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REPORT OF THE EXPERT GROUP ON 175 GW RENEWABLE ELECTRICITY (RE) BY 2022

December, 2015

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Power and Energy Division

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Preface

India is poised to achieve a growth rate which is projected to trigger a major rise in energy demand due to demographic expansion, increasing urbanization, and rising demands for mobility. Yet more than 300 million people in India are still without access to power. Therefore, it becomes imperative to analyze our supply options and explore sustainable ways of meeting the increasing demands for energy. Facing the energy trilemma of ensuring energy security, and energy access while ensuring sustainability, it is now widely accepted that renewable energy has the potential of emerging as the solution to help resolve this trilemma.

We know that India has great potential for harnessing power from renewable sources of energy. This has been recognized in the goal of attaining 175 GW of renewable energy by the year 2022. However, the ecosystem of renewable energy in India is still fraught with constraints, in particular with respect to financing. I am happy that the Department of Expenditure, and the Ministry of New and Renewable Energy entrusted NITI Aayog with the task of developing strategies for overcoming the constraints.

The report of the Expert Group, highlights the extent of financial support that may be required to support deployment of 175 GW of RE by 2022 till the point of injection in the grid. This needs building required transmission capacity, and compute costs to integrate renewable energy capacities with the grid while ensuring grid stability. The Group has assessed the requirements of public funding for deploying and integrating 175 GW of renewable energy by 2022, while exploring financing requirements and possible business models for deployment of 40 GW of rooftop solar by 2022.

The Report analyses the various financial, fiscal, policy and regulatory mechanisms that could be used to cover the incremental cost of renewable energy until grid parity is achieved. The report also estimates the direct and indirect costs to the Government, if such mechanisms are adopted, either exclusively, or in some combinations thereof.

An important aspect of NITI Aayog's charter is working as a bridge for close coordination with the States. Keeping pace with NITI's vision of fostering Cooperative Federalism, the Report also outlines a set of specific near-term steps that the Government of India, state governments and stakeholders could take to facilitate achievement of the national renewable energy targets. It also recommends possible institutional structure(s) at the central, regional and state level to effectively implement the proposed mechanisms.

With this Report it is apparent that the attainment of the goal of 175 GW of renewable energy by 2022 is no longer a financial challenge, but a technical one. The recommendations of the Expert Group also bring out other interventions like institutional structures, integrated planning approaches etc. to not only tackle the issues of financing renewable energy, but to help foster an ecosystem for its sustainable deployment.

I commend the efforts of the Expert Group in putting together this Report that breaks new ground.

I would like to place on record deepest appreciation to all the members of the Expert Group Sh. Ashwin Gambhir from the Prayas Energy Group, Dr. Anshu Bhardwaj from the Center for Study of Science, Technology and Policy, Sh. Deepak Gupta from the Shakti Sustainable Energy Foundation, Sh. Rajnath Ram, Joint Adviser, NITI Aayog (convener). The group was assisted by Dr. Gireesh Shrimali from the Climate Policy Initiative. I am grateful to each member of the group for contributing their valuable time for the successful completion of this report. I would also like to commend the entire Energy Division under Shri Anil Kumar Jain, Adviser (Energy) that worked with passion, enthusiasm and unstinting dedication to complete the Report in such a short time. I am sure it will be the foundation of many more such efforts that will build the Knowledge Hub within NITI Aayog.

(Sindhushree Khullar)
CEO, NITI Aayog

Date: 31.12.2015

Executive Summary

Today, India's 275 GW of installed electricity generating capacity is significantly higher than 140 GW of peak demand. In fact, India's coal generation capacity alone is higher than its peak demand.

Despite installed capacity exceeding power demand, some parts of the country face acute power shortages. The critical reasons are – coal supply shortages, high level of transmission and distribution losses, and poor financial health of utilities. Further, unlike domestic coal, the price of imported coal is unregulated; its price can be quite volatile. Imported coal in the recent past has been significantly more expensive than Indian coal. Distribution companies (discoms) that buy electricity generated with imported coal face significant and unpredictable upward pressure on tariffs. Some utilities have tried to avoid these high costs by simply not buying power, even when the result is local shortages, rolling blackouts, and increase in fixed costs.

These fundamental problems in the power sector are hampering the efficient use of the existing system to even meet the grid-connected demand. On top of this, more than 300 million people in India are still waiting for access to electricity. Rampant load-shedding and low-quality electricity supply forces people to resort to private, local, costly and dirty solutions such as diesel generators, which pose both health and environmental concerns. On top of this, estimates suggest that by 2021-22, India's electricity demand will be more than double the level in 2011-12.[1]

One of India's major advantages today and going forward is that its renewable energy (RE) potential is vast and largely untapped. Recent estimates show that India's solar potential is greater than 750 GW and its announced wind potential is 302 GW (actual could be higher than 1000 GW). India Energy Security Scenarios 2047 show a possibility of achieving a high of 410 GW of wind and 479 GW of solar PV by 2047 [2]. The potential of biomass and small hydro is also significant. Thus, renewable energy has the potential to anchor the development of India's electricity sector.

The question that is still unanswered is the need to do RE. From a broad public policy perspective, the major benefit of a rapid transition to RE will be the positive effect on India's macroeconomic circumstances. Tapping into abundant indigenous renewable resources could avoid revenue outflows for expensive imported fuels. At the current time – without innovative policy changes – India is facing a rapidly rising and volatile imported coal bill far into the future. India's coal imports in 2014-15 were already at 212 million tonnes at over Rs 1 lakh crore[3]. Economic principles might suggest that we should be able to find something to export – the facts on the ground suggest that it is not easy.

From a pure macro-economic perspective, reaching 175 GW RE by 2022 could dramatically reduce the coal import bill in 2022. Then there are environmental benefits (less pollution), social benefits (local employment opportunities) and investment inflows, which may need to be monetized to assess the complete range of benefits.

But, to capture the benefits of RE, India would need to make available the necessary capital,

1 18th Electric Power Survey; Central Electricity Authority

2 http://www.indiaenergy.gov.in/docs/RE_Documentation.pdf

3 http://indianexpress.com/article/business/business-others/fy15-coal-import-bill-spills-over-rs-1-l-crore/

and get comfortable with managing the variability and uncertainty of RE generation in conjunction with the existing and planned fossil fuel-based and large power plants. The Planning Commission estimates had suggested that infrastructure development under the 12th Five Year Plan would require more than a trillion US Dollars, and the investment requirements for RE may enhance it further. Therefore, 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.

With this challenge in mind, the NITI Aayog constituted an Expert Group in June 2015 to assess the requirements and utilization of public finance for achieving 175 GW RE by 2022.

The Process

In April 2015, the Ministry of New and Renewable Energy (MNRE) had submitted proposals to the Expenditure Finance Committee (EFC), Government of India, for funds to support achievement of 100 GW solar by 2022. MNRE vide D.O. No. JS (NSM)/ MNRE/2015 dated 22nd April, 2015 requested NITI Aayog to set up an Expert Group to look at various aspects connected with the scale up plan including the matter like availability of equipment, manpower, financial resources. Subsequently, a meeting was held between NITI and MNRE on 12.05.2015 to decide the modalities and expert group members. MNRE was of the view that the Group should look overall 175 GW of scale up plan and solar rooftop in particular, while Department of Expenditure vide O.M. No. 59(o6)/PFII/2009 (part) dated 12.05.2015 issues the minutes of Expenditure Finance Committee (EFC) which inter-alia asked "NITI Aayog to constitute a group of expert for exploring possibilities of Grid-Connected Rooftop system and various business models which can be implemented in the country". NITI Aayog formulated this Expert Group in June 2015. The terms of reference for this Expert Group were finalized consultation with MNRE.

The Expert Group consisted of:

1. Chairman: Mr. Anil Jain, Advisor (Energy), NITI Aayog
2. Convener: Mr. Rajnath Ram, Joint Advisor, NITI Aayog

Members:

3. Mr. Ashwin Gambhir, Prayas Energy Group
4. Dr. Anshu Bharadwaj, Center for Study of Science, Technology and Policy
5. Mr. Deepak Gupta, Shakti Sustainable Energy Foundation

The Expert Group was assisted by Dr. Gireesh Shrimali, Climate Policy Initiative

The Expert Group was assigned the following tasks:

1. Exploring the possibilities of Grid connected Rooftop Systems and various business models which can be implemented in the country
2. Recommend the overall enabling policy framework for achieving the target of 175 GW of Renewable Energy (RE) capacities by 2022.
3. Consult Department of Renewable Energy in three RE resource rich states i.e. Rajasthan, Andhra Pradesh and Maharashtra.

4. Submit a report in six weeks' time from the date of constitution and co-opt other members to assist the Group, as may be necessary

Structure of the Report

The objective of this Report is to explore financing requirements and possible business models for deployment of 40 GW of rooftop solar by 2022, and also assess the requirements and utilization of public finance for deploying and integrating 175 GW RE by 2022 – a major theme towards achieving the stated RE targets. While the report focuses on financing requirements for generation tariff parity in details, it also touches upon the finance requirements for grid expansion, grid integration, manufacturing and human resource aspects.

The following technologies are covered in the chapters, across the generation, transmission and distribution segments of the renewable energy sector to meet the targets indicated below by 2022:

1. Solar (utility-scale, distributed, off-grid/mini-grid – 100 GW)
2. Wind (utility-scale – 60 GW)
3. Small hydro (5 GW)
4. Bioenergy (10 GW)

While the report captures all common elements across these technologies, it goes into an in-depth analysis for utility-scale solar and wind, and offers indicative analysis of decentralized and distributed solar.

Chapter 2 provides the context, including the targets for deployment, and estimates the incremental cost of RE generation vis-à-vis building new conventional capacity. It thus highlights the extent of financial support that may be required to support deployment of 175 GW of RE by 2022 till the point of injection in the grid.

Chapter 3 broadly highlights cost of building required transmission capacity, integrating RE with the grid while ensuring grid stability. Given the time constraints, these estimates are primarily collected from existing literature – both domestic and international.

Chapter 4 analyses the various financial, fiscal, policy and regulatory mechanisms that could be used to cover the incremental cost of RE until grid parity is achieved. It estimates the direct and indirect cost to the Government, if such mechanisms are adopted, either exclusively or some sample combinations thereof.

Finally, Chapter 5 outlines a set of specific near-term steps that the Government of India, state governments and stakeholders could take to facilitate achievement of the national RE targets. This chapter also recommends possible institutional structure(s) at the central, regional and state level to effectively implement the proposed mechanisms.

Key Findings

1. Various policy options (enabling actions and direct/indirect financial incentives) are available to the Government of India to achieve reduction in the procurement tariff of RE. The identified enabling actions i.e. (a) bundling with cheaper thermal power and (b) de-risking of the sector to the extent possible resulting in availability of finance at market-based risk-free rates; should be exercised to the extent possible. The later action is inevitable to ensure implementation of the targets.

2. Some of the direct financial incentives such as the Viability Gap Funding (VGF) are loaded upfront with possibly lower total outlay[4] compared with some other incentives like the Generation Based Incentive - GBI (which has a lower annual outlay[5] but is spread over a longer timeframe) would require more outlay (in real terms, and not necessarily in NPV terms). As such, GBI allows for spreading of the costs for the Government over a longer time frame with an added ability of directly incentivizing generation, however at an overall high cost over the period of eight years (current GBI term for wind projects in India).

3. Any output based direct subsidy such as the GBI does not offer any leverage, however is easy to administer. Further, the costs are spread over a longer period of time, and offers maximum visibility at the procurement end.

4. Accelerated depreciation (AD) is an indirect financial support mechanism, and is easy to administer. It has the ability to attract a very distinct and possibly large class of investors without any substantial direct impact on the exchequer. And, there is no documented evidence that AD promotes in-efficiencies. Still, in order to ensure that it incentivizes performance, it is possible to design AD which is in some ways linked to performance of projects over longer timeframe (e.g. bank guarantees in lieu of availing AD, which can be released year on year subject to minimum performance). Another option may be to change AD to Production Tax Credits (in Rs./kWh) which may or may not be transferable.

5. Interest subvention and/or provision of low cost, long tenor loans have the ability to leverage a larger investment (or higher capacity) per unit of subsidy provided, as compared to options such as VGF and GBI. Low-cost/long-tenor loans are the cheapest option from an NPV perspective; however, they require more annual outlay in the earlier years. At the same time, their administration and ensuring that they reflect in the tariff would require efforts and smart policy design.

Recommendations

Based on the analysis, findings and stakeholder inputs, the Expert Group recommended the following:

1. **Bundling of RE power with cheaper conventional power:** As long as unallocated quota for conventional power is available, it must be used to bundle with RE power to incentivize procures for buying RE. This has no financial impact on the Government, and offers benefits related to timely payments, secured power purchase agreements, and generators receive the full tariff for RE, and hence do not need any additional incentives.

2. **Accelerated Depreciation (AD):** Options such as AD may be continued with improvements in design of the mechanism such that operational performance gets incentivized. Further, specific tools through which the tax credits can be passed on to individual / institutional investors will help broad-base the class of beneficiary investors, resulting in enhanced investments. The mechanism would however require additional support from other mechanisms to bring tariff parity with the alternative sources, also because not all classes of investors can benefit from it.

4 Total outlay means the total outflow of funds over the term of disbursement

5 Annual outlay means undiscounted yearly outlay

3. **Generation Based Incentive as a bridge mechanism:** Till such time the utilities pay-out for RE power is greater than marginal cost of conventional power, GBI could act as a bridge instrument, with or without any other mechanism being available. For example, if AD is able to bring down the costs partially, the GBI could bring it down further to meet the utility's cost of procuring alternative power source. In addition, the GBI is also an output /performance linked incentive and hence has very limited possibilities of misuse. An inherent limitation for GBI has been its ability to offer tariff comfort at the procurers' end, as most feed-in-tariffs approved by state regulatory commissions do not even consider GBI to be available (or not available).

   A possible change in GBI mechanism is to offer the GBI payments to the procuring utility, with clearly defined responsibilities for the discoms. Such a change could motivate utilities to buy more RE, enhance transparency, facilitate timely payments to the generators and ease out the administration of the incentive. The Central Government would only need to deal with the discoms and can offer differential GBIs based on cost differentials rather than fixed GBI for all RE generation. Such GBI payments can be related to the difference between the tariffs of RE and alternate marginal source, and can be <75%> of such differential. The remaining <25%> would need to be covered either by the state governments or discoms themselves, thus ensuring prudence in RE procurement process.

4. **Interest rate / tenure based interventions:** Any such interventions would have to be designed to ensure that they incentivize performance and do not act as markets distortions. To be more specific, these interventions should either be made available to identified pool of projects and their tariff considerations / setting should be done separately. In absence of such specific arrangements, availability of these incentives to a handful of projects / discoms / states could be a potential distortion against the remaining market.

   Another way to operationalize such an intervention is by offering such low cost / long term capital (lending) to all RE projects through balance sheet based refinancing to lenders through a central entity. The project risks would still have to be borne by the lenders in the normal course so that their due diligence process does not get impacted. The assumption here is that enough low-cost long-term money can be made available to the identified central entity.

   Towards designing such an intervention, central-government entities (e.g. IREDA, PFC) could pool various sources of low cost funds from domestic as well as international sources. This pool of funds could be administered and managed to refinance banks and financial institutions at a low rate, with upper limits of mark-up predefined so that the sector gets the benefits. Alternatively, the central entity could pool incentives available for interest subvention, and buy down the rate of interest for all RE projects. In any case, such preferential terms of finance should be considered while calculating feed-in-tariffs or any other way of RE power procurement.

5. **Innovative interventions:** The Expert Group debated on the possibility of dollar denominated tariffs and back loaded RE tariffs. Back loaded RE tariffs to a certain extent is possible if lenders can be convinced to back load their interest

and principal repayments. Beyond a certain point, any further back-loading would require large Government support either in form of subsidies or interest subventions. The extent of such desired interventions would largely depend on asset liability ratio of lenders, the acceptable levels of mismatch, lenders' comfort with the sector and extent of back-loading required.

For the dollar (or other foreign currency) denominated tariffs, the design of intervention would largely depend on the entity which agrees to bear the risks of currency fluctuations. If the risk has to be built into the tariff itself, same may not be very effective in bringiZng down the tariff. Foreign investors would certainly find this very interesting as their return will be ensured. The risk reward division between government, utilities and generators would have to be assessed carefully.

6. **Viability Gap Funding:** The current model of VGF for solar projects is unique. It is a high initial cost option, with part of the payments being deferred to ensure performance. As such, it is a hybrid of VGF and GBI, and still requires significant initial outlays, with no exceptional gains. The mechanism seems inferior to most other mechanisms.

Other Recommendations:

While the scope of the Expert Group was primarily making recommendations around financial incentives, the Group felt it was necessary to highlight some of the ecosystem level interventions, without which any amount of financial incentives may not result in deployment of targeted deployment of RE. Most importantly, there is a need for a stable and long term policy (3 years) which gives visibility and builds up investor confidence.

7. Strengthen the institutional structure to facilitate effective disbursement of central financial assistance
8. Mandate conditions such as meeting a minimum level of Renewable Purchase Obligation (RPO), timely payments to generators etc.
9. Adopt an integrated approach to power sector planning, including generation, transmission and distribution
10. Undertake measures to reduce overall project risks
11. Structure reforms such that utility tariffs are reflective of true costs and system-wide efficiencies or inefficiencies
12. Strengthen (and create if required) institutional structure to monitor implementation of Government policies and programmes and accelerate cost-effective development of the sector

Conclusion

To conclude, the Expert Group strongly feels that in the first place, all non-financial support options should be made available to RE e.g. project development, policy support, legislative enablers, and coordinated implementation ecosystem. Such interventions are critical to reach the 175GW RE targets. The ecosystems should also ensure that all direct and indirect incentives should get reflected in the tariff of RE at the procurement end. Further the incentive design and procurement mechanism should be specific to the characteristics of resource and technology under consideration.

Options which do not require any project specific government approvals like AD should be made available in any case, with appropriate changes so that operational performance is ensured.

Lenders (banks and financial institutions) should be made aware of the specific requirements and characteristics of RE projects so that they can take informed decisions, resulting in reduced risk perceptions, and hence better terms of finance. Beyond same, sector specific financing mechanism (low cost money based refinancing, interest subvention etc.) need to be structured avoiding the possibilities of market distortions.

GBI should be used as a bridge tool. Being a tail end incentive, GBI may offer very little financial leverage, however it can be designed to be very effective to incentivize distribution companies to buy RE and bring down their cost of RE procurement. Same should also be used as a tool to facilitate timely payments.

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Background

In April 2015, the Ministry of New and Renewable Energy (MNRE) had submitted proposals to the Expenditure Finance Committee (EFC), Government of India, for funds to support achievement of 100 GW solar by 2022. MNRE vide D.O. No. JS (NSM)/ MNRE/2015 dated 22nd April, 2015 requested NITI Aayog to set up an Expert Group to look at various aspects connected with the scale up plan including the matter like availability of equipment, manpower, financial resources. Subsequently, a meeting was held between NITI and MNRE on 12.05.2015 to decide the modalities and expert group members. MNRE was of the view that the Group should look overall 175 GW of scale up plan and solar rooftop in particular, while Department of Expenditure vide O.M. No. 59(o6)/PFII/2009 (part) dated 12.05.2015 issues the minutes of Expenditure Finance Committee (EFC) which inter-alia asked "NITI Aayog to constitute a group of expert for exploring possibilities of Grid-Connected Rooftop system and various business models which can be implemented in the country". NITI Aayog formulated this Expert Group in June 2015. The terms of reference for this Expert Group were finalized consultation with MNRE (copy of the order as an Annexure 7)

The Expert Group consists of:

1. Chairman: Mr. Anil Jain, Advisor (Energy), NITI Aayog
2. Convener: Mr. Rajnath Ram, Joint Advisor, NITI Aayog

Members:

3. Mr. Ashwin Gambhir, Prayas Energy Group
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TERMS OF REFERENCE

The Expert Group was assigned the following tasks:

1. Exploring the possibilities of Grid connected Rooftop Systems and various business models which can be implemented in the country.
2. Recommend the overall enabling policy framework for achieving the target of 175 GW of Renewable Energy capacities by 2022.
3. Consult Department of Renewable Energy in three RE resource rich States i.e. Rajasthan, Andhra Pradesh and Maharashtra.
4. Submit a report in six weeks' time from the date of constitution and co-opt other members to assist the Group, as may be necessary.

Chapter 1: Introduction

1.1 Today, India's 275 GW of installed electricity generating capacity is significantly higher than 140 GW of peak demand. In fact, India's coal generation capacity alone is higher than its peak demand.

1.2 Despite installed capacity exceeding power demand, some parts of the country face acute power shortages. The critical reasons are – coal supply shortages, high level of transmission and distribution losses, and poor financial health of utilities. Further, unlike domestic coal, the price of imported coal is unregulated; its price can be quite volatile. Imported coal in the recent past has been significantly more expensive than Indian coal. Distribution companies (Discoms) that buy electricity generated with imported coal face significant and unpredictable upward pressure on tariffs. Some utilities have tried to avoid these high costs by simply not buying power, even when the result is local shortages, rolling blackouts, and increase in fixed costs.

1.3 These fundamental problems in the power sector are hampering the efficient use of the existing system to even meet the grid-connected demand. On top of this, more than 400 million people in India are still waiting for access to electricity[1] Extensive load-shedding and low-quality electricity supply forces people to resort to private, local, costly and dirty solutions such as diesel generators, which pose both health and environmental concerns. On top of this, estimates suggest that by 2021-22, India's electricity demand will be more than double the level in 2011-12.[2]

1.4 So far, with her ever-growing electricity demand, India has been targeting to add large-scale conventional power capacities, with limited success on meeting these targets. The focus has always been on conventional power generation, as alternatives were very costly. Now, however, with solar and wind power becoming commercially viable in comparison to marginal mainstream sources (particularly imported coal, and nuclear based generation), there are additional choices available to policymakers concerned with the technical, economic, and environmental characteristics of a future power system that can keep pace with the economic growth.

