy. Taking note of various benefits of Renewable Energy like contribution to reducing electricity price volatility and energy imports thereby increasing energy security and positively contributing to reduction in CAD (current account deficit), minimal impacts on the local environment compared to conventional sources and its ability to mitigate Climate Change through reduced GHG emissions, the GOI has taken a considered view of significantly increasing the uptake of RE from 2015-16 till 2022. The aim is to have an installed capacity of 175 GW by 2022, implies CAGR of 25% over the next 7 years. It comprises of solar (100 GW) and wind (60 GW) the remaining 15 GW would be made up of biomass power (10 GW) and small hydropower (5 GW). (fig 1.a)



The Ministry of New and Renewable Energy (MNRE) has taken several steps to fructify Prime Minister's dream of clean energy. The largest renewable capacity expansion program in the world is being taken up by India. The government is aiming to increase share of clean energy through massive thrust in renewables. A lot of decisions has been taken by GOI in the last 2 years to reduced cost of RE. It includes a) National Tariff Policy 2016, b) Bundling of solar power with cheaper thermal power, c) Facilitating low cost and longer tenure debt, d) Accelerated Depreciation (AD), e) Viability Gap Funding (VGF), f) Generation Based Incentive (GBI) etc. The major programs / schemes on implementation of Solar Park, Solar Defence Scheme, Solar scheme for CPUs Solar PV power plants on Canal Bank and Canal Tops, Solar Pump, Solar Rooftop etc have been launched during the last two years.

Solar tariffs have fallen to an unprecedented low of Rs. 4.34 / kWh through reverse auction for one of six projects of 70 MW each to be put up in Rajasthan under the National Solar Mission. However, the tariff had further fallen to Rs 3 per unit, which was quoted by M/s Amplus Energy Solutions in an auction for rooftop solar power conducted by Solar Energy Corporation of India (SECI). Solar power is likely to become cheaper than, or equivalent to, conventional thermal energy prices over the next two to three years and reach Rs.4-4.5/kWh by FY18," India Ratings and Research, the domestic arm of Fitch Ratings, said in a report.

In spite of these benefits, the high target has profound implications and can throw up myriad challenges for the Indian power sector, especially in the short run like higher capital cost and interest rate, grid integration issues, poor RPO compliance etc. NTPC Ltd India's largest power company is taking a giant leap in renewable energy also with target of 10,000 MW of solar power by 2022 and another 15,000 MW through developers.

'This paper provides an insight into renewable energy targets sets by GOI and the policy initiatives taken to in the last 2 years to fulfill the dream of clean energy. Key challenges and positives of policy initiatives are discussed. NTPC being the biggest and trendsetter power producer of India is also expected to take the lead in exploring the opportunities of renewables energy sources for fulfilling the target of largest green Power Company.'

'This paper provides an insight into renewable energy targets sets by GOI and the policy initiatives taken to in the last 2 years to fulfill the dream of clean energy. Key challenges and positives of policy initiatives are discussed. NTPC being the biggest and trendsetter power producer of India is also expected to take the lead in exploring the opportunities of renewables energy sources for fulfilling the target of largest green Power Company.'

'This paper provides an insight into renewable energy targets sets by GOI and the policy initiatives taken to in the last 2 years to fulfill the dream of clean energy. Key challenges and positives of policy initiatives are discussed. NTPC being the biggest and trendsetter power producer of India is also expected to take the lead in exploring the opportunities of renewables energy sources for fulfilling the target of largest green Power Company.'

'This paper provides an insight into renewable energy targets sets by GOI and the policy initiatives taken to in the last 2 years to fulfill the dream of clean energy. Key challenges and positives of policy initiatives are discussed. NTPC being the biggest and trendsetter power producer of India is also expected to take the lead in exploring the opportunities of renewables energy sources for fulfilling the target of largest green Power Company.'

'This paper provides an insight into renewable energy targets sets by GOI and the policy initiatives taken to in the last 2 years to fulfill the dream of clean energy. Key challenges and positives of policy initiatives are discussed. NTPC being the biggest and trendsetter power producer of India is also expected to take the lead in exploring the opportunities of renewables energy sources for fulfilling the target of largest green Power Company.'

'This paper provides an insight into renewable energy targets sets by GOI and the policy initiatives taken to in the last 2 years to fulfill the dream of clean energy. Key challenges and positives of policy initiatives are discussed. NTPC being the biggest and trendsetter power producer of India is also expected to take the lead in exploring the opportunities of renewables energy sources for fulfilling the target of largest green Power Company.'



fig 1.a

2.0 GREEN POWER CAPACITY ADITION IN INDIA AND NATIONAL SOLAR MISSION

India has an estimated renewable energy potential of about 900 GW from commercially exploitable sources viz. Wind – 102 GW (at 80 meter mast height); Small Hydro – 20 GW; Bio-energy – 25 GW; and 750 GW solar power. With 46.33 GW installed renewable power capacity, the renewable power has a share of about 15% to the total installed capacity of 307 GW on 31.10.2016. The increased use of indigenous renewable resources is expected to reduce India's dependence on expensive imported fossil fuels.