1.5 In view of the above, India's Intended Nationally Determined Contribution (INDC) aims to base 40% of the total installed power generation capacity on non-fossil fuel resources by 2030 with international support on technology transfer and financing. This includes Government of India's ambitious target of achieving 175GW of RE by the year 2022 that marks 75 years of our independence. It also aims to reduce the emissions intensity of GDP by 33 to 35% from 2005 levels by 2030. The installed capacity of RE is 37.4 GW (as on 30th Sep 2015)[3] and the following discussion is on the modus operandi for implementation and finance to achieve RE targets.

1.6 In order to realize the stated benefits, the RE strategy for India will need to be

1 http://energymap-scu.org/energy-in-india-spotlight/energy-access-introduction/

2 18th Electric Power Survey; Central Electricity Authority

3 http://mnre.gov.in/mission-and-vision-2/achievements/

integrated with and complementary to the existing and planned power sector (particularly generation) projects. Consequently, it will require new thinking, a probable reengineering of institutions, the redefinition of policies, the re-tuning of power systems, and the replacement of old habits with new ones. Current infrastructure and policies are set up to fit the requirements of fossil fuel based resources, not RE, and a system that utilizes increasing amounts of RE can only be achieved by significant efforts and retooling of the power system. A new way of thinking is unavoidable: RE is different from the power generation technologies of the past (e.g. thermal, hydro, nuclear, etc.).

1.7 Thus, to capture the benefits of RE, India would need to make available the necessary capital, and get comfortable with managing the variability and uncertainty of RE generation in conjunction with the existing and planned fossil fuel-based and large power plants.

1.8 The objective of this Report thus is to explore financing requirements and possible business models for deployment of 40 GW of rooftop solar by 2022, and also assess the requirements and utilization of public finance for deploying and integrating 175 GW RE by 2022 – a major theme towards achieving the stated RE targets. While the report focuses on financing requirements for generation tariff parity in details, it also touches upon the finance requirements for grid expansion, grid integration, manufacturing and human resource aspects.

1.9 The following technologies are covered in the chapters, across the generation, transmission and distribution segments of the renewable energy sector to meet the targets indicated below by 2022:

1. Solar (utility-scale, distributed, off-grid/mini-grid – 100 GW)
2. Wind (utility-scale – 60 GW)
3. Small hydro (5 GW)
4. Bioenergy (10 GW)

1.10 While the report captures all common elements across these technologies, it goes into an in-depth analysis for utility-scale solar and wind, and offers indicative analysis of decentralized and distributed solar.

1.11 Presently, renewable energy accounts for ~12% of India's total installed power generation capacity, and approximately 5% of the total generation. The Government of India aims to reach a renewable energy capacity of 175 GW by 2022. 100 GW of this is planned through solar energy, 60 GW through wind energy, 10 GW through small hydro power, and 5 GW through biomass-based power projects. Of the 100 GW target for solar, 40 GW is expected to be achieved through deployment of decentralized rooftop projects, 40 GW through utility-scale solar plants, and 20 GW through ultra-mega solar parks. Considering these targets, renewables (solar, wind and hydro) will account for ~10% of the total energy mix, by 2022 (IESS 2047).

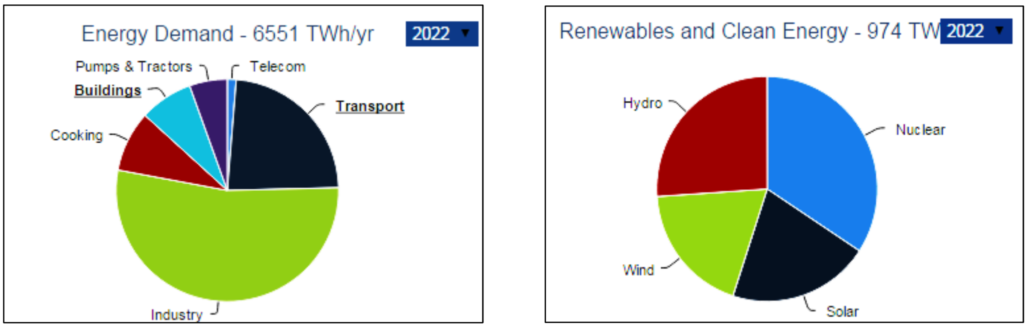


Figure 1 : Possible share of RE in India's Energy Mix in 2022

RENEWABLE ENERGY – AN IMPORTANT ELEMENT FOR INDIA'S ENERGY STRATEGY

1.12 One of India's major advantages today and going forward is that its renewable energy (RE) potential is vast and largely untapped. Recent estimates show that India's solar potential is greater than 750 GW and its announced wind potential is 302 GW (actual could be higher than 1000 GW). India Energy Security Scenarios 2047 show a possibility of achieving a high of 410 GW of wind and 479 GW of solar PV by 2047 [4]. The potential of biomass and small hydro is also significant. Thus, renewable energy has the potential to anchor the development of India's electricity sector.

1.13 An additional advantage is that most RE projects can be deployed within a time frame of less than three years from conceptualization, as compared to ten years required for conventional power projects. In fact, solar PV can be deployed in less than a year. RE can also provide access to affordable energy solutions to the India's off-the-grid population, and can create employment opportunities for local skilled and unskilled manpower. Recent studies also suggest that RE creates much more jobs than conventional power, per unit of power produced, major chunk of which are local [5]. Renewables can reduce the ever-growing dependence on imported fossil-fuels and their volatile prices, with practically no fuel costs and negligible impact on the quality of the surrounding environment.

1.14 On the flip side, it is true that renewable energy is variable – as one cannot control the time for which the sun shines or the wind blows. Some of the conservative grid operators and utilities consider power from renewables to be unmanageable. However, we must remember that for decades, grid operators and power distributors have dealt with variability and uncertainty of power demand from consumers – including demand variations within the day and across seasons. They have also tackled sudden trips of large thermal power units. Similarly, the variability and uncertainty of renewables can be successfully and cost-effectively managed as seems possible from the strategies deployed world over.

1.15 In the immediate term, the high costs associated with renewables – compared to domestic coal based power generation – is considered to be a deterrent. But

4 http://www.indiaenergy.gov.in/docs/RE_Documentation.pdf

5 http://shaktifoundation.in/initiative/re-jobs-finance/

comparators need to be highlighted. Renewable electricity is cheaper than most conventional sources such as gas, diesel, nuclear and also imported coal (in many cases), except domestic coal (see figure 1 below). In fact, real power generation tariffs of renewables are decreasing, while prices of coal-based power are increasing, despite domestic coal prices being controlled by the government. PV module prices have fallen 80% since 2008 and by 12% in 2012 alone. Wind turbine prices have fallen 29% since 2008 (see figure 2 below). These falling prices can be attributed to declines in the prices of system components (e.g., panels, inverters, racking, turbines, etc.), and dramatic improvements in efficiency, among other factors. In India today:

- new wind projects at the point of generation are cheaper than the comparable costs of power from new imported coal-based projects;
- solar photovoltaic generation costs are cheaper than the cost of natural gas-based generation;
- roof-top solar photovoltaic systems costs is cheaper than the retail tariffs for large commercial and industrial consumers and even high-use residential consumers in some states; and
- new rooftop solar costs are already significantly lower than the cost of diesel back-up generators and battery-inverter systems used by many consumers.

1.16 The good news also is that the costs of generating RE have fallen steeply in the past decade, and once projects are set-up, the costs are not likely to increase over life of the asset – typically 25 years. Within a few years, it is likely that existing RE power generation will actually become cheaper than all possible sources and hence, subsidies for RE will no longer be necessary. It will in fact be available at the same or lower cost than power from the more traditional fossil fuel-based plants.

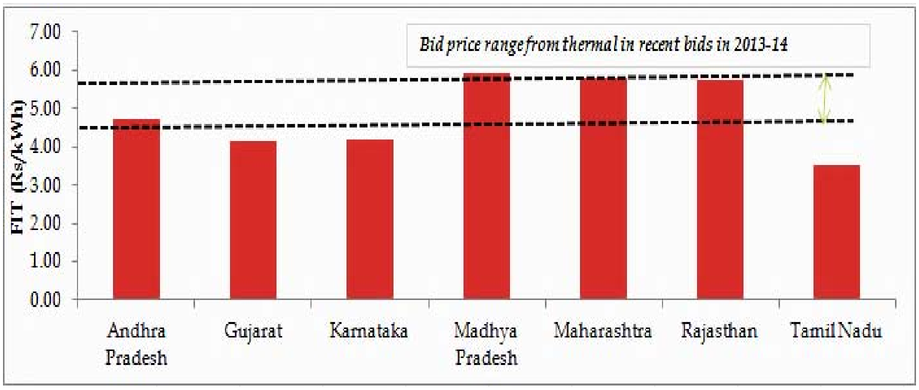


Figure 2: Thermal bids Vs Wind FIT in 2013-14

And, as renewable energy technologies continue to improve and their costs continue to fall, forecasters worldwide believe that these positive trends for RE are likely to continue (Liebreich, 2013) (see figure below).

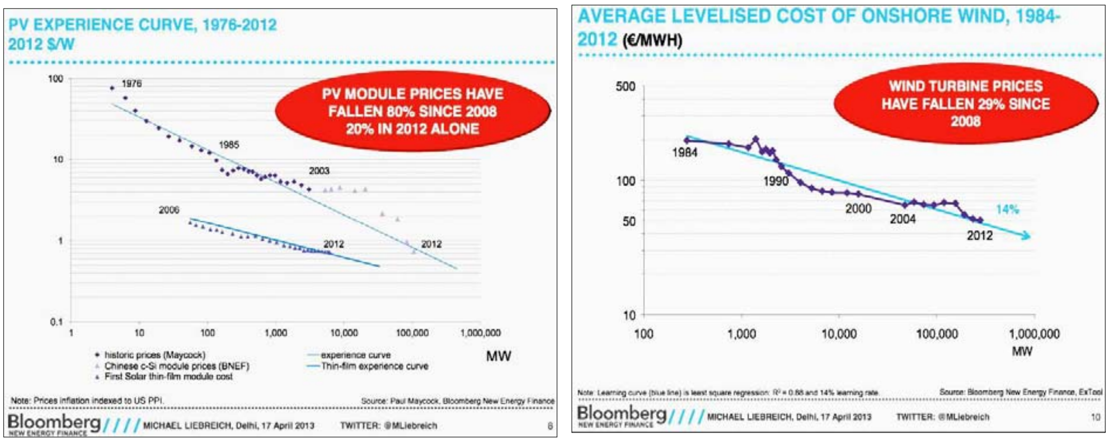


Figure 3: Falling prices of RE equipment

1.17 Another point worth consideration is grid infrastructure requirement. Not to forget that under any possible power generation scenario, billions of rupees' worth of new power plants and new transmission lines will have to be built by 2030. The value lies in planning it with all possible generation and demand scenario in mind. Any new investment in new infrastructure, be it new generation or transmission, should accommodate a high RE generation mix. New generation should preferably be from flexible resources that can complement RE's availability. And transmission should be designed to allow not only for the transfer of power from RE-rich areas to RE- poor areas, but also for more cost-effective system balancing.

1.18 The question that is still unanswered is whether there is need to increase in the energy mix from public policy perspective, the major benefit of a rapid transition to RE will be the positive effect on India's macroeconomic circumstances. Tapping into abundant indigenous renewable resources could avoid revenue outflows for expensive imported fuels. At the current time – without innovative policy changes – India is facing a rapidly rising and volatile coal import bill far into the future. India's coal imports in 2014-15 were already at 212 million tonnes and over Rs. 1 lakh crore [6]. From a macro-economic perspective, reaching 175 GW RE by 2022 could dramatically reduce the coal import bill in 2022. Then there are environmental benefits (less pollution), social benefits like local employment opportunities and investment inflows, which may need to be monetized to assess the complete range of benefits from expanding RE.

HOW TO ACHIEVE THESE TARGETS?

1.19 RE is relatively more capital-intensive than conventional power plants. 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).

6 http://indianexpress.com/article/business/business-others/fy15-coal-import-bill-spills-over-rs-1-l-crore/

- “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).

1.20 Internationally — where RE accounts for increasingly large shares of the power systems — various changes to grid design, technology, and its operation have been implemented that allow successful grid integration, i.e. minimizing and/or managing the variability and uncertainty aspects of RE. Many of these strategies are inherently useful for improving the overall efficiency of grid operations and reducing overall costs to consumers whether RE accounts for a large (e.g. >25%) share of the generation mix or not. Some of these changes are one-time changes while others would evolve over time as load shapes and the resource mix continue to change. These strategies are summarized in the Table-1 below.

Table 1: RE Grid Integration and Efficient Grid Operation Strategies[7]

Strategy	Impact on Uncertainty	Impact on Variability
One-time		
Upgrade grid technology	Minimize	Manage
Upgrade grid operation protocols	Minimize	Manage
Expand “Balancing Areas”	Minimize	Minimize and manage
Upgrade grid planning practices	Minimize	Minimize
Ongoing		
Balancing resources – estimation, procurement, dispatch	Manage	Manage

1.21 On the financing side, 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. 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).

1.22 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.

1.23 Erstwhile Planning Commission estimates suggest that infrastructure development

7 As adopted from RE Roadmap 2030, published by the NITI Aayog in February 2015

under the 12th Five Year Plan will require more than a trillion US Dollars, and the investment requirements for RE may enhance it further. Therefore, 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.

1.24 Chapter 2 provides the context, including the targets for deployment, and estimates the incremental cost of RE generation vis-à-vis building new conventional capacity. It thus highlights the extent of financial support that may be required to support deployment of 175 GW of RE by 2022 till the point of injection in the grid.

1.25 Chapter 3 broadly highlights cost of building required transmission capacity, integrating RE with the grid while ensuring grid stability. Given the time constraints, these estimates are primarily collected from existing literature – both domestic and international.

1.26 Chapter 4 analyses the various financial, fiscal, policy and regulatory mechanisms that could be used to cover the incremental cost of RE until grid parity is achieved. It estimates the direct and indirect cost to the Government, if such mechanisms are adopted, either exclusively or some sample combinations thereof.

1.27 Chapter 5 outlines a set of specific near-term steps that the Government of India, state governments and stakeholders could take to facilitate achievement of the national RE targets. This chapter also recommends possible institutional structure(s) at the central, regional and state level to effectively implement the proposed mechanisms.

Chapter 2: Support For Renewable Energy Deployment

2.1 This chapter provides the context, including the targets for renewable energy deployment, and estimates the incremental cost of RE generation vis-à-vis building new conventional capacity. It thus highlights the extent of financial support that may be required to support deployment of 175 GW of RE by 2022 at the generation end.

STATE-WISE BREAK-UP OF RE TARGETS

2.2 India is geographically, a very diverse country. Renewable energy sources in India are not equally well distributed. While solar and biomass are distributed can be deployed in almost all states, wind energy, while abundant, is concentrated in a few states in southern and western India. Even for solar and biomass, land availability might be a concern for a few states, and not so much for others. And, the state utilities have limited orientation to manage the variability of wind and solar power.

2.3 With electricity being a concurrent subject, power sector planning occurs at both the Central level and state levels, not always in a cohesive manner. Renewable energy can offer enormous benefits to the nation as a whole, eventually benefiting the states. Hence, resource-sharing can make things easy, quick and cost-effective. Sharing energy resources between states will allow for smoother integration and management, and reduce overall variability from renewables, a fact well established internationally.

2.4 Policy interventions need to be designed in a manner such that they empower the states, leverage government investments multiple times and support quick, large-scale and planned deployment of renewables. Some of the challenges and possible policy interventions are highlighted in Box 1 [8].

Box 1: Major barriers to mainstreaming renewables

Despite the obvious benefits, several factors have prevented the mainstreaming of renewable energy. First, India lacks a comprehensive national policy and legislative framework for renewable energy. Existing policies and programmes are technology-specific and vary across states restricting strategic intent. Second, there is an acute shortage of willing and credit-worthy buyers of RE-based electricity. Most of our financially distressed power distribution companies (Discoms), also the bulk purchasers of power, have held back from buying expensive power (whether conventional or renewable-based) thus confining power markets. Market risks, clubbed with other economic factors, have led to high interest rates in Indian financial markets, around 10% - 14% per annum, almost three times higher than in developed economies. These high rates impact RE more than other conventional power or infrastructure. The lack of financing for RE projects is also a result of risks at multiple stages, for example buyers not paying or grid operators backing-down operations, which results in reduced investors' interest. Third major factor, also adding to the risks, is – unplanned and non-facilitated project development environment. Finally, inadequate and outdated grid infrastructure and operations have affected not just the renewable energy sector but the overall power reliability.

8 As adopted from RE Roadmap 2030, published by the NITI Aayog in February 2015

Placing renewables at the center of India's power system will therefore require a paradigm shift in planning and governance practices.

2.5 Table 2 below presents the proposed break-up of targets for all states published on the website of the Ministry of New and Renewable Energy (MNRE).

Table 2: Proposed state-wise RE targets

State/Uts	Solar Power (MW)	Wind (MW	SHP (MW)	Biomass Power (MW)
Delhi	2,762			
Haryana	4,142		25	209
Himachal Pradesh	776		1,500	
Jammu and Kashmir	1,155		150	
Punjab	4,772		50	244
Rajasthan	5,762	8,600		
Uttar Pradesh	10,697		25	3,499
Uttarakhand	900		700	197
Chandigarh	153			
Northern Region	**31,120**	**8,600**	**2,450**	**4,149**
Goa	358			
Gujarat	8,020	8,800	25	288
Chattisgarh	1,783		25	
Madhya Pradesh	5,675	6,200	25	118
Maharashtra	11,926	7,600	50	2,469
D. & N. Haveli	449			
Daman & Diu	199			
Western Region	**28,410**	**22,600**	**125**	**2,875**
Andhra Pradesh	9,834	8,100		543
Telangana		2,000		
Karnataka	5,697	6,200	1,500	1,420
Kerala	1,870		100	
Tamil Nadu	8,884	11,900	75	649
Puducherry	246			
Southern Region	**26,531**	**28,200**	**1,675**	**2,612**
Bihar	2,493		25	244
Jharkhand	1,995		10	
Orissa	2,377			
West Bengal	5,336		50	
Sikkim	36		50	
Eastern region	**12,237**		**135**	**244**
Assam	663		25	
Manipur	105			
Meghalaya	161		50	
Nagaland	61		15	
Tripura	105			
Arunachal Pradesh	39		500	
Mizoram	72		25	
North Eastern Region	**1,205**		**615**	
Andaman & Nicobar Islands	27			
Lakshadweep	4			
Other (New States)		600		120
All India	**99,533**	**60,000**	**5,000**	**10,000**

INCREMENTAL COST OF RE GENERATION COMPARED TO THAT OF NEW COAL GENERATION

2.6 The Expert Group's assessment is that at the levels of RE under discussion, RE will predominantly replace imported coal based power generation. RE could easily replace imported coal based capacities avoiding large investments into port infrastructure and/or transportation of coal and power from coasts to inland consumption centers). Hence the current (2015-16) marginal power procurement tariffs are estimated to be in the range Rs 4.0-4.5/kWh. The utility-scale RE tariffs are considered in range of Rs. 5.00-6.25/kWh, capturing the spread within onshore wind tariffs and large-scale solar PV. RE costs are thus slightly higher as compared to coal power tariffs.

2.7 The objective which the Expert Group set out for itself was to analyse and propose options (primarily financial) to meet this differential at the least cost to Government. The Group relied heavily on two sets of analyses carried out by the EG members, to estimate the support required to meet these targets. The two analysis are appended at Annexure 2 (Analysis 1) and Annexure 3 (Analysis 2). The analyses also offer insights into non-monetary considerations which the Government may wish to bear in mind over and above nominal cost of support.

2.8 Analysis 1 considers, (more in line with current domestic norms) RE tariffs fixed for 20-25 years with escalating coal power tariffs (fig 4), while Analysis 2 compares the levelised costs of electricity from solar and wind power to a baseline of the levelised cost of electricity from coal (fig 5).

Comparing cost of RE with new coal

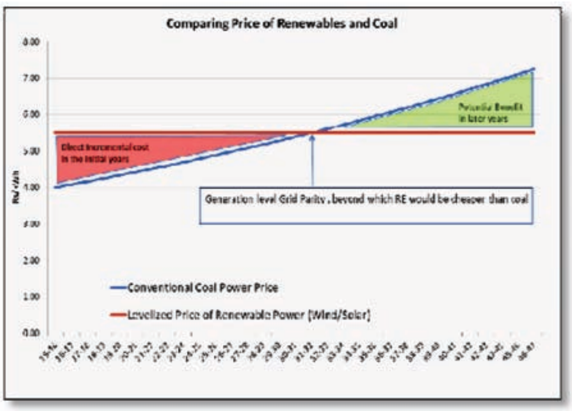


Figure 4: Analysis 1

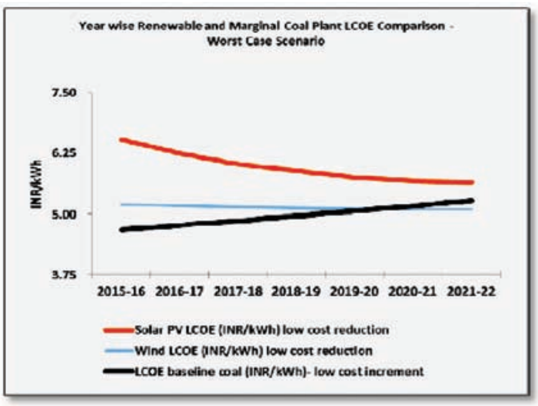


Figure 5: Analysis 2

2.9 Annexures 2 and 3 contains the detailed assumptions, methodology and results of these two sets of analyses. Chapter 4 covers some of the common assumptions used in both the analyses.

Support Required Beyond Existing Allocations

2.10 Based on the analysis, the Expert Group envisages requirement of additional Government support to achieve 175 GW of RE by 2022. The specific policy options and mechanisms to do so in a cost-effective manner are discussed in chapters 4 and 5 of this report. The details of the existing budgetary allocations through various schemes for promotion of solar energy are placed at annexure 1.

2.11 The Expert Group also assessed the extent of support required for other RE segments, namely:

- **Solar rooftop:** Government of India targets to achieve 100 GW solar capacity by 2022. Out of this, 40 GW is planned to be deployed through rooftop PV plants.

  Based on tariffs of electricity for commercial consumers across various states, it is evident that solar rooftop tariffs are already at parity. In cases, where the users can avail accelerated depreciation (AD), the cost of solar is actually lower than the commercial tariffs in many states. Hence, we expect that no subsidy will be necessary for solar installations by commercial segments in most states.

  As per existing scheme of the Government of India [9], 15% capital subsidy is allowed for residential and institutional segments. At Rs. 8 crore/MW, it is estimated that a Central Financial Assistance of a total of Rs. 12,000 crores may be required by 2022 to achieve 10 GW of rooftop capacity through residential/ institutional segments. Remaining 30 GW is expected to be deployed through commercial and industrials segments, which would require no subsidy but enabling policy and regulatory environment and support from utilities. The quantum of financial assistance required for 10 GW of rooftop by 2022 must be considered as an upper bound since the reduction in capital costs of rooftop systems is not considered.

- **RE-Based Electricity Access through Mini-Grids:** The Government of India has also rolled out "Power for All" programme to address India's energy security challenge. This programme seeks to provide round the clock electricity to each household by 2019. However, the programme appears ambitious when approximately 400 million people do not have access to electricity today.

  A transition solution could be to provide immediate access to basic electricity needs by RE-based tail-end generation with or without the need to create new distribution infrastructure (mini-grids). The table-3 provides the year wise target and cost differential envisaged for such mini-grid systems. The Expert Group acknowledges that such interventions would also require consideration of technical aspects of generation systems, distribution infrastructure, and even storage systems so that integration with the utility grid is possible whenever utility grid reaches and becomes reliable.

Table 3: Year wise target and cost-differential for RE-based mini-grid systems (refer Annexure 5 for details)

Particulars	Year - wise Target									
	2015-16		2016-17		2017-18		2018-19		Total	
	Target Addition (In MW)	Cost differential (In Rs. Crore)	Target Addition (In MW)	Cost differential (In Rs. Crore)	Target Addition (In MW)	Cost differential (In Rs. Crore)	Target Addition (In MW)	Cost differential (In Rs. Crore)	Target Addition (In MW)	Cost differential (In Rs. Crore)
Un-electrified Villages as per Census	1	9	114	1,026	170	1,530	270	2,430	555	4,995
Electrified villages – local RE based capacity	5	45	795	7,155	1200	10,800	2,000	18,000	4,000	36,000
Total	**6**	**54**	**909**	**8,181**	**1,370**	**12,330**	**2,270**	**20,430**	**4,555**	**40,995**

9 http://mnre.gov.in/file-manager/UserFiles/CFA-Solar-Rooftop-03082015.pdf

Detailed approach for estimating support to rooftop PV and mini-grid segments can be found at annexures 4 and 5 respectively.

- **Solar-Powered Agriculture Feeders**[10] **:** The 100 GW solar power target is divided into large-scale centralized power plants (50 GW) and distributed smaller scale projects (40 GW of rooftop mainly used by industrial, commercial and residential consumers and 10 GW grid-connected tail-end plants). The only option for solar power use in agriculture presently is in the form of individual solar pumps. They are suitable for areas not served by the grid and with high water tables, but require high upfront capital subsidies.

  However another more cost effective, equitable and easier to manage alternative is possible, for certain areas, especially where agricultural feeder separation has taken or is going to take place. Tail-end, MW scale PV projects could be used effectively to meet agricultural power demand. Under this approach, in areas with feeder separation, 1-2 MW tail end solar PV plants (representative of a typical feeder load) would be inter-connected to the 33 kV sub-station and such feeders would be kept live/load shedding free during the day time from 8 am – 5 pm to primarily meet agriculture load. Any excess generation from solar would flow back to the local grid. If the agriculture load is high the differential would be provided by the grid. A preliminary economic analysis suggests that it is roughly 40-50% more cost effective than solar pumps, especially if dovetailed with energy efficiency measures (see table-4 below). Apart from the cost effectiveness, this approach is investment driven and does not involve upfront subsidy.

Table 4: Cost effectiveness of different solar agricultural pumping options

Option A; Individual Solar Pumps: Upfront cost of **INR 21 crores** (at Rs. 150/Wp and replacement of 5 hp grid pump with 3 hp solar pump)
Option B; solar powered feeder: 1.4 MW solar plant to offset yearly energy use. @ Rs. 5.5/kWh, yearly payment of Rs. 1.3 crores, or an NPV of **INR 11.1 crores** over 20 years.
Option C; solar powered feeder with energy efficient pumps: 0.86 MW solar plant (40% reduction due to efficient pump). Existing pump replaced with 5 star pump @ Rs. 35,000/pump. Yearly payment of Rs. 0.99 crores (incl. pump replacement cost spread over 20 years), or an NPV of Rs. **8.4 crores** over 20 years.

Assumptions: 11 kV feeder, with 500 pumps (avg 5 hP), usage of 1200 hours/year; discount rate: 10%

The solar powered feeder approach could also be compared with the existing conventional grid supply situation. Cost of power up to agriculture feeder is about Rs. 3.5-4/kWh considering cost of generation and losses while solar power costs ~ Rs. 5.5/kWh. Efficient pumps, if integrated into this solar feeder scheme can bring down the effective cost of solar power for agriculture by about 25% (after accounting for cost of new pumps, which can reduce power requirement by 30-40%). Thus, considering the fixed cost of solar generation (over 25 yrs) and the increasing cost of grid supply, an integrated solar powered feeder with efficient pumps would be cheaper than even grid supply in just 3-4 years. This will have added benefits of reliable and better quality (rated voltage) power, leading to lower pump burn-outs. Additionally trained human resources at solar plant would be available in the farm vicinity. Both these factors, could greatly contribute

10 An article based on this concept has been published in The Hindu Business Line - 8th July 2015; http://www.thehindubusinessline.com/opinion/a-ray-of-hope-for-solarpowered-agriculture/article7399845.ece

to a successful agriculture-DSM program of pump replacement, unlike earlier isolated programs.

This approach does not need upfront capital subsidies by DISCOMs/Governments, as this solar power will be procured through PPA arrangements (either with state Gencos or private developers). It also allows for the DISCOM to account for its mandated solar purchase obligation (set to be 8% by 2019) and is also easier for grid integration as the solar capacity would be distributed over a larger geographical area.

MNRE has already recently announced a new proposal for unemployed youth and farmers wherein ~10 GW of grid connected tail end solar PV plants (0.5-5 MW) will be connected to the distribution substation. Power from these projects would be bought by the DISCOM at the rate decided by the SERC. MNRE is willing to contribute Rs. 0.5 crore/MW (~ 9% of the capital cost), provided the state sets up a committee and institutes a policy for transparent selection and allocation of projects. While several details of MNRE proposed approach have yet to be worked out, it would be beneficial for states to effectively pursue this program and align this MNRE scheme with the above suggested approach. It is suggested that 50% of capacity under the MNRE scheme (i.e. 5 GW) could be earmarked for this "solar powered agriculture feeder approach".

To begin with, it would be desirable to pilot out this approach in various states under different business models and based on the results and learnings, scale up to a national program for the use of solar power in agriculture. This will help demonstrate technical, implementation feasibility and benefits to farmers in terms of quality supply. As prices of solar power reduce and the prices from grid supply go up, the financial attractiveness of this approach will only get better when such a program could be scaled up in 2-3 years. After demonstrating the benefits of this approach in terms of improved quality and day time reliable supply to farmers, future programs could link deployment of such solar feeders to improved metering / tariff recovery and reduction in unauthorized use.

This approach could be one of the crucial steps in addressing the Achilles heel of Indian power sector – i.e. agricultural power supply. Through reliable and better quality power, it would truly support agriculture in these times of agrarian distress.

Year wise target and cost differential envisaged for RE segments is provided in Table-5

- **RE Manufacturing:** Indigenous manufacturing is one of the key focus areas of the Government. Even from the perspective of achieving energy security, it is important to support indigenization of the RE equipment. The focus of this report is primarily restricted to minimizing the generation costs; however a compilation of existing studies on cost of support for manufacturing is appended as annexure 6.

Table 5: Year wise target and cost differential envisaged for RE segments

Segment	Year													
	2015-16		2016-17		2017-18		2018-19		2019-20		2020-21		2021-2022	
	Target	Cost differential	Target	Cost differential	Target	Cost differential	Target	Cost differential	Target	Cost differential	Target	Cost differential	Target	Cost differential
Grid-connected solar	1.80	2,523-5,087	7.20	4,726-12,512	10.00	2,346-10,034	10.00	497-5637	10.00	0-2,627	9.50	0-710	8.50	0-74
Onshore wind	3.20	738-3,315	3.60	275-2,508	4.10	33-1,780	4.70	0-1,111	5.40	0-548	6.10	0-168	6.90	0
Rooftop PV (residential/ institutional)	0.05	60	1.20	1,440	1.25	1,500	1.50	1,800	1.75	2,100	2.00	2,400	2.25	2,700
Off-grid/ mini-grid segment	0.006	54	0.91	8,181	1.37	12,330	2.27	20,430	4.55	40,995	-	-	-	-

Capacity in GW; Cost differential in INR crores

Chapter 3: Support For Transmission And Grid Integration

3.1 Appropriately designed transmission infrastructure and updated grid integration and operation mechanisms are key to scaling-up RE to 175 GW by 2022. Internationally, where penetration of RE has been increasing in the power generation mix, various changes to grid design, technology and its operation have been implemented to allow cost-effective grid integration of RE. Power sector stakeholders in India have started discussing the issues around grid management and have also initiated some steps to find potential solutions. These initiatives have been listed below.

CEA's Transmission Perspective Plan 2032

3.2 The perspective transmission plan is basically indicative in nature and covers the transmission systems at 400kV and above voltage levels. The 'Perspective transmission Plan for 20 Year (2014-2034)' has been formulated in two parts, Part-I: Evolving Transmission System Additions for 13th Plan i.e. up to 2021-22 and Part-II: Evolving Transmission Corridors for period 2022-34 i.e. 14th, 15th Plans and beyond up to 2034.

3.3 For part one, i.e. up to 13th Plan end, transmission system has been evolved based on state-wise demand projections and generation plants under various stages of implementation. For part two, as the generation has been de-licensed and generation plants in this timeframe are yet to take off, it is not possible to identify the optimum generation plan for the period 2022-34. In such a scenario, broad transmission corridors have been identified.

3.4 It is estimated that during 13th Plan Period, about 62,800 circuit kilometers (ckm) of transmission lines, 15,000 MW of High Voltage Direct Current (HVDC) terminal capacity and 128,000 MVA of transformation capacity of the 400 kV and above voltage level transmission systems would be required. Accordingly, the plan estimates that total fund requirement for 13th Plan would be of the order of Rs. 260,000 crore as against Rs. 234,000 crore required in 12th plan period. This would consist of Rs. 160,000 crore for 400kV and above transmission system and about 100,000 crores for 220 kV and below systems most of which would be for state transmission systems.

Green Corridors Phase I and Desert Power

3.5 The transmission plan for envisaged renewable capacity, the "Green Corridors" report, was released by Power Grid Corporation of India Limited (PGCIL) in July 2012. Its objectives were threefold: to identify additional transmission infrastructure needs of likely wind, solar and hydro capacity in RE-rich states such as Tamil Nadu, Karnataka, Andhra Pradesh, Gujarat, Maharashtra, Rajasthan, Himachal Pradesh and Jammu & Kashmir during the period of the 12th Five Year Plan; to estimate the CAPEX of such additions; and to propose approaches to funding.

3.6 Desert Power India – 2050 – Integrated Plan for Desert Power Development was released by PGCIL in December 2013. It focuses on opportunities to harvest solar power in the north and north-west of the country, specifically in the deserts and wastelands of the Thar in Rajasthan, the Rann of Kutch in Gujarat, Ladakh in Jammu and Kashmir, and the Lahaul and Spiti valley in Himachal Pradesh. The study suggests that 5-10% of the unproductive wastelands in these areas (7,400 – 14,800 km2) could produce 220 to 450 GW of solar and wind power. Similar to the Green Corridors report, the study assesses the cost and extent of transmission infrastructure to evacuate electricity thus generated to demand centres.

Green Corridors Phase II

3.7 The Power Grid Corporation of India Limited (PGCIL) is in the process of formulating a transmission scheme for identification and construction of transmission lines for 20 GW of solar parks. Table-6 below are the broad cost estimates shared by PGCIL.

Table 6: Proposed plans under Green Corridor Phase II

S. No.	State	Name of Solar Park	RE capacity proposed in MW	No. of Sub Stations	Trans-mission Capacity in MVA	Trans-mission Lines in kms	Estimat-ed Cost in Rs. Crore
1.	Andhra Pradesh	Anantpur	1000	1	1500	64	506.43
2.	Andhra Pradesh	Galiveedu, Kadapa	500		500		40.53
3.	Karnataka	Tumkur	2000	1	2500	300	983.40
4.	Telangana	Mehboob Nagar	1000	1	1500	65	475.35
5.	Gujarat	Banaskantha	750	1	1500	80	335.34
6.	Madhya Pradesh	Rewa	750	1	1500	80	357.29
7.	Madhya Pradesh	Neemuch & Agar	750	2	1425	190	614.65
8.	Rajasthan	Bhadla – Phase-III	1000	1	1500	300	1848.58
9.	Rajasthan	Jaisalmer –Phase-I & II	2000	2	3500	430	2727.61
10.	Uttar Pradesh	Jalaun	370	1	1000	30	205.96
11.	Jammu & Kashmir	Leh & Kargil	7500	2	14000	1250	11205
Total			**17,620**	**13**	**30,425**	**2,789**	**19,300.14**

TRANSMISSION NEEDS FOR RE

3.8 While solar resources are abundantly available throughout the country, harnessing the best wind resources might require new transmission lines. International experiences suggest that the most important task is to manage the trade-offs between:

1. The cost of building the transmission line
2. The transmission capacity of the line
3. The benefits represented by new lines in terms of reducing the need for balancing power (by smoothing aggregated output), and increasing capacity value.

3.9 It is of primary importance that the planning of new transmission to cater for the needs of new renewable power plants should take into account the needs of other power plants, and upgrades to the power grid necessary even in the absence of these new needs.

3.10 At the same time the trade-off mentioned above between connecting distant RE resources and the marginal benefit of doing so in terms of cost needs to be considered. Accessing high quality resources generally lowers the per kilowatt-hour generation cost of VRE power plants. However, connecting distant plants to the grid can be costly. It may be cost-effective to connect large RE plants (e.g. solar parks, large wind farms) to the inter-state transmission system. Considering this, the recent amendments to the Tariff Policy suggest waiving off the inter-state transmission charges for solar power.

3.11 There is also a trade-off between the cost of transmission and the proportion of rated capacity that can be accommodated. A wind power plant, for example, may only generate at rated output for a small number of hours per year. This means that if transmission capacity is dimensioned according to rated output, a proportion of it may be underused for the rest of the year. The cost of this unused portion may outweigh its benefit in terms of those few hours, and it may instead be prudent to plan the curtailment of the margin of wind output instead, with sufficient incentives being offered to the wind-generators for such planned curtailment.

TRANSMISSION COSTS

3.12 Broadly, cost for transmission strengthening is estimated around 1 crore/MW. Based on consultations with PGCIL, an assessment of the implications of RE capacity additions on the transmission network and the schemes sanctioned under the Green Corridor Phase 1, the Expert Group estimates that half of this cost – 50 lakh/MW – will be required for inter-state transmission network and remaining half will need to be used for strengthening intra-state transmission network.

3.13 According to the Report of The Committee on "Transmission Corridors for Evacuation of Renewable Power" under the chairmanship of Member (Energy), Planning Commission", it is estimated that 40% of the cost of strengthening intra-state transmission network will be required to be provided to states as financial support from the Centre to the states. In addition, equity contribution from the states may be taken as 20%. Remaining 40% of the cost may be raised as debt. The Expert Group remarks that strengthening of transmission network should be based on competitive bidding.

3.14 Inputs considered to estimate indicative costs are listed below:

- RE target – 175 GW by 2022
- Grid-connected RE capacity already commissioned as on Mar 2012 (considered by Green Corridors Phase I report) – 24.915 GW
- RE capacity to be built under Green Corridor Phase 1 – 30 GW
- Residual RE capacity for which transmission system has to be strengthened = 175 – 24.915 – 30 = 120.085 GW

Cost calculation

3.15 Assuming an estimate of 1 crore/MW, the fund requirement for transmission strengthening will be 120,085 crore for 120 GW of additional RE capacity. Table -7 provides an estimate to investments required for strengthening of transmission capacity

Table 7: Estimated investments required for strengthening of transmission capacity

Inter-state strengthening	50%	60,043 crores
Intra-state strengthening	50%	60,042 crores

3.16 It is expected that the PGCIL will be able to raise the necessary investments for strengthening the inter-state transmission network. These costs are planned to be socialized across the power system and hence no financial support is envisaged for this component.

3.17 However, for strengthening of intra-state transmission networks, using the above formulation, it is estimated that the central government may support 40% of the total cost, i.e. 24,017 Cr towards achieving the targets.

GRID INTEGRATION AND BALANCING COSTS

3.18 There are no domestic studies carried out in this respect. In 2013, Denmark, Germany and Spain had a generation share of renewable electricity of 56%, 25% and 42%, respectively, with at least half of power generation capacities being renewable-based. The examples of Denmark, Germany and Spain show that up to about 20% to 25% variable renewable energy (VRE), specifically solar PV and wind, in total annual electricity supply do not pose a major challenge and can be easily accommodated in most power systems. Higher VRE shares pose challenges and increasingly require rethinking of the power system operation and planning. At moderate VRE shares, instantaneous penetration levels can become very high in some hours of a year, and VRE supply can sometimes even exceed electricity demand.

3.19 However, these challenges can be met and there is wide consensus that the challenges of VRE variability create no insurmountable technical barriers to high VRE shares, however, the specific properties of VRE can cause additional costs at the system level (Sims et al. 2011, Milligan and Kirby 2009, Holttinen et al.

2011, Milligan et al. 2011, Katzenstein and Apt 2012, Ueckerdt et al. 2013, IEA 2014, Hirth et al. 2015).

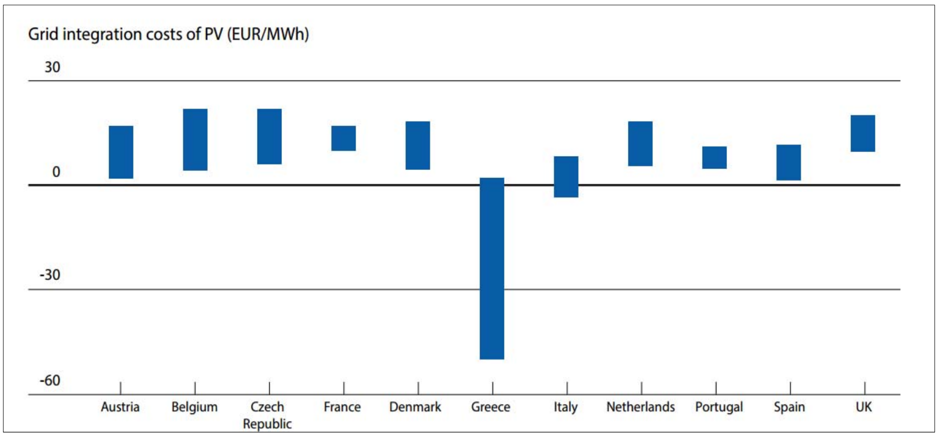


Figure 6: Integration Costs for Solar PV in The European Union for Between 2% and 18% of Electricity Generation with Demand Response (Source: Pudjinato 2013)

3.20 A partial analysis of the additional costs of integrating significant levels of solar PV generation in Europe, taking into account capacity adequacy and reserves, upgrading of the main European Union (EU) transmission network, the cost of reinforcing the distribution network and the impact of solar PV on network losses (beneficial at low penetration rates), indicated average integration costs of around USD 0.02/kWh for 10% of EU's generation from solar PV, rising to around USD 0.025/kWh for 18% of EU generation coming from solar PV. Taking a more holistic approach to integrating solar PV by including demand response as an additional source of flexibility would reduce these costs by an average of 20% (Figure 6). This also has to be put in context of today's retail electricity rates in the EU, which range from a low of around USD 0.11/kWh to USD 0.40/kWh and averaged USD 0.27/kWh in the first half of 2014 [IRENA 2014].

In the Indian context

3.21 IESS 2047 envisages that RE will constitute approximately 15% of India electricity generation mix by 2022 (The heroic effort scenario of the IESS 2047 estimates 460 TWh RE in a total electricity supply of 3026 TWh). International literature states that this will not exert any significant pressure on generation costs provided the grid planning and operation protocols are appropriately designed.

3.22 Based on the empirical assessments in other countries, it can be assumed that grid integration will constitute approximately 10% of the levelized cost of RE in the present context. This cost share can be possibly made to reduce to 6% by 2021-22 as planning and operations related interventions are adopted (Table 8 below). It may be noted that this is a ballpark estimate and detailed studies need to be carried out to determine costs of integration (according must-run status to RE plants) to a reasonable level of accuracy. Some of the desired interventions are described in the next section.