A total of 7,518 MW of grid-connected power generation capacity from renewable energy sources has been added so far this year (Jan 2016 to Oct 2016) in the country. A capacity addition of 14.30 GW of renewable energy has been reported during the last two and half years under Grid Connected Renewable Power. As on 31st October, 2016, Solar Energy Projects with an aggregate capacity of over 8727.62 MW has been installed in the country.

2016-17 is a key milestone while progressing towards the 2022 target. MNRE has targeted a total RE capacity addition of 16.6 GW this year of which the bulk is from solar (12 GW) followed by wind (4 GW). The previous highest capacity addition in any year was in 2015-16 when 6.7 GW was added (Wind 3.3 GW; Solar 3 GW). To achieve 2016-17 RE targets, a growth rate of 138% over 15-16 capacity addition would be needed. In comparison, growth rate from 2014-15 to 2015-16 was only 71%. The 175 GW target implies a quintupling of RE capacity from 2015 to 2022. While the mainstay of RE capacity growth in the past has been from wind power, solar power is rapidly increasing its share and is expected to grow much faster than wind in the coming years.

Tentative Capacity Targets beyond 2022 and up to 2032

Even though no firm renewable energy targets have been announced beyond 2022, one can mostly expect the uptake of RE to keep increasing given the falling costs and increasing environmental and climate considerations. India's INDC aims to achieve about 40% cumulative electric power installed capacity from non-fossil fuel based energy resources by 2030 (GoI, 2015). The capacity share of RE is expected to sharply rise from 14% in 2016 to 32% in 2022 and 35% in 2032.

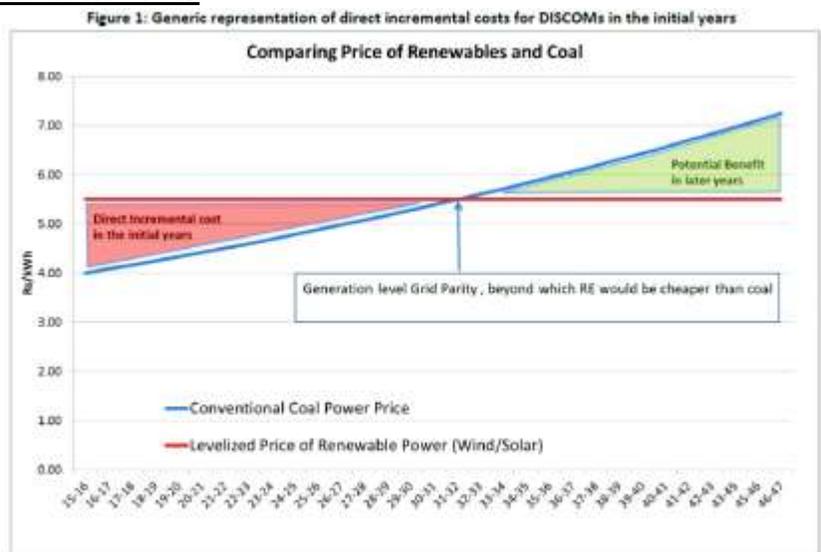
The national solar mission launched in 2009 had originally set the 2022 target at 22 GW. The National Solar Mission aims to promote the development and use of solar energy for power generation and other uses, with the ultimate objective of making solar energy compete with fossil-based energy options. A subsequent amendment to the national tariff policy in 2011 recommended all states to have a 3% solar RPO by 2022, translating to a target of 34 GW by 2022. In 2015, the solar mission's target was significantly revised upwards to 100 GW. In line with this, the tariff policy was amended in 2016, recommending State Electricity Regulatory Commission (SERCs) to set solar RPOs to reach 8% of total consumption of energy, excluding hydro power, by March 2022 (MoP, 2016). This roughly translates to a capacity of 85 GW, specified for years which range from 2017 to 2022. Most of large MW scale utility projects are expected to come up in solar parks. These parks will have appropriately developed land with all clearances, a transmission system, water access, road connectivity, communication network, etc. The Solar Energy Corporation of India (SECI) is developing these solar parks in collaboration with the respective state governments. The choice of implementation agency is left to the state governments. It could be done by a) The designated state PSU, b) a joint venture between SECI and the state PSU, c) SECI, d) private entrepreneurs.

3.0 CHALLENGES FOR POWERING AHEAD WITH RENEWABLES

In spite of these benefits, the high target has profound implications and can throw up myriad challenges for the Indian power sector, especially in the short run. Some of the challenges are described as below:-

3.1 High Capital Investment

Renewable energy technologies, unlike conventional energy technologies, often tend to have high (as much as twice or more) capital costs and very low operating costs (less than 10% in few cases). Thus, the cost of capital (finance) emerges as one of the most significant contributors to the delivery of clean energy. In contrast, conventional energy sources are less capital intensive, and the cost of capital has much less contribution to cost of delivered energy (fuel costs are most significant contributors). The relatively higher upfront renewable energy tariffs act as a hindrance for large scale uptake by Distribution Companies (DISCOMs), especially for those in weak financial health. Given the absence of fuels in wind and solar power generation, nearly all their cost constitutes upfront capital investments for generation and transmission equipment. Hence it is obvious to expect investments in renewables to closely track the growth in capacity addition. The capital requirements/investment opportunities for realising the 175 GW plan are quite high. Wind and solar power projects (generation and transmission) would need approximately Rs. 7-8 lakh crore of capital investments from 2016-22.



3.2 Higher cost of financing

The reality is that RE project developers in India often struggle to access the large quantities of financing they require and even when available, the cost of financing is often high. The cost of capital is inherently high in India – debt costs in India is typically 12-14%, vis-à-vis 3-7% range in the developed economies, equity return expectations are even higher. This can mostly be attributed to the inherent structure of India's financial sector and the state of the economy which influences factors such as the cost of money, its variability and tenor, and inflation. These terms adversely affect RE projects. Financing is certain to be a challenge for RE. Renewable energy tariffs, of which 70% are financing costs (but no fuel costs for 25-30 years), will reduce if loans are provided at lower interest rates.

3.3 Technically less reliable

Technically, RE is typically described as an intermittent source of electricity. Intermittency consists of two distinct aspects: "Predictability/Uncertainty" refers to the lack of accurate knowledge about future RE generation (e.g., a sudden drop in wind power), which is not very different from fossil fuel-based generation/transmission systems (e.g., an unforeseen failure of a fossil-based generator or a transmission line). "Variability" is the known natural variation in RE generation (e.g., wind peaking during monsoon and reduced availability in other seasons), just as we have on the demand side currently (e.g., low demand at midnight and high demand during late afternoon).



3.4 Lack of Synergy in Solar Targets under Various Regulations, Policies, and Plans

At present, there are at least four different avenues wherein state-wise solar targets are specified. These are a) State 'Power for All' (PFA) Plans, b) Solar RPOs notified by SERCs, c) State solar/RE policies, and d) MNRE allocation of national target to states. While the PFA plan and RPO regulations specify year-wise targets, state policy targets and MNRE allocated targets are for one terminal year. State targets have been specified for various years from 2015 to 2022, while the MNRE state-wise allocation is known only for 2022.

3.5 Grid Integration

Reliable and cost-effective RE grid integration is a key requirement for the success of the 175 GW plan. A high percentage of variable renewable generation will fundamentally change the nature of the electricity grid planning and operation over the long run. Therefore, transmission planning and pricing, operation of conventional generators and their pricing mechanisms, grid codes etc., will have to change appropriately.

Some SLDCs, especially in states with high RE (Tamil Nadu, Gujarat, etc.) are already facing some integration issues which need careful coordination and multi-government and appropriate institutional responses. CERC and some states have already started implementing one key element of the solution, forecasting and scheduling requirements for wind and solar plants. A lot more work is required for a complete solution to be in place.

3.6 Lacking in Roof top Capacity Addition

The rooftop solar PV segment seems to be the weakest link in the build up to 175 GW. 40 GW of rooftop capacity by 2022 may be too big a hurdle to overcome in spite of the best efforts of various stakeholders. Depending on the rooftop capacity addition in the next 2 years, the MNRE may possibly have to consider revising the rooftop target downwards if necessary. Increasing consumer awareness while easing procedural issues can go a long way in galvanising demand.

3.7 Poor RPO Compliance

RPOs are minimum renewable energy targets which are specified in percentage terms in proportion to total electricity consumption. RPO compliance is still rather weak across most states and this is a fundamental issue for the renewable energy sector to address. Unless this is strictly implemented by SERCs, demand for the 175 GW will be surely lacking. Additionally, while RPO mandates are equally applicable to OA/CPP consumers, there is a complete lack of information with regard to their compliance of such targets.

4.0 POLICY OPTIONS/FINANCIAL SUPPORT MECHANISMS FOR RENEWABLE ENERGY

Recognizing the role that renewable energy technologies can play in enhancing sustainability, access to energy and security of supply, the GOI has introduced various policy and incentive measures to promote the growth of renewable energy in the country and to reduce the cost of RE procurement by the state DISCOMs. Some of the facilitating actions/policies are as below

4.1 National Tariff Policy 2016

The GOI in January 2016 amended the National Tariff Policy (NTP). Several reform measures have been announced in this change. NTP 2016 has increased focus on renewable energy, sourcing power through competitive bidding and the need for 'reasonable rates.

4.1.1. Main features of NTP 2016:

- Co-generation from non-RE sources to attract RPO
- Competitive bidding to be the norm for RE procurement.
- Provisions for Renewable Generation Obligations (RGO) announced
- Long term RPO to be announced by Ministry of Power

HIGHLIGHTS



For the first time a holistic view of the power sector has been taken and comprehensive amendments have been made in the tariff policy 2016.