Table 8: Possible roadmap to reduction in grid integration costs

Grid integration and balancing	10%	9.2%	8.5%	7.8%	7.2%	6.6%	6%

INTERVENTIONS TO REDUCE OVERALL SYSTEM COSTS

3.23 Countries are exploring strategies that are inherently useful for improving the overall efficiency of grid operations and reducing overall costs to consumers whether RE accounts for a large (more than 25%) share of the generation mix or not. Some of these changes are one-time changes while others would evolve over time as load shapes and the resource mix continue to change. This section describes these strategies [11].

i. **Upgradation of Grid Technology:** System operators at all levels (i.e. state, regional and national) should have visibility of the grid status in neighboring balancing areas and also the ability to easily coordinate with them. Most of the transmission companies (i.e. central and state transmission utilities) and Load Dispatch Centers (LDCs) (i.e. POSOCO and State LDCs) have initiated grid technology upgrades in recent times. These initiatives need to be significantly ramped up to deploy sensors for generating real-time high geographic resolution data on grid conditions. These data generation sensors need to be coupled with sophisticated analytical engines that provide the necessary information for grid operations. Centralized RE forecasting mechanisms need to be tightly integrated with system operations. Lastly, advanced decision-making and control systems need to be implemented that enable system operators to respond significantly faster to changed grid conditions.

ii. **Upgradation of Grid Operation Protocols:** Various aspects of system operations need to be updated. These include but are not limited to:

- Grid Codes: System operators around the world – especially those encountering a high share of RE on their grid – are continually updating their grid codes to ensure that RE additions do not affect the grid adversely, and to explicitly acknowledge attributes unique to RE generators and, consequently, require appropriate capabilities

- Scheduling and Dispatch: Through both practice and theory, it has become evident that grids that are operated in a manner where scheduling and dispatch are implemented over short time durations (e.g., as low as five minutes) have significantly lower overall costs to consumers as the need for ancillary resources decreases. Currently, in India, scheduling occurs on a day-ahead basis while dispatch occurs on a 15-minute basis. System operations technologies and protocols need to be updated to enable five-minute scheduling and dispatch of all resources connected to the grid and automated incorporation of RE forecasts. This will also lower ancillary service requirements.

iii. **Expand Balancing Areas:** It has been seen globally that larger balancing areas (or the ability to coordinate among balancing areas) have significantly lowered the overall cost to consumers as ancillary services requirements are reduced substantially. Currently, balancing areas in India — specifically, states — neither have the visibility of their neighbors' grid condition nor the ability to coordinate with them. A single national-

11 Adapted from NITI Aayog's RE Roadmap 2030

level load dispatch center that is nonprofit, independent, and regulated by CERC is sufficient for managing the entire national grid.

iv. **Promote Flexible Demand and Supply Resources:** Power systems, especially those with a high share of RE, require access to sufficient flexible resources (e.g., demand response, gas turbines, hydroelectricity, etc.) to ensure continued stability of the grid at each moment. Currently, there are no mechanisms in India to ascertain the amount of balancing resources needed and how these can be procured and dispatched. Grid simulations that are used to identify resource pools (both built and un-built), specifically for providing various types of flexible resources including ancillary services, should be conducted routinely. Procurement mechanisms need to be implemented to ensure these resources are connected for use in assuring grid stability. Finally, mechanisms for fair price discovery and compensation of flexible resource providers (e.g. ancillary services) need to be established. The responsible LDC should be made responsible for procuring ancillary services to ensure grid stability. The procurement process should be similar to the usual competitive bidding process used by discoms for procuring energy. The compensation could be cost-plus as approved by the relevant regulatory commission and paid by all the buyers to the LDC.

SUMMARY OF TOTAL COSTS FOR STRENGTHENING OF TRANSMISSION SYSTEM

Year-Wise Split of Targeted Installed Capacity is provided in Table-9.

Table 9: Year-Wise Split of Targeted Installed Capacity[12]

	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	**TOTAL (GW)**	Already commis-sioned capacity by 2014-15 (GW)
Solar	2	12	15	16	17	17.5	17.5	**97**	3.0
Wind	3.2	3.6	4.1	4.7	5.4	6.1	8.9	**36**	24.0
Small Hydro[13]	0.14	0.14	0.14	0.14	0.14	0.14	0.14	**0.95**	4.1
Biomass[14]	0.0	0.9	0.9	0.9	0.9	0.9	0.9	**5.58**	4.4
Total (GW)	**5.3**	**16.7**	**20.2**	**21.8**	**23.5**	**24.7**	**27.5**	**139.5**	**35.5**

- RE target – 175 GW by 2022
- Grid-connected RE capacity already commissioned as on Mar 2012 (considered by Green Corridors Phase I report) – 24.915 GW
- RE capacity to be built under Green Corridor Phase 1 – 30 GW
- Residual RE capacity for which transmission system has to be strengthened = 175 – 24.915 – 30 = 120.1 GW

12 http://mnre.gov.in/file-manager/grid-solar/100000MW-Grid-Connected-Solar-Power-Projects-by-2021-22.pdf

13 Remaining capacity divided equally between seven years

14 Remaining capacity divided equally among six years starting 2016-17

Yearly Investments Required for Strengthening of Transmission Capacity has been estimated in Table-10

Table 10: Estimated Yearly Investments Required For Strengthening of Transmission Capacity [15]

Segment	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**	**2021-22**	**TOTAL (thousand crore)**
Inter-state transmission strengthening (50% share in total cost)	4.0	7.6	10.9	11.6	12.6	8.7	4.6	**60.0**
Intra-state transmission strengthening (50% share in total cost)	4.0	7.6	10.9	11.6	12.6	8.7	4.6	**60.0**
TOTAL (thousand crore)	**8.0**	**15.3**	**21.8**	**23.3**	**25.2**	**17.4**	**9.2**	**120.1**

15 Assuming the investment of 1 Cr/MW is split equally among years X, X-1, and X-2 for capacity to be commissioned in year X

Chapter 4: Policy Options/Financial Support Mechanisms

4.1 The objective of this chapter is to identify and analyse financial support mechanisms, either stand alone or any combinations thereof, to highlight their attractiveness in making RE procurement tariffs comparable to marginal cost of alternative power sources.

POLICY OPTIONS

4.2 Various policy options (facilitating actions and direct/indirect financial incentives) are available to the Government of India (GoI) to reduce the incremental cost of RE procurement by the state DISCOMs.

Some of the facilitating actions that do not have a direct financial burden on GoI include

i. **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.

ii. **Easing liquidity and de-risking so that low-cost finance is available to RE (at market-based risk-free interest rate):** This will include introduction of enabling policy and regulatory environment, and easing project development so that risk premium for these projects reduces. In any case, these interventions are anyways necessary to be able to meet the 175GW RE targets.

Some of the incentives that will result in direct or indirect impact on the Government are

iii. **Accelerated Depreciation (AD)**: Presently GoI allows 80% AD benefit for wind and solar power projects. This is an indirect fiscal benefit for investors who can offset their overall tax liability (from profit making companies/operations). This has been a significant support for wind power investments in the past. 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. The other limitation of AD is that there is no linkage to operational performance, as the incentive is due with investments being made.

iv. **Viability Gap Funding (VGF):** 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.

v. **Generation Based Incentive (GBI):** GBI is a fixed incentive payment for every unit of electricity generated and is spread over a number of years (currently 8 years for wind power in India). 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. It allows more flexibility for policy makers (allowing for adjusting the needed level of support from GoI considering market conditions) and thus paves the way for a faster transition to full cost/market based pricing for RE in the coming years.

vi. **Provision/Facilitation of low cost and longer tenure debt:** Capital cost intensive RE technologies (wind and solar have no fuel cost) are very sensitive to the cost of debt. Hence facilitating availability of low cost debt through green bonds or passing on the low cost and longer tenure rupee or non-rupee debt (including hedging cost) offered by multilaterals/ bilaterals/domestic financial institutions can directly help reduce the cost of RE, thereby reducing incremental costs of procuring states. As low cost debt will have its support over years of debt repayment, the impacts on tariff would be similar to that from GBI, or AD spread over years. This option primarily aims at using non domestic / non-conventional sources of capital.

vii. **Interest Rate Subvention:** Under this option, the GoI could directly pay a part of the interest costs to banks. This policy also allows spreading of the costs over a longer time frame (debt tenure). A limitation of this approach is that the incentive is not linked to performance. Again, as low cost debt will have its support over years of debt repayment, the impacts on tariff would be similar to that from GBI, or AD spread over years.

viii. **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.

ix. **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 [16]. Discussions with stakeholders indicate that a buffer for rupee depreciation risk will be built into the bidding process. However, any depreciation beyond the built-in buffer will have to be borne by the Government of India.

EXPERT GROUP ANALYSIS

4.3 The Expert Group has arrived at a matrix to highlight the effectiveness of the policy options discussed above. This matrix draws on the two analyses mentioned in Chapter 2, and appended as annexure 2 and 3 of this report. Table-11 provides details on Common assumptions used for the two analyses.

4.4 The key objective behind both these analysis was to assess the possibility of Government support making utilities and/or buyers become indifferent between RE power and power from the key alternative source which renewable energy replaces (namely imported coal based power generation), and also assess the least cost solutions to achieve it. Table-12 provides details on Capital cost series used in the LCOE calculations.

Table 11: Common assumptions used for the two analyse

Assumptions	Wind	Solar
POWER GENERATION		
Capacity Utilization Factor (P50 PLF)	25% in 2015, and increasing by 0.5% per year.[17]	20%
Useful Life	25 Years	25 Years
CAPITAL COST		
Capital Cost (INR million/MW)	From table below	From table below
OPERATING EXPENSES		
O & M Expenses(1st Year)	INR 1.01 million/MW	INR 1.23 million/MW
Fuel Cost Expenses (1st Year) including transportation cost	NA	NA

16 http://www.livemint.com/Industry/BHEI31Rt2grljz48ICWTZI/India-may-include-yen-along-with-dollar-euro-to-pay-for-sol.html

17 The 0.5% per year increase is based on linear interpolation between 2015 and 2022. CUF would be 25% for the wind power plants commissioned in 2015 and would increase by 0.5% every year for the plants to be commissioned in the subsequent years.

Escalation in O & M Expenses	5.72%	5.72%
Escalation in Fuel Cost and Transportation Cost	NA	NA
FINANCING ASSUMPTIONS		
DEBT TERMS		
Repayment Period	12 years	12 years
Interest Rate (Fixed)	12%	12%
EQUITY		
Expected Return on Equity (Post Tax)	16%	16%
TAX INCENTIVES		
Tax Holiday	10 years	10 years
Minimum Alternative Tax	20%	20%

Table 12: Capital cost series used in the LCOE calculations

Year	15-16	16-17	17-18	18-19	19-20	20-21	21-22
Solar PV Capex (INR crores/MW) low cost reduction	6.00	5.64	5.36	5.14	4.94	4.79	4.69
Solar PV Capex (INR crores/MW) high cost reduction	6.00	5.46	5.02	4.72	4.44	4.17	4.00
Wind Capex (INR crores/MW) low cost reduction	6.19	6.25	6.31	6.38	6.44	6.51	6.57
Wind Capex (INR crores/MW) high cost reduction	6.19	6.19	6.19	6.19	6.19	6.19	6.19

4.5 As mentioned earlier in Chapter 2, Analysis 2 compares the levelized costs of electricity from solar and wind power to a baseline of the levelized cost of electricity from coal, and the Analysis 1 has considered RE tariffs fixed for 20-25 years with escalating coal power tariffs.

TOTAL COST OF SUPPORT FOR RE SUPPLY

4.6 The Expert group's analysis estimates incremental cost for deploying and/or tying an additional 79 GW of RE capacity. This includes 36.5 GW of utility scale wind (23.5 GW out of 60 GW already commissioned) and 42 GW of solar. From MNRE's solar deployment target of 57 GW large-scale solar PV (2015-16 to 2021-22), 15 GW has been deducted as already sanctioned under the Viability Gap Funding (5 GW) and bundling route (10 GW). Details are available at Annexure 1.

4.7 The analysis suggests that after considering available approved subsidies and programs towards achieving 175GW of RE, the incremental costs to the procurers for remaining wind and solar power (i.e. 79 GW) will be in the range of Rs. 8,361 – 43,403 crores (NPV@ 7.5%) depending on the actual solar/wind price reduction trajectories and price trends of imported coal based power generation.

COST EFFECTIVENESS INDICES

4.8 The Expert Group suggested that one of the possible ways to look at preferable polices is cost effectiveness in terms of leverages that the government support can seek. Accordingly, both the Analysis determined the cost-effectiveness of different policy options in terms of the NPV of the total cost of support required to bring down the LCOEs of all the renewable power plants to be commissioned by 2022, to the LCOE of the baseline coal power plant. Presumably, lower the NPV of a policy support, better the cost effectiveness of the policy from overall subsidy standpoint (for analysis 2). For analysis 1, the cost effectiveness index is defined as the ratio of the cost reduction in RE to the cost of the Government support (both in NPV terms), hence higher the ratio, the better the financial effectiveness of that policy option. Important to mention here that the time value of money has been considered, however the actual time of the year at which money would be required is not considered. The cost effectiveness ranking from both the analyses is placed below:

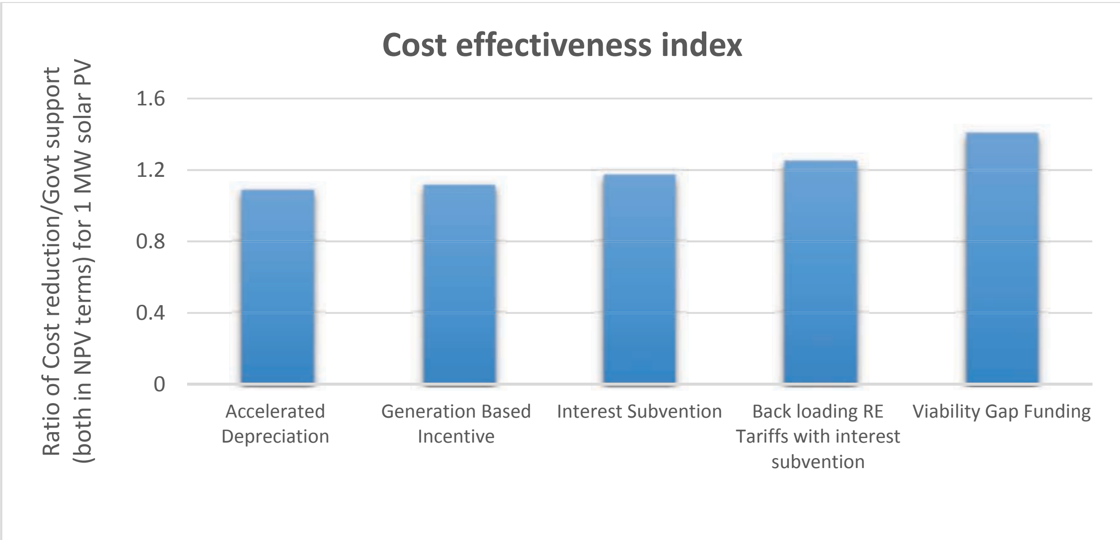


Figure 7: Cost effectiveness index as per Analysis 1

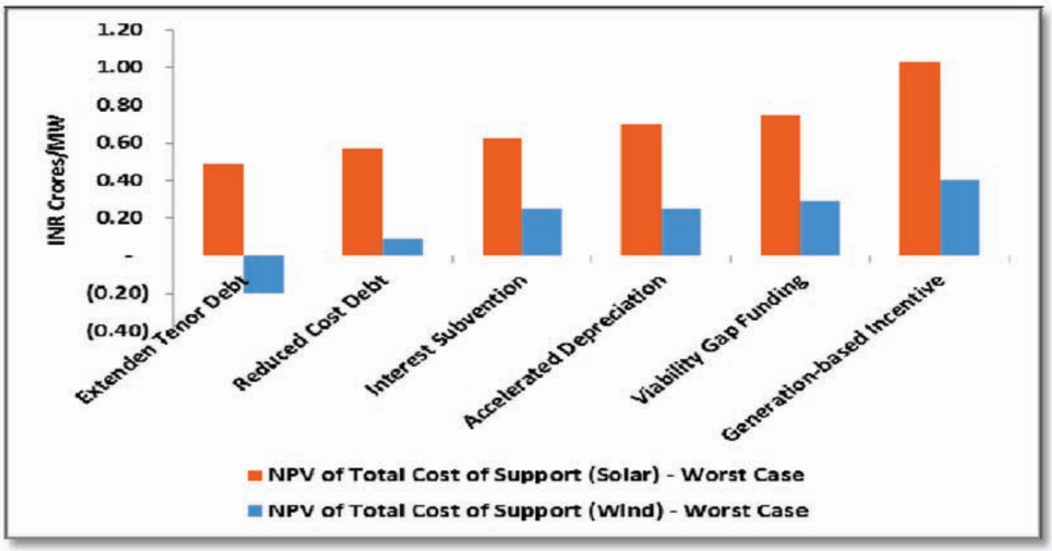


Figure 8: Cost effectiveness index as per Analysis 2

KEY INFERENCES FROM THE ANALYSIS

4.9 Various key inferences from the analysis are:

1. Various policy options (enabling actions and direct/indirect financial incentives) are available to the GoI to achieve reduction in the procurement tariff of RE. The identified enabling actions i.e. (a) bundling with cheaper thermal power and (b) de-risking of the sector to the extent possible resulting in availability of finance at market-based risk-free rates; should be exercised to the extent possible. The later action is inevitable to ensure implementation of the targets.

2. Some of the direct financial incentives such as the VGF are loaded upfront with possibly lower total outlay[18] compared with some other incentives like the GBI (which has a lower annual outlay [19] but is spread over a longer timeframe) would require more outlay (in real terms, and not necessarily in NPV terms). As such, GBI allows for spreading of the costs for the Government over a longer time frame with an added ability of directly incentivizing generation, however at an overall high cost over the period of eight years (current GBI term for wind projects in India).

3. Any output based direct subsidy such as the GBI does not offer any leverage, however is easy to administer. Further, the costs are spread over a longer period of time, and offers maximum visibility at the procurement end.

4. Accelerated depreciation (AD) is an indirect financial support mechanism, and is easy to administer. It has the ability to attract a very distinct and possibly large class of investors without any substantial direct impact on the exchequer. And, there is no documented evidence that AD promotes in-efficiencies. Still, in order to ensure that it incentivizes performance, it is possible to design AD which is in some ways linked to performance of projects over longer timeframe (e.g. bank guarantees in lieu of availing AD, which can be released year on year subject to minimum performance). Another option may be to change AD to Production Tax Credits (in Rs./kWh) which may or may not be transferable.

5. Interest subvention and/or provision of low cost, long tenor loans have the ability to leverage a larger investment (or higher capacity) per unit of subsidy provided, as compared to options such as VGF and GBI. Low-cost/long-tenor loans are the cheapest option from an NPV perspective; however, they require more annual outlay in the earlier years. At the same time, their administration and ensuring that they reflect in the tariff would require efforts and smart policy design.

18 Total outlay means the total outflow of funds over the term of disbursement

19 Annual outlay means undiscounted yearly outlay

Chapter 5: Recommendations

5.1 The Expert Group has analyzed the various possible policy dispensations on the following yardsticks:

- **Y1**: Cost to the Government in short to medium term – **important for any government**
- **Y2**: Total cost to the Government over the lifetime of the project – **is a policy choice**
- **Y3**: Ability of the policy intervention to bring the cost of RE at par (or very close) with marginal cost of power procurement from alternative power sources (primarily imported coal) and thus motivates utility to buy RE – **is a policy choice**
- **Y4: Ability to attract investments – critically important**
- **Y5**: Ability to ensure continued performance of projects – **critically important**
- **Y6**: Ease of administering the support mechanism – **critically important**

Table 13: The evaluation of various policy options on the identified yardsticks

S. No.	Policy	Y1	Y2	Y3	Y4	Y5	Y6
1	Bundling	Green	Green	Green	Green	Green	Green
2	AD	Green	Green	Purple	Green	Red	Green
3	GBI	Green	Purple	Green	Green	Green	Purple
4	Dollar-based competitive bidding	Green	Purple	Green	Green	Red	Green
5	Low cost and/or extended tenor loans	Red	Green	Green	Green	Purple	Purple
6	Interest rate subvention	Purple	Purple	Green	Green	Purple	Red
7	Back-loaded RE tariffs	Purple	Red	Purple	Purple	Green	Red
8	VGF	Red	Purple	Red	Purple	Red	Green
Green	Low cost/Able to achieve/Easy to administer						
Purple	Moderate cost/Able to achieve with change in design /Possible to administer with change in design						
Red	High cost/Not able to achieve/Not possible to administer						

5.2 Based on the analysis, findings and stakeholder inputs, the Expert Group recommends the following:

i. **Bundling of RE power with cheaper conventional power**: As long as unallocated quota for conventional power is available, it must be used to bundle with RE power to incentivize procures for buying RE. This has no financial impact on the Government, and offers benefits related to timely payments, secured power purchase agreements, and generators receive the full tariff for RE, and hence do not need any additional incentives.

ii. **Accelerated Depreciation (AD) is an indirect fiscal benefit**: that attracts a significant class of investors (who can offset their tax liability from profit making companies). This has been a significant contributor to wind power investments in the past. The mechanism is simple to administer, and the cost to the GoI under this option is essentially just the deferred income tax payments. Hence options such as AD may be continued with improvements in design of the mechanism such that operational performance gets incentivized. Further, specific tools through which the tax credits can be passed on to individual / institutional investors will help broad-base the class of beneficiary investors, resulting in enhanced investments. The mechanism would however require additional support from other mechanisms to bring tariff parity with the alternative sources, also because not all class of investors can obtain this benefit.

iii. **Generation Based Incentive as a bridge mechanism**: Till such time the utilities pay-out for RE power is greater than marginal cost of conventional power, GBI could act as a bridge instrument, with or without any other mechanism being available. For example, if AD is able to bring down the costs partially, the GBI could bring it down further to meet the utility's cost of procuring alternative power source. In addition, the GBI is also an output /performance linked incentive and hence very limited possibilities of misuse. An inherent limitation for GBI has been its ability to offer tariff comfort at the procurers' end, as most feed-in-tariffs approved by state regulatory commissions do not even consider GBI to be available (or not available).