- Vintage and technology multiplier allowed in REC
- Inter-state transmission charges waived off for RE power
- Solar RPO to be 8% by 2022 (excluding hydro power)
- Calculation of Cross-subsidy methodology is suggested to be changed to make it less arbitrary

The most significant change made in the NTP 2016 says is that Solar RPO increased to 8% by 2022. This is a substantial increase as current solar R is below 1% in most states. Another major change suggested in this clause is that solar RPO will not apply to power sourced from hydro power plants. The policy document states – “8% of total consumption of electricity, excluding hydro power, shall be from solar energy by March 2022”

4.2 Accelerated Depreciation (AD): One of the key factors underlying this increase in capacity was the Accelerated Depreciation (AD) benefit, which was first introduced in 1994, with a depreciation rate of 100 per cent. In 2002 the depreciation rate was reduced to 80 per cent and the scheme was subsequently withdrawn completely in March 2012. In August 2014 the AD benefit was reinstated at the previous rate of 80 per cent for plants installed on or after April 1, 2014. Depreciation is an accounting concept that allocates an asset’s cost towards expense during its period of useful life. As with other expenses, depreciation is deducted as an expense before calculating the taxable profit, thus reducing the tax burden on a company. AD increases the depreciation on the assets during the initial years of the asset’s useful life, which allows the asset owner to write off more of the value of the asset during the initial years of ownership, thereby reducing the greater proportion of taxable income.

This is an indirect fiscal benefit for investors who can offset their overall tax liability (from profit making companies/operations). The mechanism is simple to administer, and the cost to the GOI under this option is essentially the deferred income tax payments. However, AD can only be availed by profit making companies and hence poses a disadvantage for pure-play Independent Power Producers (IPPs) in the sector, who are solely into RE projects, and it would be years before they start making large profits. This policy is similar to the investment tax credit (ITC) in the US which is a dollar-for-dollar reduction in the income taxes for qualified tax-paying owners based on capital investment in renewable energy projects. Though the AD scheme supported the creation of a large renewable capacity base in the country, it was perceived to be lacking in focus on long-term generation efficiencies as incentive was linked to the initial capital cost of the project with no provision to penalize for under-performance.

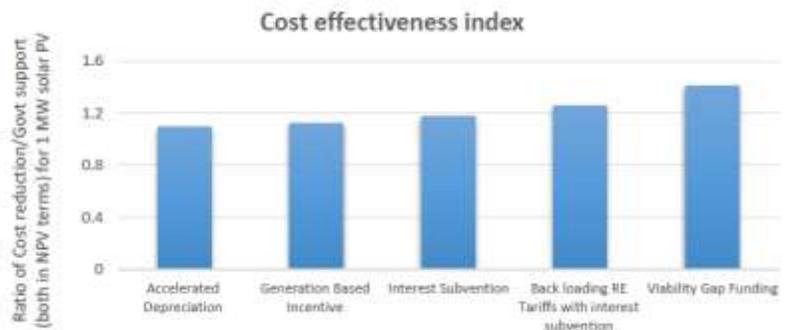
4.3 Generation Based Incentive (GBI): In 2009 the Ministry of New and Renewable Energy (MNRE) announced the GBI scheme in parallel to the AD scheme for the period 2009– 2012. After it expired in 2012, the scheme was reinstated after a gap of one year in August 2013. Generation based incentive (GBI) is a direct subsidy that is paid over and above the tariff for each kWh of power that the developer supplies to the grid. The objective is to incentivize higher power production. The scheme is available for both wind and solar in parallel to accelerated depreciation, but on a mutually exclusive basis. The scheme in its present form provides incentive of INR 0.50/kWh for a minimum of four years and a maximum of ten years with a cap of INR 10 million/MW to be available for all projects on or after April 2014 and for the remaining 12th Five-Year Plan (FYP) period (2012–17). For wind projects, solar projects in the range of 100 Kw to 2 MW can avail this scheme.

Globally, GBI scores better in terms of incentivizing performance, giving a level playing field for IPPs and allows for the incentive payment to be made over a longer time frame, thus reducing upfront pressure on budgetary allocations. GBI is also an output /performance linked incentive and hence has very limited possibilities of misuse. The GBI policy is similar to the production tax credit (PTC) federal incentive in the US which provides a 2.3 cent/kWh incentive for first ten years of renewable energy facility's operations.

4.4 Viability gap funding (VGF) Viability gap funding is a capital grant from the government to enable a project developer to supply renewable power at a pre-determined tariff. It was introduced for solar projects under Phase 2, Batch 1 of the National Solar Mission. The government provided a capital subsidy in installments with an upper limit of 30% of the project cost or INR 25 million per MW (USD 0.42 million per MW). This policy is similar to the KfW renewable energies capital grant programme which is a multisectoral policy applicable for small and large power plants in Germany.