A possible change in GBI mechanism is to offer the GBI payments to the procuring utility, with clearly defined responsibilities for the Discoms. Such a change could motivate utilities to buy more RE, enhance transparency, facilitate timely payments to the generators and ease out the administration of the incentive. The Central Government would only need to deal with the Discoms and can offer differential GBIs based on cost differentials rather than fixed GBI for all RE generation. Such GBI payments can be related to the difference between the tariffs of RE and alternate marginal source, and can be <75%> of such differential. The remaining <25%> would need to be covered either by the state governments or Discoms themselves, thus ensuring prudence in RE procurement process.

iv. **Interest rate / tenure based interventions**: Any such interventions would have to be designed to ensure that they incentivize performance and do not act as markets distortions. To be more specific, these interventions should either be made available to identified pool of projects and their tariff considerations / setting should be done separately. In absence of such specific arrangements, availability of these incentives to a handful of projects / discoms / states could be a potential distortion against the remaining market.

Another way to operationalize such an intervention is by offering such low cost / long term capital (lending) to all RE projects through balance sheet based refinancing to lenders through a central entity. The project risks would still have to be borne by the lenders in the normal course so that their due diligence process does not get impacted. The assumption here is that enough low-cost long-term money can be made available to the identified central entity.

Towards designing such an intervention, central-government entities (e.g. IREDA, PFC) could pool various sources of low cost funds from domestic as well as international sources. This pool of funds could be administered and managed to refinance banks and financial institutions at a low rate, with upper limits of mark-up predefined so that the sector gets the benefits. Alternatively, the central entity could pool incentives available for interest subvention, and buy down the rate of interest for all RE projects. In any case, such preferential terms of finance should be considered while calculating feed-in-tariffs or any other way of RE power procurement.

v. **Innovative interventions**: The Expert Group debated on the possibility of dollar denominated tariffs and back loaded RE tariffs. Back loaded RE tariffs to a certain extent is possible if lenders can be convinced to back load their interest and principal repayments. Beyond a certain point, any further back-loading would require large Government support either in form of subsidies or interest subventions. The extent of such desired interventions would largely depend on asset liability ratio of lenders, the acceptable levels of mismatch, lenders' comfort with the sector and extent of back-loading required.

For the dollar (or other foreign currency) denominated tariffs, the design of intervention would largely depend on the entity which agrees to bear the risks of currency fluctuations. If the risk has to be built into the tariff itself, same may not be very effective in bringing down the tariff. Foreign investors would certainly find this very interesting as their return will be ensured. The risk reward division between government, utilities and generators would have to be assessed carefully.

In view of this, the Expert Group is of the view that while these options look promising, they should be thoroughly analyzed before even conducting trial runs. Once tried and tested, they can adopted on large scale. As such they do not seem to be options for a significant chunk of projects in immediate term.

vi. **Viability Gap Funding**: The current model of VGF for solar projects is unique. It is a high initial cost option, with part of the payments being deferred to ensure performance. As such, it is a hybrid of VGF and GBI, and still requires significant initial outlays, with no exceptional gains. The mechanism seems inferior to most other mechanisms.

Other Recommendations:

While the scope of the Expert Group was primarily making recommendations around financial incentives, the Group feels it necessary to highlight some of the ecosystem level interventions, without which any amount of financial incentives may not result in deployment of targeted deployment of RE. Most importantly, there is a need for a stable and long term policy (3 yrs) which gives visibility and builds up investor confidence.

Institutional structure to facilitate effective disbursement of central financial assistance: A uniform, simple financial support and disbursal mechanism focuses on buyers (i.e. discoms) of RE, is transparently designed and provides certainty over a reasonable period of time could significantly help in expediting RE growth. The financial support could be disbursed through an (or more) Intermediary Institution(s) that ensures that bulk buyers are made as much as possible indifferent between new RE and marginal fossil fuel-based generation. The Government of India may set up an intermediary institution (could be new or identified as an existing institution) to:

I) Disburse funds to state nodal agencies (to support systematic and planned project development in states) distribution companies (GBI scheme) or RE project developers (VGF) or lenders (refinance or interest subvention).

II) Support large-scale and coordinated project development.

III) Streamline the contracting process (e.g., standardization of contracts), and make available relevant information (e.g., that could lead to a more transparent price discovery process) in a centralized manner. This could significantly reduce contracting-related transaction costs and project risks.

IV) It is also possible for the intermediary institution to centrally procure RE from developers at an auction-price and sells to bulk buyers.

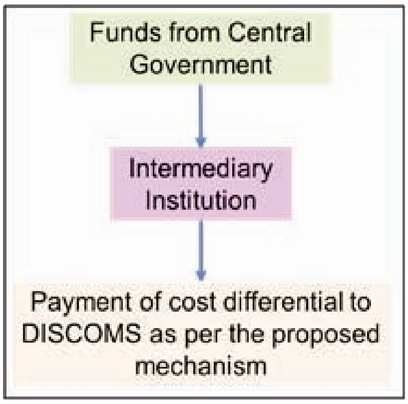


Figure 9: Proposed structure for disbursement of incentives from the Centre to Discoms

vii. **Mandate conditions such as meeting a minimum level of Renewable Purchase Obligation (RPO), timely payments to generators etc.**: This could be achieved through linking central government incentives around RE and also other Power sector specific schemes such as Integrated Power Development Scheme, Rural electrification schemes etc.

viii. **Adopt an integrated approach to power sector planning, including generation, transmission and distribution**: Comprehensive and analytically sophisticated planning exercises should be undertaken routinely in order to assess the benefits and costs of various aspects of the electricity sector, including supply-side resources (e.g., coal, hydro, gas, nuclear, RE), the transmission and distribution networks and their operation, and demand-side resources (e.g., energy efficiency, demand response, etc.). These planning exercises should explicitly and systematically account for various risk factors such as fuel availability, fuel costs, and other possible benefits and costs.

ix. **Undertake measures to reduce overall project risks**: One of the major constraints on rapid RE development is the lengthy and costly project development process that includes investment-grade RE resource assessments, access to land (either acquisition or leasing), supporting infrastructure development (roads, water, transmission interconnections, etc.), and so on. States working with the Center should lead the facilitation process to reduce soft costs in project development (e.g., siting, permitting, supporting infrastructure) with technical and logistical support from the Intermediary Institution described above. This is largely aimed at de-risking the sector and fast-tracking RE deployment, thereby managing/ reducing expected returns on investment (both debt and equity).

x. **Structure reforms such that utility tariffs are reflective of true costs and system-wide efficiencies or inefficiencies**: The tariff design structures of utilities need to be corrected so that all cost components are clearly identified and compensated for, or offset through benefits accrued along the value chain.

xi. **Strengthen (and create if required) institutional structure to monitor implementation of Government policies and programmes and accelerate cost-effective development of the sector**: The Central Government, through existing or new institutions, needs to facilitate / perform functions as illustrated in the draft Renewable Energy Law published by the Ministry of New and Renewable Energy in October 2014.

Conclusion

5.3 To conclude, we strongly feel that in the first place, all non-financial support options should be made available to RE e.g. project development, policy support, legislative enablers, and coordinated implementation ecosystem. Such interventions are critical to reach the 175GW RE targets. The ecosystems should also ensure that all direct and indirect incentives should get reflected in the tariff of RE at the procurement end. Further the incentive design and procurement mechanism should be specific to the characteristics of resource and technology under consideration.

5.4 Options which do not require any project specific government approvals like AD should be made available in any case, with appropriate changes so that operational performance is ensured.

5.5 Lenders (banks and financial institutions) should be made aware of the specific requirements and characteristics of RE projects so that they can take informed decisions, resulting in reduced risk perceptions, and hence better terms of finance. Beyond same, sector specific financing mechanism (low cost money based refinancing, interest subvention etc.) need to be structured avoiding the possibilities of market distortions.

5.6 GBI should be used as a bridge tool. Being a tail end incentive, GBI may offer very little financial leverage, however it can be designed to be very effective to incentivize Discoms to buy RE and bring down their cost of RE procurement. Same should also be used as a tool to facilitate timely payments.

ANNEXURE 1: SOLAR ENERGY- BUDGETARY ALLOCATIONS & CAPACITY ADDITION TRAJECTORY [20]

Table 1: Government of India's budgetary support for solar

Scheme/Programme for Solar	Capacity	Amount/Funding
Already funded solar projects (ongoing programmes)	10 GW (4 GW already commissioned)	Includes Solar Mission phase 1 projects and those envisaged through bundling.
Newly approved/Planned for sanction		
Viability Gap Funding (VGF)	5 GW	15,050 crores from NCEF
Rooftop solar	4.2 GW	
Unemployed youth/rural entrepreneur scheme	9.5 GW (out of 10 GW)	
Solar parks	Total sanctioned = 13 GW	Transmission financing: World Bank ($350 million) and ADB ($350 million)
Bundling scheme	15 GW (out of which 3 GW is already approved with 1:2 bundling ratio)	
State Government targets to be supported to central government funding	20 GW	

So far approx. INR 2000 crores have been disbursed to MNRE from the National Clean Energy Fund

Table 2: Solar capacity addition trajectory

Capacity Addition (Year wise)	As on 31st March 2015*	15-16 #	16-17	17-18	18-19	19-20	20-21	21-22	Total
Solar Capacity to be deployed per year (GW)	3.7	1.80	7.20	10.00	10.00	10.00	9.50	8.50	60.70
Declared incentives									
VGF (5GW)		1.80	3.20						
Bundling (10 GW)			1.00	2.00	2.00	2.50	2.50		
Effective Solar Capacity for Calculation		0.00	3.00	8.00	8.00	7.50	7.00	8.50	
* http://mnre.gov.in/mission-and-vision-2/achievements/									
# http://mnre.gov.in/file-manager/grid-solar/100000MW-Grid-Connected-Solar-Power-Projects-by-2021-22.pdf									

20 As per input received from MNRE

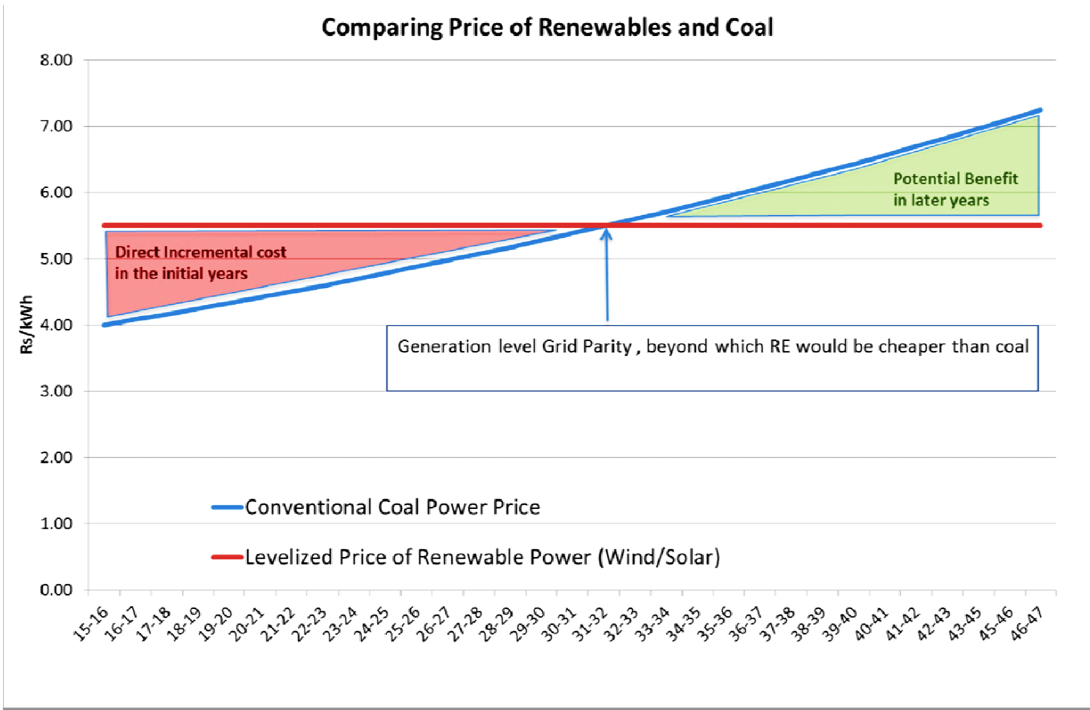
ANNEXURE 2: ANALYSIS 1 - RENEWABLE ENERGY (RE) GENERATION COSTS [21]

A. Introduction:

Taking note of various benefits of RE (contribution to reducing electricity price volatility and energy imports thereby increasing energy security and positively contributing to reduction in 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, which implies an ambitious CAGR of 25% over the next 7 years.

While the socio-environmental benefits of RE accrue to society as a whole, the direct incremental cost of RE in the initial years (say in comparison to coal power) has to be borne by the states DISCOMs who are not in the best of financial health for a variety of reasons. With RE, the practice has been to set tariffs (by ERCs) on a levelized basis (depicted by the red line in graph below) and PPAs signed for this fixed price for 20-25 years. While coal power tariffs (depicted by the blue line in graph below) are generally made up of two parts (a fixed component and a variable component). The variable component generally has an element of escalation built into it. The graph below (figure 1) clearly shows the direct incremental costs for DISCOMs in the initial years. This is just a generic representation for illustrative purposes.

Figure 1: Generic representation of direct incremental costs for DISCOMs in the initial years



21 Led by Ashwin Gambhir with support from Shweta Kulkarni, Prayas Energy Group, and calculations carried out on tariff calculator developed by Prayas Energy Group

Given the national importance of RE for the country, the GoI has been historically sharing some part of such incremental costs for states through a variety of financial incentives and subsidies. Given the increased deployment target of 175 GW by 2022, the Expert Committee was asked to look afresh into policy options by which GoI could bear part of whole of this incremental cost.

B. Estimation of Incremental Costs for procuring DISCOMs:

The bulk of 175 GW target comprises of solar (100 GW) and wind (60 GW). Hence this analysis is limited to only utility scale wind and solar power to get a broad idea of the incremental costs. We have also assumed (for the present calculation purpose) that all the wind capacity will be onshore and all solar capacity will be based on PV. A detailed methodology for estimating incremental costs is given in the table below.

Note: For the purposes of these calculations, presently we have estimated incremental cost for 79 GW of utility scale wind (36.5 GW) and solar (42 GW) to be procured by States. However these results of incremental costs would be an over-estimate since some of this capacity would be procured by states without any GoI incentives (as is been done for some solar capacity being presently procured by states through competitive bidding and for wind projects coming up in states based on feed-in-tariffs). Additionally some share of this 79 GW would be tied up through bilateral deals between two private parties (through the Open Access and Captive route), which will not have such incremental costs considerations for DISCOMs.

Table 1: Methodology for calculating incremental cost of RE

S.No.	Methodology / Steps	Data Source
1	Assume a certain trajectory of the RE capacity addition from 2015-16 to 2021-22. The estimates below are only for 79 GW (42 GW solar PV and 36.5 GW wind power) of RE deployed from 15-16 to 21-22. This is because 5 GW and 10 GW of solar PV are already sanctioned under the Viability Gap Funding (5000 cr.) and bundling route respectively.	Solar Capacity addition is as per MNRE projections while for Wind we have assumed a CAGR to result in a total capacity of 60 GW by 2022.
2	Estimate a capital cost price trajectory for solar PV and wind power for each year from 15-16 to 21-22. Given the dynamic nature of the sector and the uncertainty in projecting future prices, we have assumed two price trajectories (a low and a high cost reduction scenario) for sensitivity analysis.	These estimates have been made considering IESS data, some recent news/reports/publications etc. All projections are in nominal terms.
3	Calculate the Levelized Cost of Electricity (LCOE) of wind and solar PV projects for each year based on the Prayas - RE Tariff and Financial Analysis Tool. Estimates of solar PV and wind tariff are shown in figure 2 and 3.	Most assumptions are based on CERC 2015-16 RE tariff order. Only deviation is for ROE (20% pre-tax instead of 22.4%; 10% discount rate instead of 10.81%). Tax holiday assumed from year 6 to 15. CUF for solar PV fixed at 20%, while for wind power are assumed to increase 0.5% p.a. from 25% (installations in 15-16) to 28% (installations in 21-22). This is some what of an approximation for wind power since in practice CUF's will vary from 20%-32%.

4	Two scenarios of benchmark prices (indicative coal power prices) have been used to estimate incremental costs. Given the high uncertainty in the future coal power prices (over 25 years), we have created two price benchmarks. These are 1) Coal power projects with a first year price of Rs 4/kWh and 4.5/kWh in 2015-16. Both these benchmarks would escalate at 2% p.a. over 25 years. Estimates for benchmark prices shown in figure 4.	These are indicative estimates/scenarios purely for the purposes of calculation. All projections are in nominal terms. These are a proxy for what DISCOMs may be willing to pay for RE power. At least 70 BU electricity of existing coal power plants have marginal cost over Rs 3/kWh (Prayas Analysis).
5	**Calculate the incremental cost per MW/kWh of RE over each of these benchmarks**	

Note: The scenarios for solar, wind and coal prices from 2015-16 to 2021-22 are not predictions or forecasts but have been only estimated (scenarios created) for the purposes of calculation under the above methodology. Actual solar, wind and coal prices should be discovered through competitive bidding processes in those years.

Figure 2: Year wise solar PV tariffs considered for analysis

Solar PV tariffs reduce between 17% - 27% in the next 7 years.

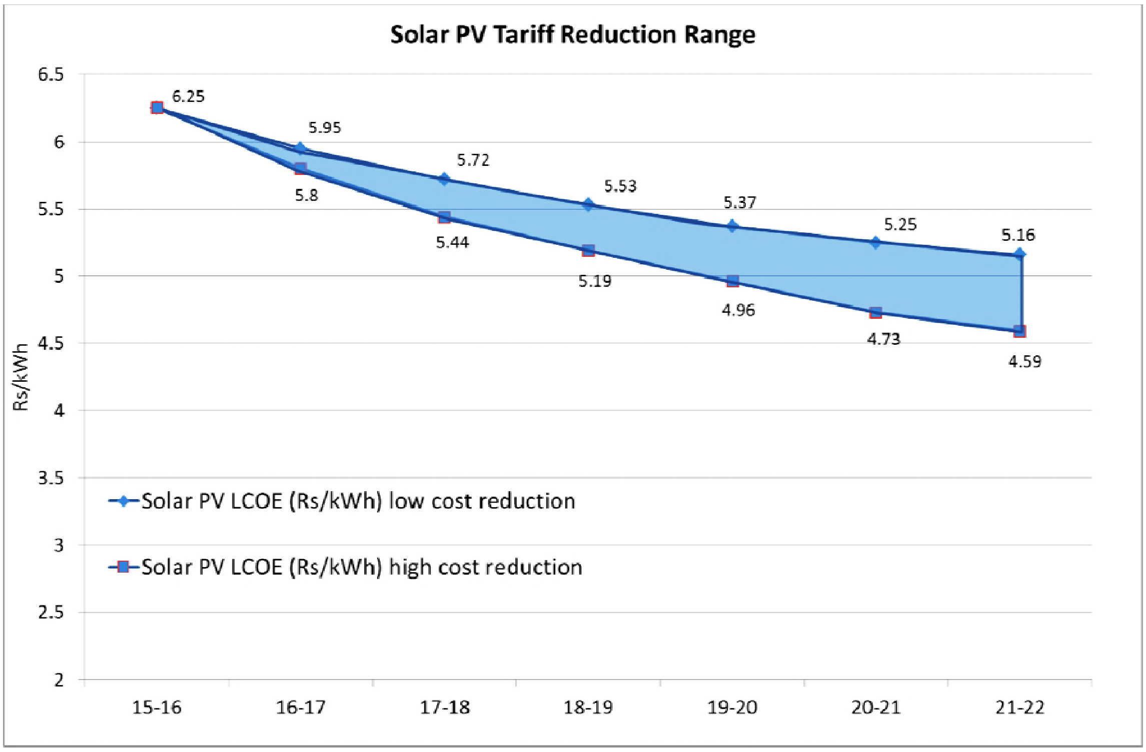


Figure 3: Year wise wind tariffs considered for analysis

Wind tariffs reduce between 6% - 11% in the next 7 years.

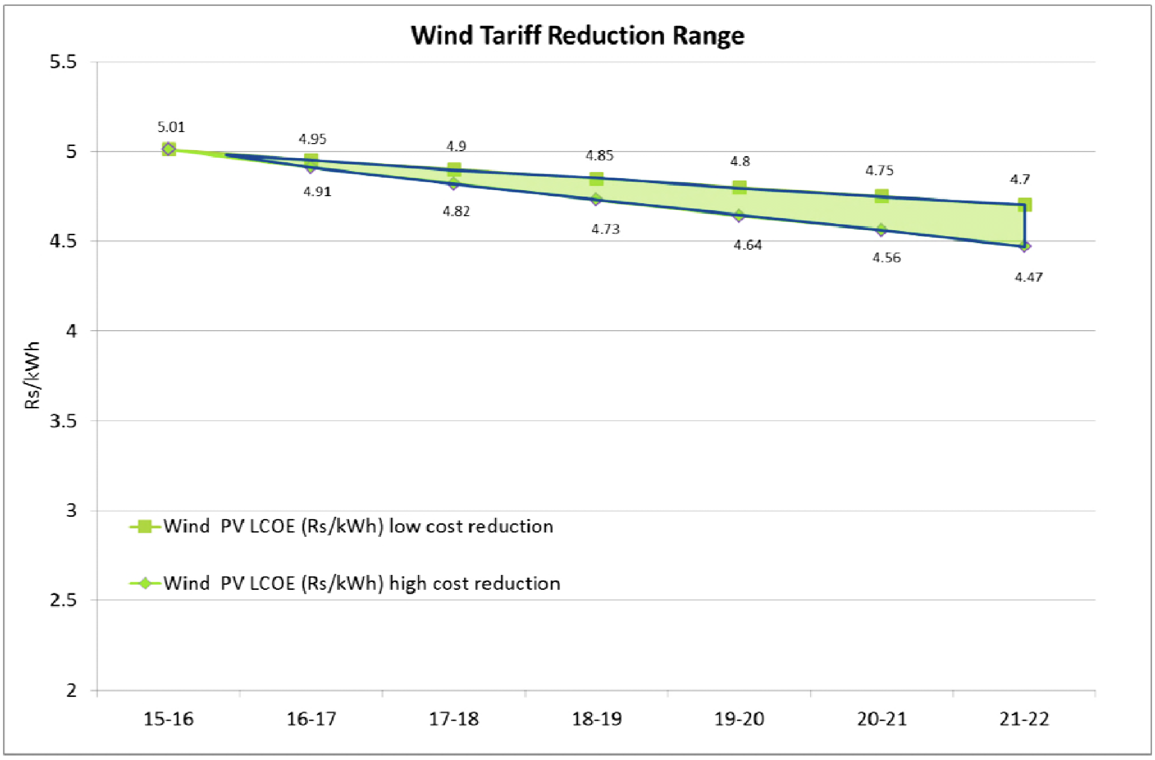
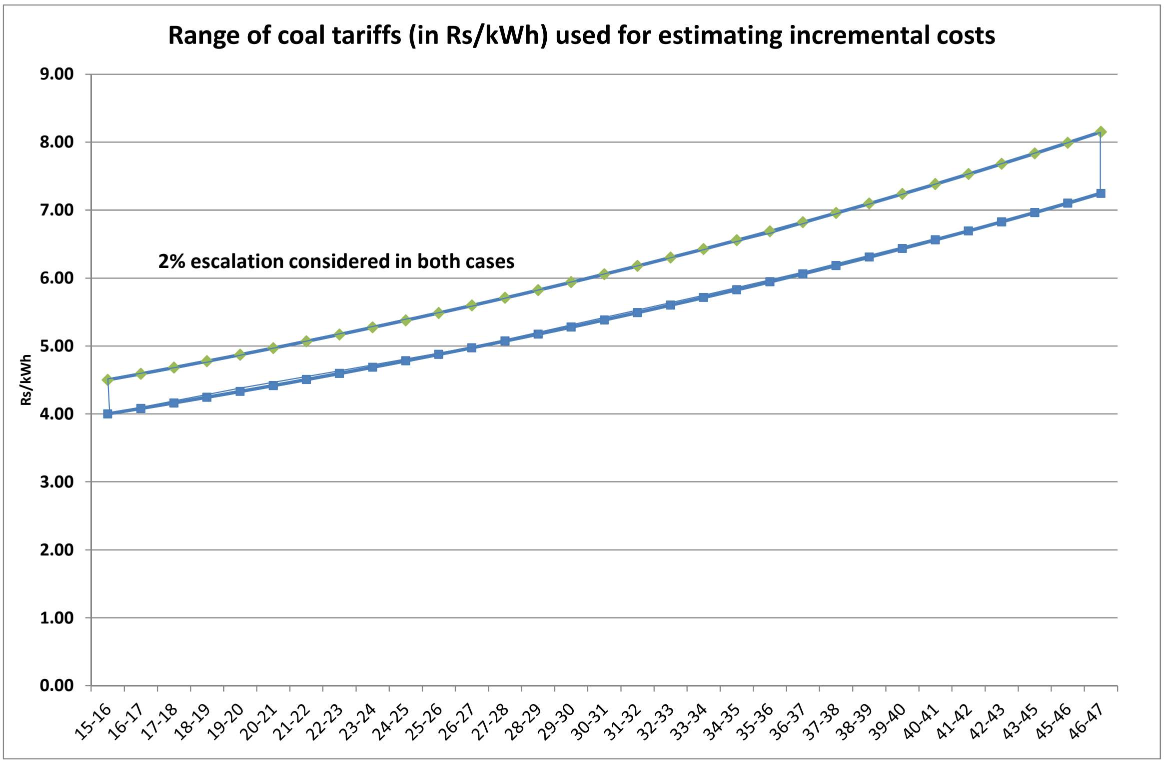


Figure 4: Year wise coal tariffs considered for analysis



The model developed by Prayas was then used to estimate incremental costs under the various scenarios of wind/solar tariffs (high and low cost reduction) and the benchmark coal tariffs (starting at Rs 4/kWh and 4.5/kWh in 2015-16 and escalating at 2% p.a.). It is important to note that these incremental cost estimates are not projections or forecasts but more of scenario based indicative estimates for the purpose of the Committee's mandate. This is unavoidable given the large uncertainty in future solar/wind/coal prices. The estimates of these incremental costs (representing the red area in figure 1) in NPV terms are shown in the table 2 and 3 for solar and wind respectively. Year wise incremental costs for solar and wind are shown in figure 5 and 6 respectively.

Table 2: Range of Incremental Costs of Solar (for 42 GW) over various coal benchmarks (Numbers are in Rs crore, NPV @ discount rate of 7.5%)

Coal power price (2015-16) bench-mark based on	Low Cost Reduction Scenario for Solar	High Cost Reduction Scenario for Solar
Rs 4/kWh, escalating at 2% p.a.	**33,598**	**13,250**
Rs 4.5/kWh, escalating at 2% p.a.	**20,320**	**7,056**

Figure 5: Range of incremental costs for 42 GW solar over two coal benchmarks

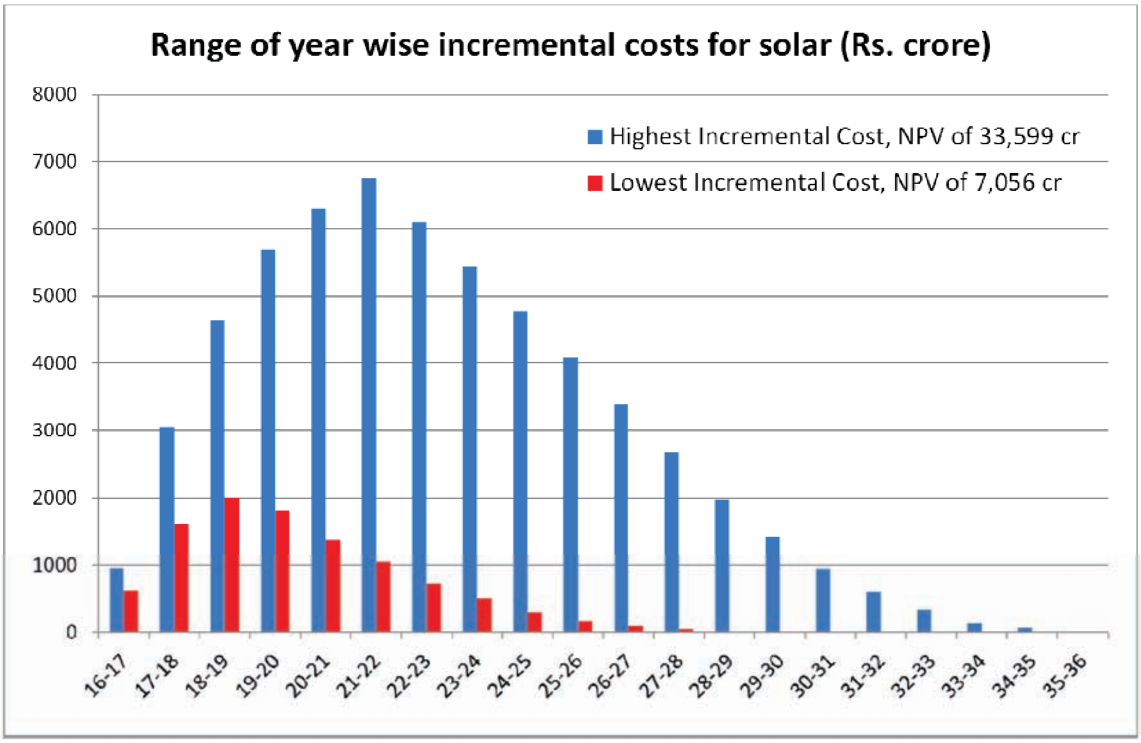
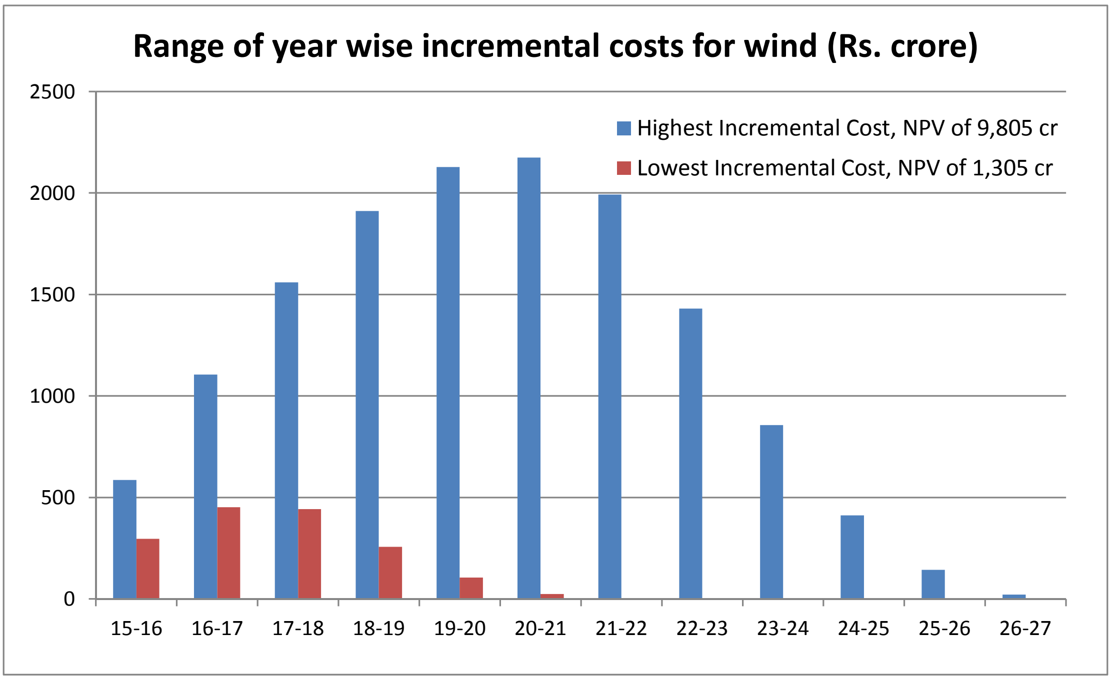


Table 3: Range of Incremental Costs of Wind (for 36.5GW) over various coal benchmarks

(Numbers are in Rs crore, NPV @ discount rate of 7.5%)

Coal power price (2015-16) bench-mark based on	Low Cost Reduction Scenario for Wind	High Cost Reduction
Rs 4/kWh, escalating at 2% p.a.	**9,805**	**1,542**
Rs 4.5/kWh, escalating at 2% p.a.	**7,811**	**1,305**

Figure 6: Range of incremental costs for 36.5 GW wind over two coal benchmarks



Tables 2-3 represent the various possible incremental costs arising from a combination of two sets of RE prices (high and low cost reduction, figure 2and 3) and two sets of coal price benchmarks (starting at Rs 4/kWh and 4.5/kWh in 2015-16 and escalating at 2% p.a.; figure 4). Year wise incremental costs (in Rs crore, represented in graphs 5-6) increase from 2016-17 for the next few years (depending on the scenario) as a combination of increasing RE capacity being deployed; its reducing price and the increasing price of coal. The decline in the later years is due to reduction in RE costs, increases in coal prices and also since for the purpose of this exercise we have only considered the 79 GW deployed till 2022.

The NPV of the incremental costs for wind and solar combined (79 GW) range from Rs 8,361 – 43,403 crores. This is based on a discount rate of 7.5% (indicative GoI bond rate).

C. Possible policy support options from Government of India:

Various policy options (facilitating actions and direct/indirect financial incentives) are available to the GoI to achieve reduction in the incremental cost of procuring RE for state DISCOMs.

a. Some of the facilitating actions that do not have a direct financial burden on GoI include

1. Bundling of solar power with (cheaper) NTPC thermal power in which solar power is sold to DISCOMs along with relatively cheaper coal power from older

NTPC plants. While the absolute cost of solar 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 GoI to states. NTPC has plans to bundle 10 GW of solar power with their cheaper coal plants and deliver the bundled power at Rs 3.2/kWh [22].

2. **Facilitating low cost and longer tenure debt**: Capital cost intensive RE technologies (wind and solar, having no fuel cost) are very sensitive to the cost of debt. Hence facilitating availability of low cost debt through green bonds[23] or passing on the low cost and longer tenure rupee or non rupee debt (including hedging cost) offered by multilaterals (World Bank, ADB etc.) / bilaterals (kfW etc.) /domestic financial institutions to developers can directly help reduce the cost of RE, thereby reducing incremental costs of procuring states.

3. **Dollar based competitive bidding**: 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). 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 yrs, 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 is not without its overall risks and hence should be explored gradually and with much due diligence. Very recently GoI has allowed NTPC and PFC to conduct dollar denominated bids for 1000 MW each and if successful, go in for another 10,000 MW each.[24] Recent news suggests that the Japanese Yen and Euro denominated bidding may also be allowed[25]. GoI does not face any direct cost as long as the rupee depreciation risk is built into the bidding process.

The first two options do not involve any direct financial implication for the GoI and hence should be followed up and exercised to the extent possible. The third option should be exercised carefully, if at all, considering the inherent risks involved.

b. Some of the direct and indirect financial incentives include

1. **Accelerated Depreciation (AD)**: Presently GoI allows 80% AD benefit for wind and solar power projects.[26] This is an indirect fiscal benefit for investors who can offset their tax liability from profit making companies. This has been a significant factor for wind power investments in the past. However given that this is a capacity linked incentive, it does not incentivize generation (better performance) nor does it incentivize reduction in capital expenditure. Another limitation is that it can

22 http://www.livemint.com/Companies/LQ6oWHAE4j4v6AjSJaZu7M/Game-of-thrones-at-NTPC.html

23 http://www.business-standard.com/article/companies/iifcl-s-credit-enhancement-debuts-with-renewable-energy-issuance-115092301088_1.html

24 http://www.thehindubusinessline.com/companies/ntpc-ptc-india-allowed-dollarlinked-tariffs-for-new-solar-projects/article7389364.ece

25 http://www.livemint.com/Industry/BHEI31Rt2grljz48ICWTZI/India-may-include-yen-along-with-dollar-euro-to-pay-for-sol.html

26 There is also an additional 20% depreciation allowed for new plant and machinery.

be availed only by profit making companies and hence poses a disadvantage for pure-play Independent Power Producers (IPPs) in the sector. Finally, one is not sure whether this fiscal incentive could be continued under the expected new Direct Tax Code. The cost to the GoI under this option is essentially the deferred income tax payments.

2. **Viability Gap Funding (VGF)**: Similar to AD, VGF is a capacity linked subsidy and hence disproportionately incentivizes developers to focus on capital cost reduction without possibly giving enough attention to long term performance. However unlike AD, VGF is a direct financial incentive requiring upfront payments from the GoI. To ensure project performance, VGF payments for solar projects are presently spread over 6 years.

3. **Generation Based Incentive (GBI)**: GBI is a fixed incentive payment for every unit of electricity generation and is spread over a number of years (~8-10). GBI scores much 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 (unlike the onetime VGF payment), thus reducing upfront pressure on budgetary allocations. Also the level of GBI per kWh can be more precisely tailored to reflect actual incremental costs (resulting from the dynamic nature of future RE and coal prices) in coming years. It allows more flexibility for policy makers (allowing for adjusting the needed level of support from GoI considering market conditions) and thus paves the way for a faster transition to full cost/ market based pricing for RE in the coming years.

4. **Interest Rate Subvention**: Under this option, the GoI directly pays a part of the interest costs to banks. This policy also allows spreading of the costs over a longer time frame (debt tenure). A limitation of this approach is that the incentive is not linked to performance.

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

The above 5 options have been explored in more detail and a Cost Effectiveness Index has been developed for them. This is detailed out in Table 4 below. While the VGF option scores the highest (if paid upfront unlike over 6 yrs as is the existing practice), it does not inherently incentivize performance and front-loads all the needed Government budgetary support. To ensure that Government support is spread over a longer time frame, we have analyzed the more appropriate options of interest subvention and GBI in much more detail.

Table 4: Financial cost effectiveness for various GoI policy instruments for 1 MW solar PV installed in 2016-17

1 MW Solar PV installed in 2016-17	Capital Expenditure	Interest Rate	DSCR Min	DSCR Avg	Project IRR post Tax	Equity IRR post Tax	LCOE	Tariff Reduction in LCOE	Absolute Cost reduction for procurer over 25 yrs	Direct Incentive payment from GoI	Income Tax Paid by project	Income Tax loss for GoI	Indirect Income Tax loss for GoI due to AD benefit	Total Cost to GoI	Cost Effectiveness
Units	**Rs Lakh**	**%**			**%**	**%**	**Rs/ kWh**	**Rs/ kWh**	**Rs Lakh (NPV)**	**Rs Lakh (NPV)**	**Rs Lakh (NPV)**	**Rs Lakh (NPV)**	**Rs Lakh (NPV)**	**Rs Lakh (NPV)**	**(L/O)**
Baseline	546	12	1.07	1.45	12.79	14.17	**5.81**	-		-	87.5	-	-	-	-
Accelerated Depreciation (1)	546	12	0.97	1.30	12.69	14.56	**5.26**	0.55	107	0	65.7	21.84	76.59	98.43	**1.09**
Generation Based Incentive (2)	546	12	1.07	1.45	12.79	14.17	**5.22**	0.59	115	103	87.54	0	-	102.6	**1.12**
Interest Subvention	546	6.5	1.25	1.52	10.59	14.82	**5.20**	0.61	119	93	78.86	8.68	-	101.6	**1.17**
Back loading RE Tariffs with interest subvention (3)	546	6.5	1.07	1.61	10.55	14.38	**5.20**	0.61	119	93	85	2.54	-	95.46	**1.25**
Viability Gap Funding (4)	450	12	1.09	1.46	12.84	14.32	**5.00**	0.81	158	96	71.1	16.44	-	112.44	**1.41**

1. Will need loan moratorium to improve DSCR in first 1-2 yrs.
2. GoI pays GBI over 8 years @ Rs 1/kWh; making the effective LCOE for the procurer Rs 5.22/kWh. From the developers point of view, there is no difference in income streams and hence on IRR/DSCR etc.
3. Combination of interest subvention and back loaded RE tariff. First year tariff of Rs 4.5/kWh; 3.2% esc for 12 yrs, 13-25 fixed at Rs 5.2/kWh. This tariff stream is equal to a levelized tariff of 5.2/kWh.
4. This calculation assumed that total VGF is paid up front. Actual VGF policy in vogue for solar is for payments over 6 years to ensure performance of the project and hence this analysis over estimates the actual cost-effectiveness.