Similar to AD, VGF is also a capacity linked subsidy and does not focus to long term performance. However unlike AD, VGF is a direct financial incentive requiring upfront payments from the GOI, and can benefit any investor. The conventional premise of a VGF scheme is to lower down the capital cost at investment stage resulting in reduced risk perception by lenders, lowering of tariffs and promotion to the sector. In the current, almost unconventional VGF scheme being offered for solar power projects, VGF payments are spread over a period of 6 years, with an aim to elicit project performance. The scheme therefore does not necessarily result in lower upfront capital costs, and in many cases similar to generation based incentive scheme, with the exception that VGF amounts are decided through a competitive process, and the payments are not specifically linked to amount of power generated.

4.5 Back-loaded RE tariffs: This option can only work along with a soft loan or interest subvention scheme to ensure a viable Debt Service Coverage Ratio. Under this framework, instead of the existing practice of signing Power Purchase



Agreements (PPAs) based on fixed levelized tariffs, DISCOMs and developers agree to a slightly lower tariff in the first year, but allow for an escalation in tariff in the coming years. This is akin to how coal tariffs are presently set up. Some states (Andhra Pradesh - 3% escalation for 10 years, Tamil Nadu – 5% escalation for 10 years) have already proposed this for solar projects as well. This will help reduce incremental costs for procuring states in the initial years, and even with escalation the RE tariffs would remain attractive in long term due to ever-increasing conventional power tariffs. As stated in the beginning, such a tariff structure would have cash flow problems in initial years which would need to be dealt with, either through policy dispensations resulting in lenders agreeing to delayed repayments, or through a financial support mechanism.

4.6 Dollar denominated tariffs: GOI has been considering allowing dollar denominated competitive bidding for solar power projects (including a pre-defined hedging cost) in an attempt to reduce the cost of power from the infusion of dollar denominated capital (lower cost debt). As an illustration (from one of the Analysis) if a Solar PV project with capital cost of Rs 5.5 cr/MW were to access debt at 5% over 15 years instead of 12% over 12 years, the levelized tariff would reduce from Rs 5.81/kWh to Rs 5.08/kWh. This does not include any cost arising from rupee depreciation. If the Rupee were to depreciate 3.5% p.a. over the debt tenure of 15 year, this would lead to the tariff dropping only to 5.49/kWh. However, this route has its inherent risks, primarily relating to hedging against rupee depreciation (or its cost). Very recently GoI has allowed National Thermal Power Corporation (NTPC) and Power Finance Corporation (PFC) to conduct dollar denominated bids for 1000 MW each and if successful, go in for another 10,000 MW each. Recent news suggests that the Japanese Yen and Euro denominated bidding may also be allowed.

4.7 Bundling of renewable electricity with (cheaper) thermal power: in which RE is sold to DISCOMs along with relatively cheaper coal power from thermal power plants. While the absolute cost of RE power does not decrease in this case, the lower bundled price of power is an incentive for procuring states. This is essentially allocation of low cost depreciated resources from Central Government to states. National Thermal Power Corporation, the Central power generating PSU has plans to bundle 10 GW of solar power with its cheaper coal power and deliver the bundled power at reduced rates (~Rs. 3.2/kWh). As such this formulation has no financial burden. However, the limitation here is the quantum that can be offered, as the availability of cheap thermal power with Government of India is limited.

5.0 NTPC PROSPECTIVE FOR POWERING AHEAD IN RENEWABLE ENERGY IN COST EFFECTIVE WAY

NTPC is a great success story of our times. It is imbued with the spirit of “can do it”. India’s largest power company, NTPC was set up in 1975 to accelerate power development in India. NTPC is emerging as a diversified power major with presence in the entire value chain of the power generation business. NTPC A trendsetter in power business as reckoned worldwide now with capacity 48,028 MW at present, marching relentlessly to achieve long term goal of 128000MW Company by year 2032. NTPC presently has 18 Coal based stations, 7 combined cycle gas/liquid fuel based stations, 8 Solar and one Hydro based station, besides many thermal, hydro and solar projects are under construction.

**“NTPC revising corporate plan till 2032 to add more wind, solar power projects.”
CMD NTPC. Jun 17,2016**

India's thermal power giant, NTPC Ltd, is taking a giant leap in renewable energy although it believes that for the next 10 to 15 years coal will remain the country's primary source for generating electricity. NTPC continues its legacy of being India's thermal power giant, NTPC Ltd, is taking a giant leap in renewable energy although it believes that for the next 10 to 15 years coal will remain the country's primary source for generating electricity. NTPC continues its legacy of being India's No.1 power generation company even in the renewable energy space. NTPC will have 10,000 MW of solar power by 2022 and another 15,000 MW we are going to buy from developers and sell it to Discoms. NTPC also looking at 1,000 MW of wind power. Company plans to add 2,500-MW of conventional capacity and at least an equal amount of renewable plants every year. In addition to 310 MW of solar capacity under operation recently NTPC’s Board of Directors has approved investment approval for Mandsaur Solar PV Projects of 5x50 MW in the State of Madhya Pradesh and Bhadla Solar Project of 4x65 MW in the State of Rajasthan. It is faster to set up renewable capacity. The construction period for solar



projects is a few months only and since they are modular capacity can be added faster. It is also easier to get clearances for land and environment for these projects. Besides there is easy availability of funding.

In addition to explore all GOI Policy initiatives NTPC should look for all possible options for reducing cost of Renewable Energy. NTPC should explore possibility of Exploring maximum funding through green Masala bond compare to ECBs, identifying the sites for Installing Hybrid Capacity, venturing into manufacturing facility for solar PV modules and joint R&D for developing Storage solution. Solar power tree can be a good alternative for rooftops of township and street lightings.

5.1 Exploring maximum funding through green Masala bond compare to ECBs.

Masala bonds are nothing but another form of a debt instrument — the only difference being that these bonds are denominated in Indian rupees, but are issued in geographies outside India. The name ‘Masala Bonds’ came to give a bit of Indian flavour to the name, and therefore relying on the Indian culture and cuisine; basing it on the fact that Indian cuisine as represented by the ‘Spicy Masala Curry’, which is quite popular throughout the western world. An issuer can issue Masala bonds worth a maximum \$750 million a year and the bonds must have a minimum maturity of five years.

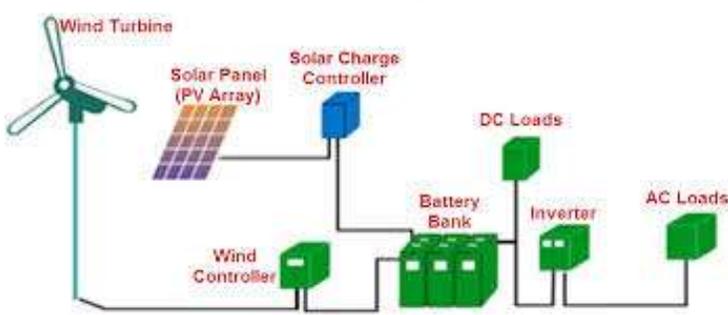
In the month of August 2016 NTPC list world’s first Green Masala bond by an Indian Issuer on London stock exchange and had raised \$300 million (Rs 2000 crores) with a 7.48 per cent annual yield. NTPC will invest the proceeds of the Green Masala bond in the renewable energy sector in India to achieve its target of 10 GW by 2022. The bond is Climate Bonds Initiative certified and will be listed on London Stock Exchange’s green bonds segment.

Masala Bonds can turn out to be a significant **game changer** for the Indian economy, going forward. The bonds are issued to foreign investors and settled in US dollars. Thus the currency risk lies with the investor and not the issuer, unlike external commercial borrowings (ECBs). While ECBs help Indian companies raise debt capital internationally by taking advantage of the lower interest rates in international markets, the cost of hedging the currency risk can be significant and has to be borne by the issuer — if unhedged, adverse exchange rate movements can have significant negative impact to the borrower and thus the “all – in” cost of borrowing through ECBs land up will be much higher than the international market rates. However, in the case of Masala Bonds, as the currency risk is borne by the investor, the cost of borrowing can work out much lower compared with ECBs.

Masala bond will help NTPC to reduce its interest cost burden on the debt amount on its balance sheet. Masala Bonds outside India is issued below 7.50% interest rate compare to an interest rate of 7.5%-9.00% in India.

5.2 Hybrid Solar & Wind Renewable Energy Model

The Word hybrid means something which is made by the combination of more than one element. In energy system the



electricity can be generated by more than one source at a time like Wind, solar, biomass etc. Studies revealed that solar and winds are almost complementary to each other and hybridation of two technologies would help in minimizing the variability apart from optimally utilizing the infrastructure including land and transmission system.

Hybrid energy generation is more important because the wind not floe continuously and sun radiation is only present approx. 8 to 10 hours in a day. So for continuous power it is important to hybridize the solar and wind power with the storage batteries.

Superimposition of wind and solar resource maps shows that there are large areas where both wind and solar have high to moderate potential. Under the category of wind-solar hybrid power plants, Wind and Solar PV systems will be configured to operate at the same point of grid connection. There can be different approaches towards integrating wind and solar depending upon the size of each of the source integrated and the technology type. Sufficient utilization of transmission infrastructure and better grid stability can be achieved by reducing the variability in renewable power generation. NTPC is intending to set up wind energy projects at its various power stations having wind potential across the country. Early this year, NTPC invited proposals from interested parties, who are willing to work with the company for identification of sites (at NTPC’s existing stations) where wind energy projects can be set up and which are economically viable .NTPC Ltd is mulling over plans to establish 100 MW capacity wind energy power projects at various locations of Country. Fortunately most of NTPC projects are located in high sun light and wind intensity regions and NTPC should explore all possibility of identifying the sites for Installing Hybrid (Solar + Wind) Capacity of at least 5000 MW.