D. Generation Based Incentive (GBI) Scenarios for solar and wind power.

We have assumed GBI payments for 8 years for each project. For a project commissioned in 2015-16, payments would be made from 2015-16 to 2023-24 at fixed level of GBI; for projects commissioned in 2016-17 payments would be from 2016-17 to 2024-25 at a fixed but lower scale of GBI. The scale of the GBI (in Rs/ kWh) was estimated for each year and for each technology so that the NPV of the incremental cost under various scenarios (shown in graphs 5-6) would match the NPV of the GBI payments stream. Figure 7 and 8 show the year wise scale of GBI for wind and solar under the scenarios of highest and lowest incremental costs. ***Note: These estimates for GBI are only indicative in nature for the purposes of the Committee's mandate and are not predictions or forecasts. Actual GBI payments would differ and should be based on the then prevailing solar, wind and coal prices which should be discovered through competitive bidding.***

Figure 7: Year wise solar GBI estimates for highest and lowest incremental cost scenarios

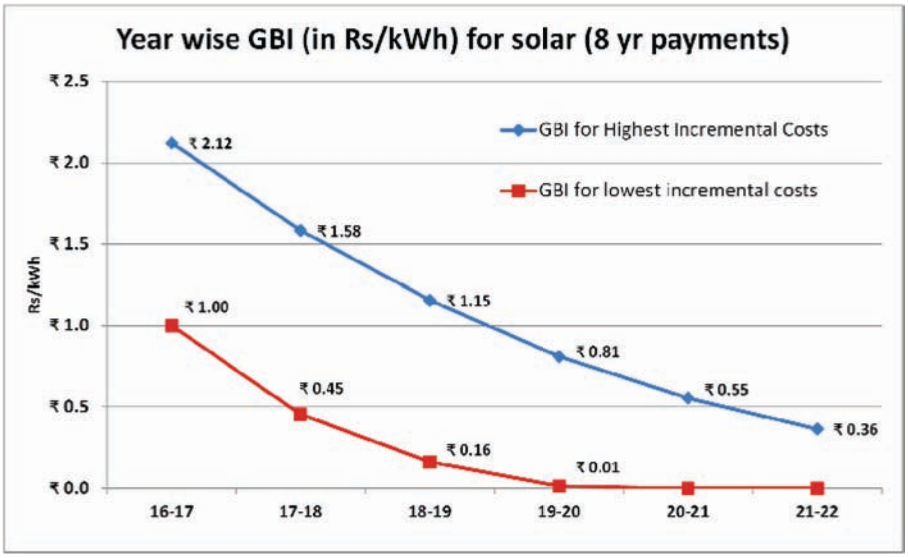


Figure 8: Year wise wind GBI estimates for highest and lowest incremental cost scenarios

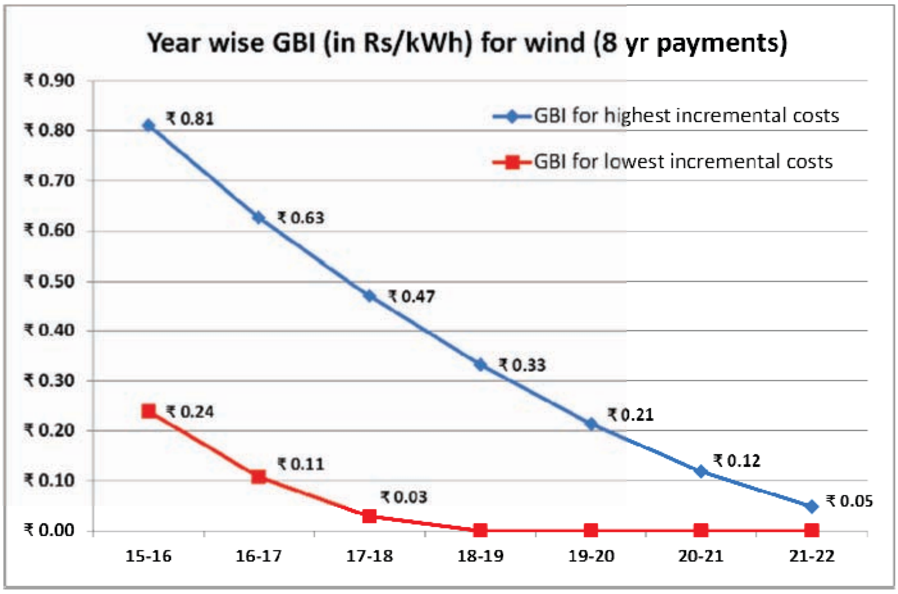


Figure 9: Annual Solar GBI payments (for 42 GW) for highest and lowest incremental cost scenarios

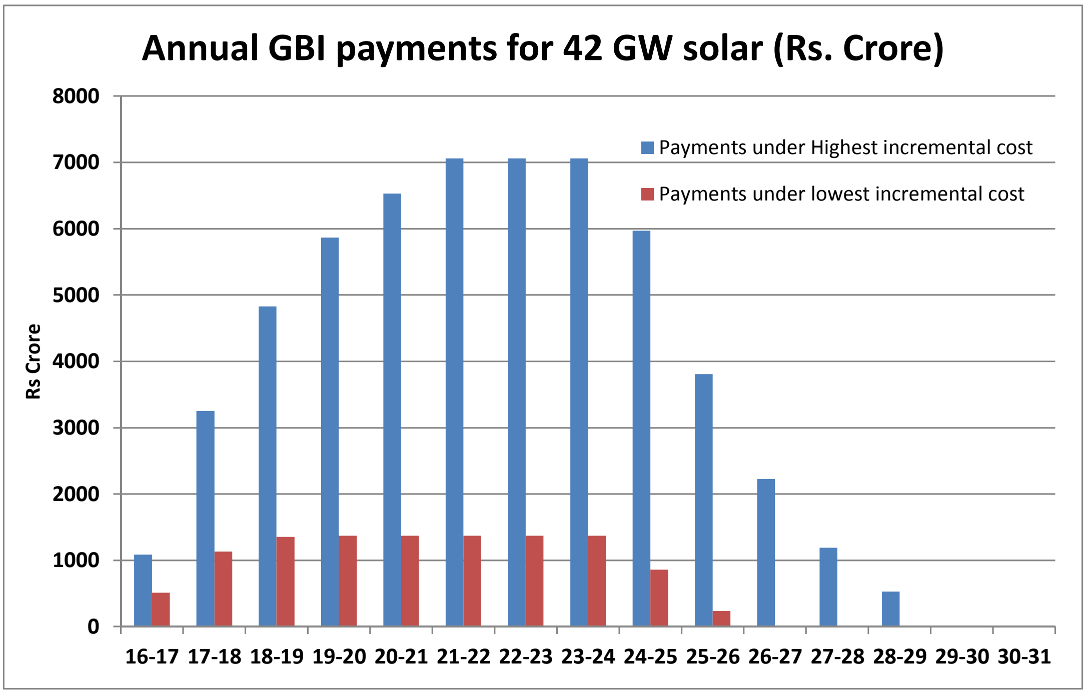
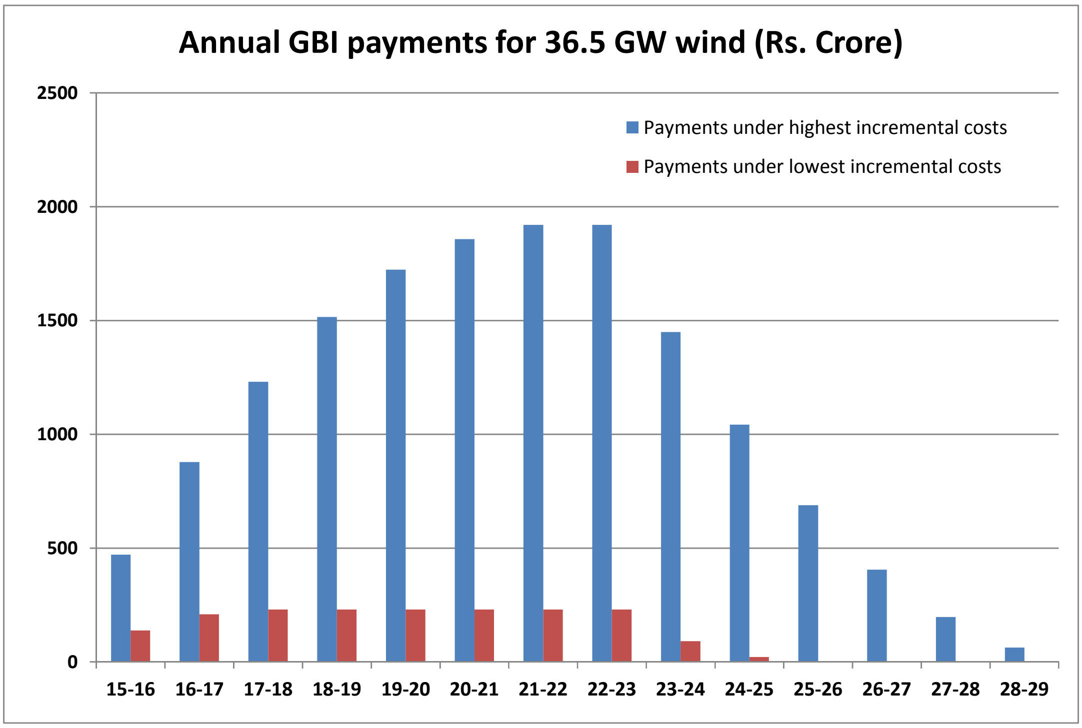


Figure 10: Annual Wind GBI payments (36.5 GW) for highest and lowest incremental cost scenarios



Annual GBI payments for solar and wind power are shown in figures 9 and 10 respectively. If one were to consider the worst case from the point of view of the budgetary exposure to the GoI (highest incremental cost from low coal prices (Rs 4/kWh in 2015-16 escalating at 2% p.a.) and low cost reduction in RE), then the following picture emerges in terms of GBI. Year wise GBI per kWh reduces from Rs 2.12/kWh to 0.36/kWh from 2015-16 to 2021-22 in case of solar PV, while for wind power it starts with Rs 0.81/kWh and practically gets eliminated (Rs 0.05/kWh) in 2021-22. (See Figure 7-8 below). The absolute payments to be made by GoI for wind and solar combined begin with Rs 471 crore in 2015-16, rise to a high of ~Rs 9,000 cr in 2021-22 and sharply come down thereafter ending with Rs 592 cr in 2028-29. The NPV of the total payments under this scenario would be Rs 43,403 crore. To put these numbers in context, the yearly inflow of funds into the National Clean Energy fund in 2015-16 is likely to be 13,180 crore [27]; and possibly Rs 20,000 crore by 2020 if coal production (1 billion tonnes by 2020) and uptake goes as per plans.

If one were to consider the best case from the point of view of the budgetary exposure to the GoI (lowest incremental costs, i.e. higher coal prices and high cost reduction in RE), then the following picture emerges in terms of GBI. Year wise GBI per kWh reduces from Rs 1/kWh to 0.01/kWh from 2016-17 to 2019-20 in case of solar PV, while for wind power it starts with a mere Rs 0.24/kWh and practically gets eliminated (Rs 0.03/kWh) in 2017-18. This means that grid parity for solar PV with respect to higher estimate of coal power (Rs 4.5/kWh in 2015-16, esc at 2% p.a.) will be achieved by 2020 and for wind power by 2018. The absolute payments to be made by GoI for wind and solar combined begin with Rs 296 crore in 2015-16, rise to a high of Rs 1611 cr in 2018-19, plateau for the next few year and sharply come down thereafter ending with Rs 18 cr in 2026-27. The NPV of the total payments for 79 GW to be deployed over 7 years under this scenario would be Rs 8,361 crore (~ one fourth of the worst case scenario). This is significantly lower than the total collection expected in NCEF through the coal cess in 2015-16 alone.

E. Interest Subvention Scenarios for solar and wind power

The scale of the interest subvention (in % of the interest to be borne by GoI) was estimated for each year and for each technology so that the NPV of the incremental cost under various scenarios (shown in graphs 5-6) would match the NPV of the interest subvention payments stream. Tables 5-6 below show the scale of the interest subvention required to offset the highest and lowest incremental cost scenarios.

Table 5: Interest Rate Subvention need to offset incremental costs for solar

Year	Highest Incremental Cost Scenario			Lowest Incremental Cost Scenario		
	Solar Tariffs without interest Subvention (interest at 12%)	Interest Subvention Needed to offset incremental Cost	Solar Tariffs after interest Subvention	Solar Tariffs without interest Subvention (interest at 12%)	Interest Subvention Needed to offset incremental Cost	Solar Tariffs after interest Subvention
2015-16	**6.25**	**12.0%**	**4.83**	**6.25**	**12.0%**	**4.83**
2016-17	**5.95**	**12.0%**	**4.61**	**5.8**	**5.9%**	**5.15**
2017-18	**5.72**	**9.6%**	**4.69**	**5.44**	**2.9%**	**5.14**
2018-19	**5.53**	**7.3%**	**4.78**	**5.19**	**1.1%**	**5.08**
2019-20	**5.37**	**5.3%**	**4.84**	**4.96**	**0.1%**	**4.94**
2020-21	**5.25**	**3.7%**	**4.88**	**4.73**	**0.0%**	**4.72**
2021-22	**5.16**	**2.5%**	**4.92**	**4.59**	**0.0%**	**4.57**

27 http://164.100.47.132/LssNew/psearch/QResult16.aspx?qref=14692

Table 6: Interest Rate Subvention need to offset incremental costs for wind

Year	Highest Incremental Cost Scenario			Lowest Incremental Cost Scenario		
	Wind Tariffs without interest Subvention (interest at 12%)	Interest Subvention Needed to off-set incremental Cost	Wind Tariffs after interest Subvention	Wind Tariffs without inter-est Subven-tion (interest at 12%)	Interest Sub-vention Needed to offset incre-mental Cost	Wind Tariffs after interest Subvention
2015-16	**5.01**	**4.2%**	**4.59**	**5.01**	**1.3%**	**4.89**
2016-17	**4.95**	**3.2%**	**4.63**	**4.91**	**0.6%**	**4.86**
2017-18	**4.9**	**2.4%**	**4.66**	**4.82**	**0.1%**	**4.80**
2018-19	**4.85**	**1.7%**	**4.68**	**4.73**	**0.0%**	**4.73**
2019-20	**4.8**	**1.1%**	**4.69**	**4.64**	**0.0%**	**4.64**
2020-21	**4.75**	**0.6%**	**4.69**	**4.56**	**0.0%**	**4.56**
2021-22	**4.7**	**0.0%**	**4.7**	**4.47**	**0.0%**	**4.47**

Figure 11: Annual Interest Subvention payments for 42 GW Solar for highest and lowest incremental cost scenarios

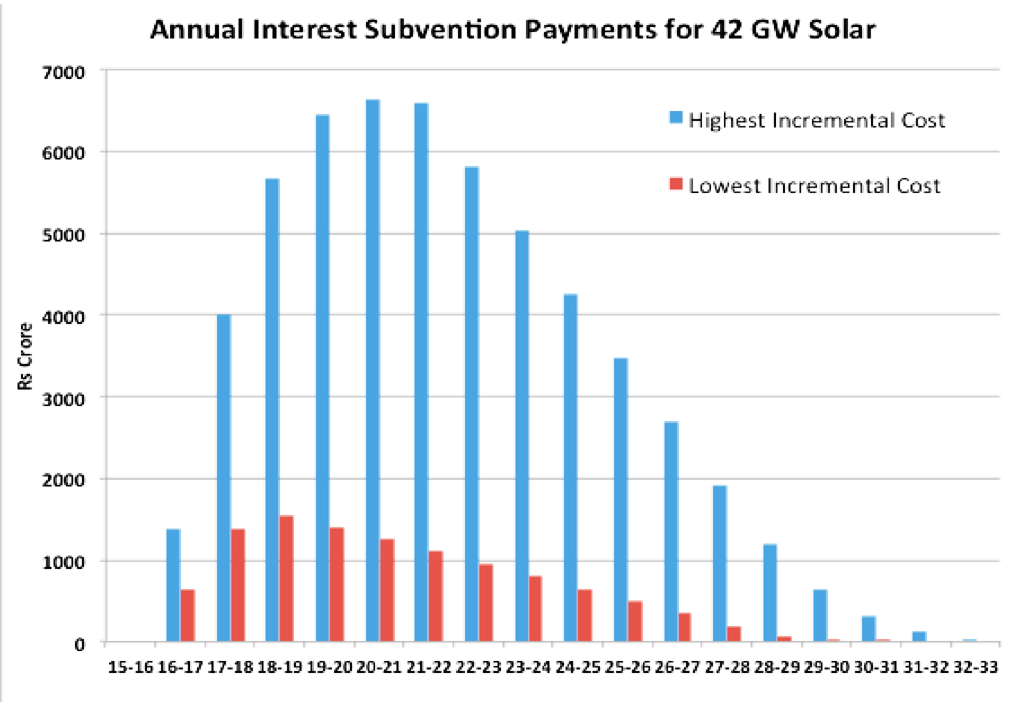
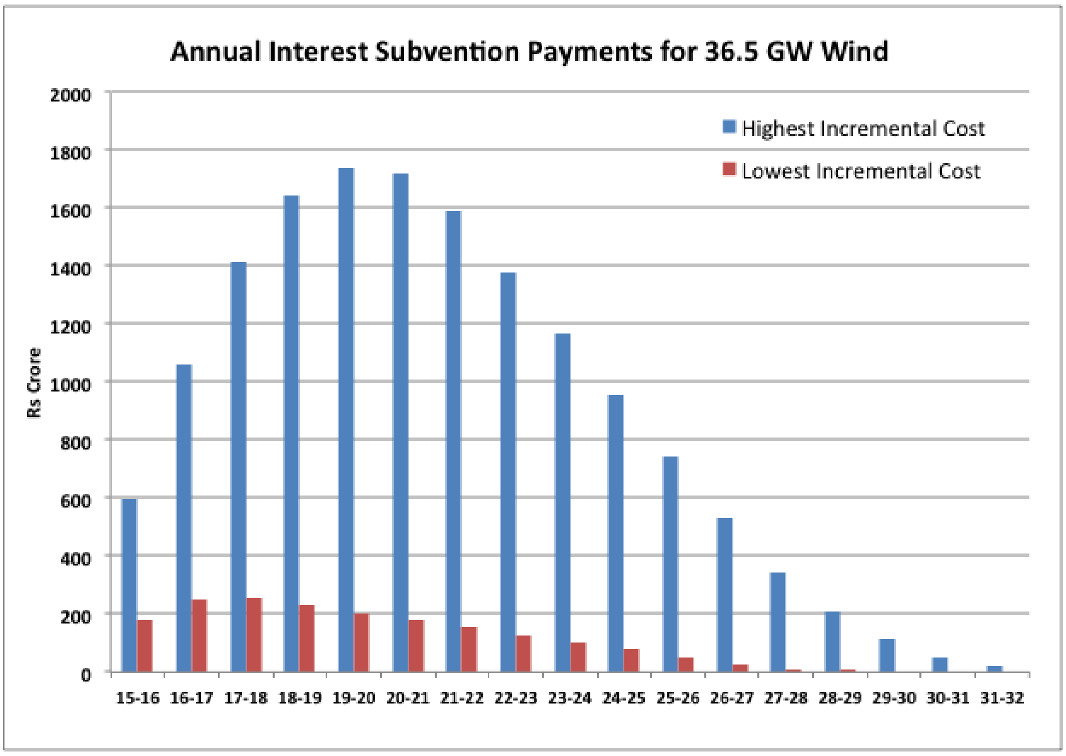


Figure 12: Annual Interest Subvention payments for 36.5 GW Wind for highest and lowest incremental cost scenarios



The annual payments arising from these interest subventions are shown in figures 11-12.

If one were to consider the worst case from the point of view of the budgetary exposure to the GoI (highest incremental cost from low coal prices (Rs 4/kWh in 2015-16 escalating at 2% p.a.) and low cost reduction in RE), then the following picture emerges. Year wise interest subvention reduces from 12% to 2.5% from 2015-16 to 2021-22 in case of solar PV, while for wind power it starts with 4.2% and practically gets eliminated (~0%) in 2021-22. The absolute payments to be made by GoI for wind and solar combined begin with Rs 599 crore in 2015-16, rise to a high of ~Rs 8,359 cr in 2020-21 and sharply come down thereafter ending with Rs 33 cr in 2032-33.

If one were to consider the best case from the point of view of the budgetary exposure to the GoI (lowest incremental costs, i.e. higher coal prices and high cost reduction in RE), then the following picture emerges. Year wise interest subvention starts from 12% in 2015-16 and get eliminated by 2019-20 in case of solar PV, while for wind power it starts with a mere 1.3% and practically gets eliminated (0.1%) in 2017-18. This means that grid parity for solar PV with respect to higher estimate of coal power (Rs 4.5/kWh in 2015-16, esc at 2% p.a.) will be achieved by 2019 and for wind power by 2017. The absolute payments to be made by GoI for wind and solar combined begin with Rs 177 crore in 2015-16, rise to a high of Rs 1768 cr in 2018-19, ending by 2030-31.

F. Conclusions:

1. The incremental costs for wind and solar combined (79 GW) range from Rs 8,361 – 43,403 crores (NPV@ 7.5%) based on the scenarios of solar/wind price reduction and coal power price increase.

2. Various policy options (facilitating actions and direct/indirect financial incentives) are available to the GoI to achieve reduction in the incremental cost of procuring RE for state DISCOMs. Some of the facilitating actions include a) bundling with cheaper thermal power, b) facilitating low cost and longer tenure debt, c) dollar-denominated bidding. The first two options do not involve any direct financial implication for the GoI and hence should be followed up and exercised to the extent possible. The third option should be exercised carefully, if at all, considering the inherent risks involved.

3. Some of the direct and indirect financial incentives include a) Accelerated Depreciation, b) Viability Gap Funding (VGF), c) Generation Based Incentive (GBI), d) Interest Rate Subvention and e) Back-loaded RE tariffs + interest subvention/soft loan. The cost effectiveness of all these five options has been detailed out in Table 5.

4. The limitations of AD and VGF are well known and have been documented in section C (b). Hence the policy options of GBI and interest subvention are the more preferred options and have been considered for a more in depth analysis (Section D & E). These options allow for spreading of the costs over a longer time frame and GBI has the added advantage of directly incentivizing generation. The estimates for GBI and interest subvention shown below are only indicative and not projections, forecasts or recommendations for actual scale of GBI/interest rate subvention. Actual values of GBI/interest rate subvention should be determined in a dynamic way (from year to year) considering the actual discovered costs of solar/wind/coal from competitive bidding processes in those years.

5. Considering the scenario of highest incremental costs, year wise GBI per kWh reduces from Rs 2.12/kWh to 0.36/kWh from 2015-16 to 2021-22 in case of solar PV, while for wind power it starts with Rs 0.81/kWh and practically gets eliminated (Rs 0.05/kWh) in 2021-22. The absolute payments to be made by GoI for wind and solar combined begin with Rs 471 crore in 2015-16, rise to a high of ~Rs 9,000 cr in 2021-22 and sharply come down thereafter ending with Rs 592 cr in 2028-29. The NPV of the total payments under this scenario would be Rs 43,403 crore.

6. Considering the scenario of highest incremental costs, year wise interest subvention reduces from 12% to 2.5% from 2015-16 to 2021-22 in case of solar PV, while for wind power it starts with 4.2% and practically gets eliminated (~0%) in 2021-22. The absolute payments to be made by GoI for wind and solar combined begin with Rs 599 crore in 2015-16, rise to a high of ~Rs 8,359 cr in 2020-21 and sharply come down thereafter ending with Rs 33 cr in 2032-33.

To put these numbers in context, the yearly inflow of funds into the National Clean Energy fund in 2015-16 is likely to be 13,180 crore [28]; and possibly Rs 20,000 crore by 2020 if coal production (1 billion tonnes by 2020) and uptake goes as per plans.

28 http://164.100.47.132/LssNew/psearch/QResult16.aspx?qref=14692

ANNEXURE 3: ANALYSIS 2 - RENEWABLE ENERGY (RE) GENERATION COSTS[29]

The primary objective of this chapter is to calculate the cost of government support needed to achieve India's renewable energy deployment targets, and to identify the most cost-effective policy mechanisms the government can use to support renewable energy. Since government support is required when renewable energy is more expensive than the fossil fuel it would replace – i.e., the baseline fossil fuel, which is coal – we calculate the cost of government support by comparing the levelized cost of electricity from renewable energy to the levelized cost electricity from baseline fossil fuel.