Many NTPC Stations are in high Solar & Wind intensity regions

5.3 Ventures into Manufacturing Capacities for Solar PV Modules

At present in India there is having a dearth of manufacturing capability of solar technology. For the advanced technology we have to rely majorly upon foreign manufacturers. However, continuous rely on manufacturer has resulted into lagging into development of efficient & best technology suitable for Indian conditions. Due to this majority of power players like Reliance, Lanco, and JP power are going to procure power equipments particularly (BTG) from Chinese equipment

manufacturer. Most of the solar power plants coming in India will follow the guidelines to use indigenous manufactured PV Module as prescribed by ministry of power.

NTPC should make solar equipment as part of its strategy to be present across the renewable value chain in order to meet the company vision of becoming world's largest power producer. To start with, India's largest power generator can plan to set up a 1,000-megawatt (MW) per annum manufacturing capacity, which may require an investment of Rs.5, 000 crore.

6.8. Summarizing the cost components:

| S.No. | Particulars | Capital Cost norm proposed for FY 2016-17 (Rs. lakhs/MW), for Solar PV projects | % of Total Cost |
|-------|--|---|-----------------|
| 1 | PV Modules | 310.19 | 61.9% |
| 2 | Land Cost | 25 | 5% |
| 3 | Civil and General Works | 35 | 7% |
| 4 | Mounting Structures | 35 | 7% |
| 5 | Power Conditioning Unit | 30 | 6% |
| 6 | Evacuation Cost up to Inter-connection Point (Cables and Transformers) | 40 | 8% |
| 7 | Preliminary and Pre-Operative Expenses including IDC and Contingency | 26.13 | 5.2% |
| | Total Capital Cost | 501.32 | 100% |

Advantages

As represented here in the figure, the major cost component of any solar power plant is equipment cost at 61 % of total project cost. The land cost consumes only 5 %, Civil works at 10 %, & IDC –Others at 5%. Thus equipment cost assumes the high impact position in the Tariff of generation plant. As per research estimate the indigenous manufacturing has resulted into reduction of product cost up to 15 % even more is possible. As per internal tariff analysis the Equipment cost reduction by 1Cr/MW results into significant reduction in levelized tariff up to 60 Paise/kWh.

Silicon and quartz are available in abundance in the eastern part of India. NTPC has the money, and the with this present costs can be reduced by manufacturing from polysilicon to solar panels.

Joint Venture formation can be done preferably with technology

leader headed by NTPC as a major stock holder (E.g. NTPC 51 % : Partner 49 %), The JV shall be formulated for covering following objective (1) To Acquire Expertise & (2) Technology Transfer Agreement. The manufacturing facility shall be strategically located so that it will have optimized distance from the various locations of potential project site. The manufactured product shall cater in-house requirements as well as it will compete in the manufacturing market sector for bringing level playing & competitiveness in the sector.

5.4 Advanced R&D for Power Storage

Storage of electricity is a challenge given that solar power can only be harnessed when the sun shines. To use that electricity at night, or on cloudy days, an effective and economical storage solution is required. This is where NTPC's



should put efforts. Solar storage would be among the most important priorities five to 10 years down the lane, as India is ramping up its solar power capacity to 100 GW by 2022. "We have our own R&D centre, money and everything required for this new project.

"Research activity targeted towards storage of green energy is the need of the hour,"

CMD, NTPC, in a 31 March 16.

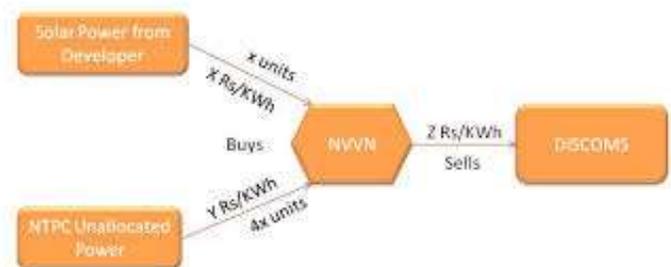
It may prove to be a game changer solution for India's energy security efforts. Experts, too, believe that such efforts will help in solving the issue of energy security. "With solar and wind power, we have the basic problem of storage. If NTPC is going ahead with battery storage solutions like Sodium Sulphur (NAS) batteries or Japan's NGK Batteries, it is definitely a welcome step," said India's former power secretary.

5.5 Reducing variable cost of Bundled Thermal & Solar Plants.

NTPC has to sign fresh power purchase agreements (PPAs) with existing customers and bundle thermal power with solar power in 85:15 ratio. According to a directive issued by the power ministry ones that decline to take solar power will not be allocated any thermal power.

At least 9,200 MW of NTPC's installed thermal power capacities include coal-fired units named Singrauli, Korba, Rihand Stage I and Ramagundam, are more than 25 years old and another 3,000-4,000 MW includes Vindhyachal Stage I will turn 25 years old in the next three four years. Power from these plants can be bundled with solar power produced from an existing installed capacity of 310 MW to begin with. Singrauli in north India is the first coal plant to take part in the programme. The 1,700 MW unit's output will be sold along with power from 300 MW of solar installations. "In case of Singrauli, if the present tariff is Rs.1.80, then the bundled tariff will be only Rs.3.12 or Rs.3.15," It may be cheaper than the current price of power from thermal plants in the market.

NTPC is in the process of adding 10,000 mw of solar power capacity in the near future and supply from these plants will be added to the bundled supply as and when the power becomes available. Under the new PPAs, the NTPC will charge the average price of thermal and solar power. It will sign new agreements for 25 years, with a provision to review them after a period of 15 years, depending on the condition of the coal-based power stations used for bundling with solar power. During the extended period of the PPAs will continue to be considered as additional expenditure for the determination of



tariff, "NTPC to explore all options to reduce variable cost of these old bundling thermal projects through adoption of latest technologies for efficiency improvement, supplying cheapest coal to these plants through coal swapping etc.

5.6 Exploring Solar Power Tree for lighting and roof top applications.

Solar SPV method seems to be the only successful method of tapping sun for practical purposes but it consumes vast amount of land surface. Land is the greatest crisis of Earth today. **SOLAR POWER TREE** is the perfect solution to the question of availability of the land in the future - It takes up only 1% of space consumed by conventional systems. A solar tree harnesses solar energy for producing electricity with an innovative vertical arrangement of solar cells. The construction of solar tree is quite simple, the solar panels arranged on a pole, in a manner that they harness maximum solar energy.

TREE Stands For:

T - Tree generating
R - Renewable
E - Energy and
E - Electricity

Solar tree is most advantageous for countries having very less space to produce energy efficiently and having very large population like India. This technique can also be used for system of street lighting, industrial power supply etc. It takes only 4 square feet of land for installing a 5 KW Solar Power tree compare to conventional horizontal layout which requires 400 square feet of land. Solar Tree are facilitated with water sprinkler at the top for self-cleaning of panels which help to increase the efficiency of the solar panels. Solar tree can produce 25% to 30% more power as because - all panels may be rotated by 180° in the afternoon and morning towards the east and the west by an easy mechanism.

NTPC is targeting all rooftops of its building and power stations for solar installations. Solar power tree can prove to be a very good alternative for fulfilling NTPC Target of rooftops of township and street lightings. In all the new projects that are coming Solar power tree can be installed for street lighting purpose and for township quarters, common buildings and even for plant office buildings it can be used for proving solar power. Since it is relatively new technology for harnessing solar power in India, NTPC Can look power advance R&D through NTPC NETRA in collaboration with renowned solar power tree R&D companies of world to make it more suitable and reliable option for NTPC.



7.0 CONCLUSION

India as a developing economy has an ever growing demand of power. For an industrialized nation development of power sector faster than industry is must. While the environmental benefits of renewables both for the local ecology as well as mitigating climate change are well known, some of their other macro-economic contributions have not been fully appreciated as yet. Absence of fuels (especially with respect to wind and solar) and minimal operation costs make renewables amenable to long term Power Purchase Agreements (PPAs) based on fixed levelised prices, thus reducing electricity price volatility and lowering future risks. Finally, renewables have very low gestation periods, as low as one year for wind and solar power, resulting in low Interest During Construction (IDC) costs.



The 175 GW renewable energy target is an ambitious and bold target having profound and myriad implications, including benefits and challenges, for the Indian power sector. The success of this unprecedented capacity addition plan will need the highest levels of political commitment, both at the central and state levels, and serious synergy and coordination between ministries, governments, and regulatory institutions. Additionally, a strong Monitoring and Verification mechanism as well as significant investment in capacity building of institutions is paramount.

In order to accelerate growth, NTPC has to once again take the lead forward. In view of realizing the dream of becoming the world's largest & best power producing company, the organization has to change strategy for powering ahead with renewables in cost effective way. Exploring maximum funding through green Masala bond compare to ECBs, Manufacturing of Solar equipments, identifying sites for Hybrid Solar and wind projects, exploring solar tree as alternative for roof top and lighting requirements, advance R&D for power storage and taking bundling of thermal power with renewable power as an opportunity we can remain business leader in future also and shall realize our vision of becoming largest and best power producer in the world, in the years to come.

significant investment in capacity building of institutions is paramount.

In order to accelerate growth, NTPC has to once again take the lead forward. In view of realizing the dream of becoming the world's largest & best power producing company, the organization has to change strategy for powering ahead with renewables in cost effective way. Exploring maximum funding through green Masala bond compare to ECBs, Manufacturing of Solar equipments, identifying sites for Hybrid Solar and wind projects, exploring solar tree as alternative for roof top and lighting requirements, advance R&D for power storage and taking bundling of thermal power with renewable power as an opportunity we can remain business leader in future also and shall realize our vision of becoming largest and best power producer in the world, in the years to come.

REFERENCES:

- MNRE, Ministry of Power, SECI website
- Approach papers of NITI Ayog, Prayas Group etc.
- News articles, Power line Magazine
- Crisil & ICRA Research report Coal
- NTPC Website and Intranet
- Blog prosperingindianpowersector.blogspot.com