1 METHODOLOGY

The levelized cost of electricity (LCOE) represents the average cost of generating energy over the life cycle of a project. At a conceptual level, it is calculated as the net present value of the total costs over a project's life cycle, divided by the total amount of energy produced over the life cycle. It enables comparison of the cost of energy across different technologies, particularly when capital cost, scale, and project life differ ().

A representative formula for calculating the LCOE is (Shrimali et al., 2013):

$$lc = \frac{C - \alpha \sum_{t=1}^{T} \frac{D_t}{(1+r)^t} + (1-\alpha) \sum_{t=1}^{T} \frac{W_t}{(1+r)^t} - (1-\alpha) \frac{C_T}{(1+r)^T}}{(1-\alpha) * 8760 * \sum_{t=1}^{T} \frac{CF_t * x_t}{(1+r)^t}}$$

where lc: LCOE; T: the life of project, C: capital expenditure (or CAPEX); D: depreciation; W: operating expenditure (or OPEX); CT: terminal value; α: tax rate; CF: capacity factor (i.e., plant load factor); x: degradation factor; and r: cost of capital. The cost of capital is derived under the assumption that projects would maximize (optimize) leverage.

To calculate the cost of government support needed for renewable energy, we began by forecasting the LCOE for three technologies up to 2022: utility-scale wind power and solar power, which are the dominant renewable energy technologies, and the baseline fossil fuel-based power plant. The levelized cost of electricity from the baseline fossil fuel serves as the baseline cost of electricity. We then calculated the amount of policy support required to reduce the LCOE from renewable energy so that it is competitive with the baseline LCOE.

2 STEPS AND ASSUMPTIONS

The steps for calculating the cost of government support for renewable energy are:

1. Calculate the unsubsidized LCOEs of solar power plants that will be commissioned from 2015-16 to year 2021-22. To calculate the LCOE of renewable power, we used the LCOE formula above, with inputs for key assumptions, namely capital cost, capacity utilization factor, return on equity, and debt rate are consistent with the rest of this report. The table below summarizes our parameter assumptions.

29 Led by Gireesh Shrimali, with support from Saurabh Trivedi, Climate Policy Initiative, and calculations carried out on tariff calculator developed by Climate Policy Initiative (CPI)

Assumptions	Wind	Solar
POWER GENERATION		
Capacity Utilization Factor (P50 PLF)	25% in 2015, and increasing by 0.5% per year.[30]	20%
Useful Life	25 Years	25 Years
CAPITAL COST		
Capital Cost (INR million/MW)	From table below	From table below
OPERATING EXPENSES		
O & M Expenses(1st Year)	INR 1.01 million/MW	INR 1.23 million/ MW
Fuel Cost Expenses (1st Year) including transporta-tion cost	NA	NA
Escalation in O & M Expenses	5.72%	5.72%
Escalation in Fuel Cost and Transportation Cost	NA	NA
FINANCING ASSUMPTIONS		
Minimum Debt Service Coverage Ratio (DSCR)[31]	1.3	1.3
P90 PLF[32] (Debt condition)	22.5% in 2015, and increasing by 0.5% per year.	19%
DEBT TERMS		
Repayment Period	12 years	12 years
Interest Rate (Fixed)	12%	12%
EQUITY		
Expected Return on Equity (Post Tax)	16%	16%
TAX INCENTIVES		
Tax Holiday	10 years	10 years
Minimum Alternative Tax	20%	20%

The capital cost series which we used in our LCOE calculations, which is consistent with the rest of this report:

Year	15-16	16-17	17-18	18-19	19-20	20-21	21-22
Solar PV Capex (INR crores/MW) low cost reduction	6.00	5.64	5.36	5.14	4.94	4.79	4.69
Solar PV Capex (INR crores/MW) high cost reduction	6.00	5.46	5.02	4.72	4.44	4.17	4.00
Wind Capex (INR crores/MW) low cost reduction	6.19	6.25	6.31	6.38	6.44	6.51	6.57
Wind Capex (INR crores/MW) high cost reduction	6.19	6.19	6.19	6.19	6.19	6.19	6.19

2. Calculate the levelized tariff of the baseline cost of electricity, which is the LCOE of the baseline fossil fuel. To calculate the LCOE of a fossil-fuel power plant, we took the yearly escalating coal tariffs that are consistent with the rest of this report and levelized them using the corresponding cost of capital. [33]

30 The 0.5% per year increase is based on linear interpolation between 2015 and 2022. CUF would be 25% for the wind power plants commissioned in 2015 and would increase by 0.5% every year for the plants to be commissioned in the subsequent years.

31 DSCR (in any year) is the ratio of cash flow available for debt servicing to the sum of interest and principal.

32 P50 PLF represents the most likely output of the plant, while P90 PLF is a conservative estimate. For wind, based on conversations with stakeholders, we assumed P90 PLF = CUF (Wind) - 2% and for solar, we assumed it to be CUF (Solar) – 1.5%.

33 The discount rate used to calculate the LCOEs is the cost of capital (WACC) of a typical coal plant (Cost of equity of a coal plant = 15%; Cost of debt = 12%; D/E = 75%; Corporate Tax = 33%)

3. Calculate the cost of support for existing (AD [34], GBI, and VGF) and debt-based subsidies. The cost of support refers to the required government net cash outflow to bridge the gap between the unsubsidized levelized cost of renewable energy and the baseline cost of electricity from imported coal.

Formula used to calculate the cost of support

In previous work (Shrimali et al., 2014), we found that 100% support by state-level feed-in tariffs is the least cost-effective policy, and that the total cost of support decreases as federal policies cover more of the viability gap between the unsubsidized levelized cost of renewable energy and the fossil fuel baseline.

Thus, for any federal policy, the most cost-effective approach is to cover as much of the viability gap through federal policies as possible. Further, ensuring that the net present value of the cash flows for the state equals zero, ensures that states would be neutral in terms of buying renewable energy or fossil fuel energy.[35]

So, we assumed that federal support is maximized, and that the viability gap is not fully covered by the federal policy under consideration is supported by GBI, so that:

Cost of support[36] = Cash flow for federal policy under investigation (existing or debt-based)

+

Cash flow for GBI (so that the remaining viability gap is covered)

We calculated the cost of support in three different forms:

Total (net present value of the) cost of support: To measure and compare the cost effectiveness of various policy options, we used the total cost of support as our key metric, which indicates the net present value (to 2015) of all the government cash flows over the project life for all project capacities to be commissioned each year until the unsubsidized LCOE of renewable power becomes cheaper than the baseline cost of electricity.

Yearly undiscounted (nominal) cost of support: The nominal cost of support indicates the net annual cash outflow for the federal government in nominal terms, i.e. without discounting for the time value of money. It is calculated as the sum of net cash outflows for projects deployed in a particular year, as well as continuing obligations for projects deployed in previous years, starting from 2015.

While the total cost of support includes the effect of future cash flows over a project's life cycle from the provision of a subsidy, the nominal cost of support only measures the net cash outflow for the government at a particular point of time. The nominal cost of support is instructive from a budgetary perspective in showing government cash flow profiles for each year. However, it does not facilitate a fair comparison of the cost-effectiveness of policies since it does not take into account all the costs over a project's life cycle, which is the focus of the total cost of support.

34 AD is the benefit (outflow or the cost of support) that a project developer gets on its company level (not at the project level SPV) financial statements and hence its calculation will be done at company level to arrive at the cost of support under AD policy

35 We assumed that our goal – making the net present value of state support zero – is equivalent to equating the subsidized LCOE of renewable energy and derived LCOE of fossil energy. Given the differences in the cost of capital for the government and fossil fuel plant, our numbers are likely to be over-estimated.

36 Ideally, the cost of support should include the difference in tax collections between a renewable energy plant and the baseline fossil fuel plant. However, these calculations tend to be somewhat complex, and are likely to be second-order, and therefore have been excluded.

Yearly (net present value of the) cost of support: Defined as the net present value (NPV) of the cost of support for capacity deployed in a particular year (only). For example, the yearly NPV for 2016 would be the NPV of the cash flows of the government for all the projects commissioned in 2016. The rationale of using this metric is to compare the federal policy support in terms of their yearly NPV profiles.

Note: Given that yearly profiles have a lot of variation over time among policies, as we discover later on, the only objective comparison is one based on the total cost of support.

Methodological Assumptions

We used the **government discount rate** to discount the nominal cost of support: 7.5% for existing policies, to reflect the government's cost of borrowing; and 10% for debt-related policies, to also reflect the project risk premium.

We used an **optimized leveraged cash flow model.** That is, we assumed that, given any tariff, the project developer would maximize debt to maximize the returns on equity (Shrimali et al., 2014). This optimization is typically subject to a minimum debt service coverage ratio condition of 1.3 and ROE of 16% (post-tax) for the entire course of a renewable energy project.

The **generation-based incentive (GBI)** has been assumed to be paid in equal amounts for eight years for all the renewable energy plants commissioned in the same year.

Viability Gap Funding (VGF) is assumed to be fully disbursed in the first year of the operation of the renewable energy plant.

Under the **accelerated depreciation (AD)** scheme, we have assumed up to 100% AD during the first year of operation, wherever required.

Under the **interest subvention (IS)** scheme, the federal government would service a part of the interest obligation of a project, by directly making a partial interest payment to the bank for a commercial loan. We have assumed that there is no upper cap on the interest subvention, such that an equivalent debt rate of 0% is possible. Many of the schemes under discussion, including the $-tariff scheme, fall under this category.

Under the **reduced cost debt (RCD)** policy, the federal government would facilitate the availability of low cost debt for the renewable energy project developers. We have assumed that the cost of debt can be as low as 0%.

Under **extended tenor debt (ETD)** policy, the federal government would facilitate the availability of longer term debt for the renewable energy project developers. We have assumed maximum debt tenure of 20 years to bridge the viability gap between LCOEs of renewables and fossil fuel power.

Note: In cases where a particular policy support is unable to bridge the viability gap between the LCOE of renewable energy and coal-based power, an additional support in the form of GBI is provided, such that the viability gap is zero – i.e., LCOEs of renewable energy and fossil fuels are equal.

3 RESULTS AND DISCUSSION

We calculated the cost of government support for wind and solar power under two scenarios, based on forecasts: a best case scenario, where the LCOE for renewable energy is low while the LCOE for fossil fuels is high, leading to low government support required; and the worst case scenario, where the LCOE for renewable energy is high and the LCOE for fossil fuels is low, leading to a high government support required.

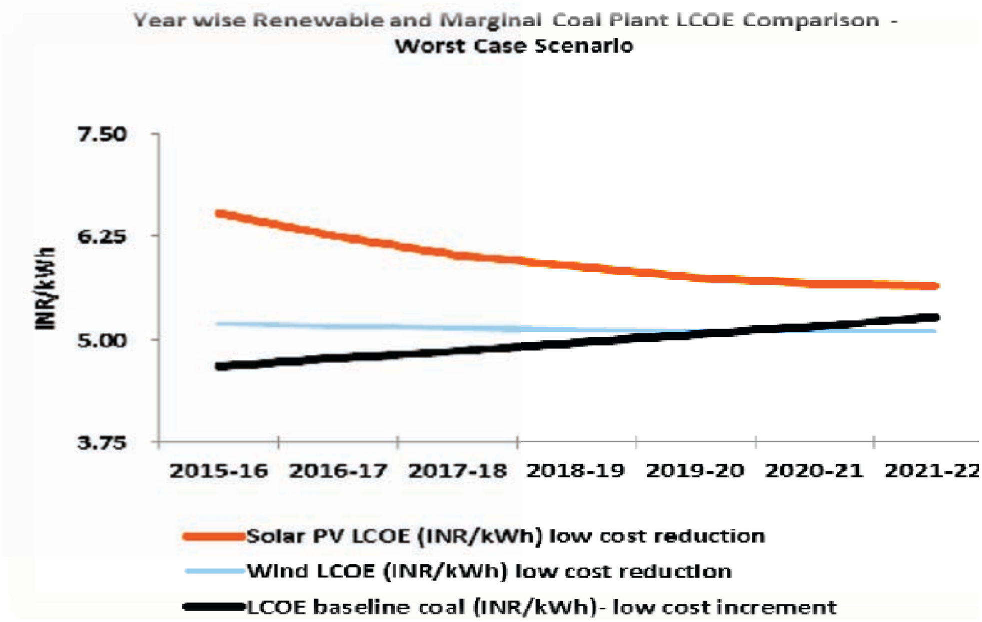
We first compare the LCOEs of renewable energy with that of the baseline coal-based power under the worst and best case scenarios. We then present the yearly undiscounted (nominal) cost of support and the total (NPV of) cost of support. The yearly (NPV of the) cost of support in presented the Appendix. We end this section with the cumulative annualized cost of support to allow comparison in terms of undiscounted cash flows.

3.1 COMPARING THE LEVELIZED COST OF RENEWABLE ENERGY WITH THE BASELINE

By comparing the levelized costs of electricity from solar and wind power to a baseline of the levelized cost of electricity from coal, we can then estimate the cost of government support required to meet its renewable energy targets.

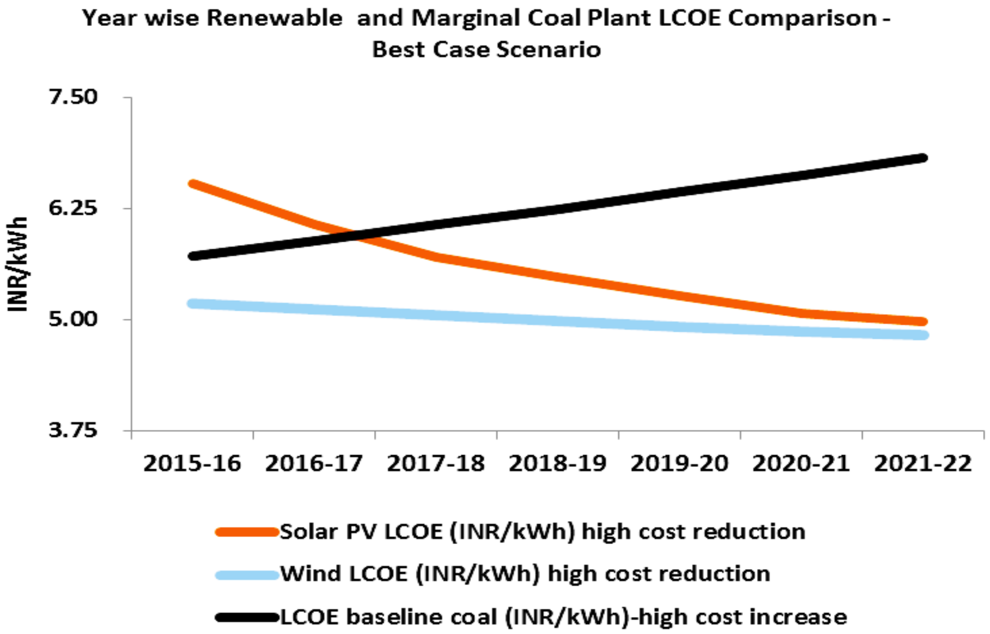
Worst case scenario

Under the worst case scenario, the LCOE of solar power would remain more expensive than the LCOE of coal beyond 2022. Therefore, it would require continued government support through 2022. The LCOE of wind power would become cheaper than that of coal in 2019-20, and would therefore only require government support until 2019-20. In 2015-16, the LCOEs of solar and wind power would be 40% and 11% more expensive than that of baseline coal, respectively.



Best case scenario

Under the best case scenario, the LCOE of solar power would become cheaper than the LCOE for baseline coal after 2016-17. Hence, solar power projects would not require government support after 2016-17. The LCOE of wind power would already be cheaper than that of coal power. Hence, wind power projects would not require any government support under the best case scenario. In 2015-16, the LCOE for solar power would be 14% more expensive than that of baseline coal.

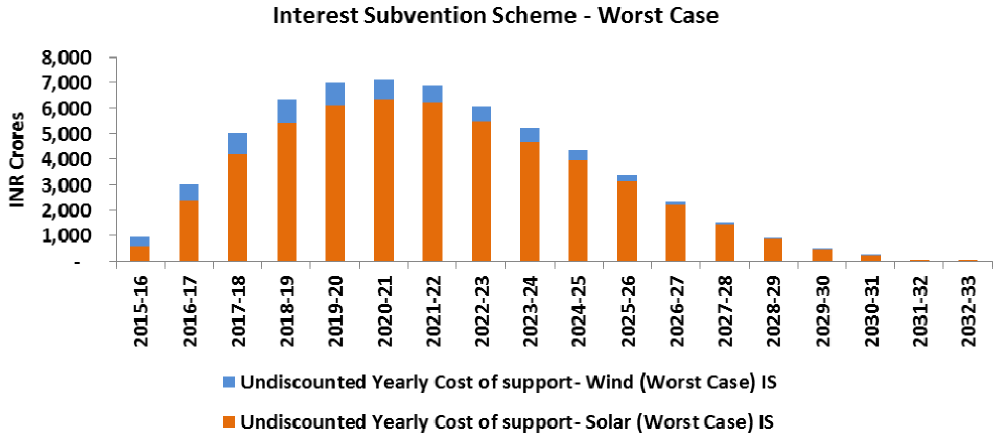


3.2 THE YEARLY UNDISCOUNTED (NOMINAL) COST OF SUPPORT UNDER DIFFERENT POLICIES

We now present the undiscounted yearly cost of support requirement for renewable energy under the different policy schemes, for the worst case scenario, in order to determine which policies are most cost-effective. The results for the best case scenario are in the Appendix. The capacity targets of grid connected Solar PV and wind are also in the Appendix.

Generation-based incentive

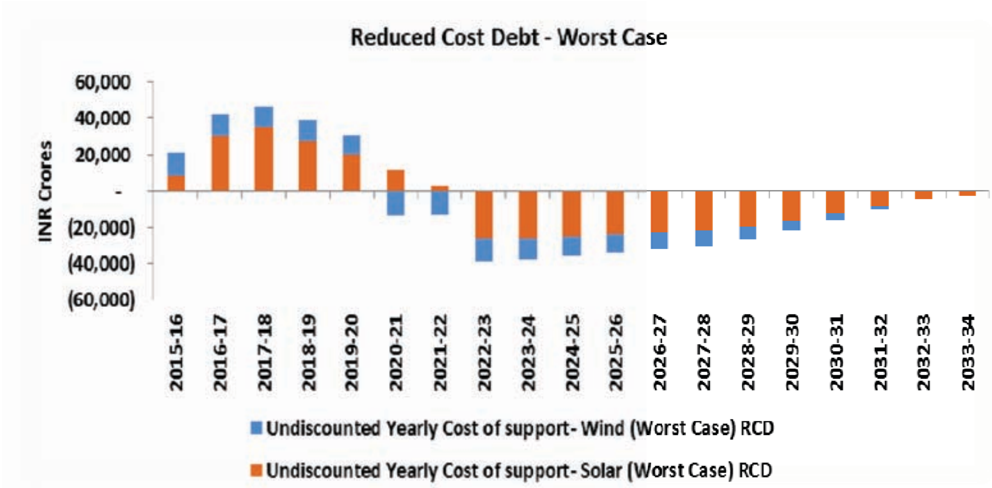
In 2015-16 the combined generation-based incentives required for solar and wind power would be INR 1,204 crores, which would peak to INR 12,716 crores in 2021-22 and 2022-23. It would then reduce to INR 745 crores in 2028-29, before going to zero in 2029-30. The GBI required for solar power plants commissioned in 2015-16 would be INR 2.38/kWh and would reduce to INR 0.50/kWh in 2021-22. The GBI required for wind power plants commissioned in 2015-16 would be INR 0.65/kWh and would reduce to INR 0.06/kWh in 2019-20.



Accelerated depreciation

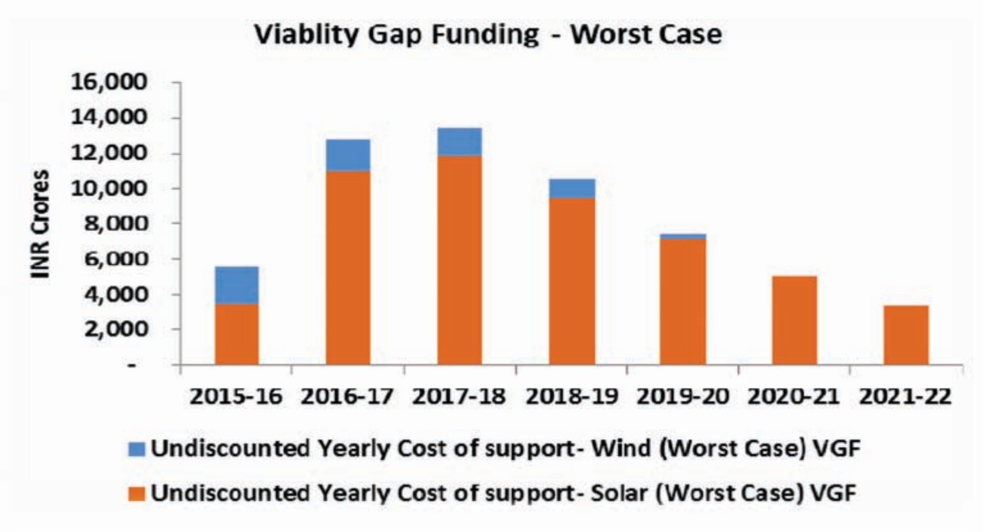
The combined annual cash outlay (the tax loss to the GoI due to the accelerated depreciation scheme plus the GBI cash outlay if needed) in 2015-16 would be INR 6,305 crores which would peak to INR 17,743 crores in 2017-18. After 2021-22, there will be subsidy recovery in the form of increased tax revenue once the AD benefits end. For the solar power plants to be commissioned between 2015-16 and 2019-20, even after providing 100% AD support there was viability gap between solar LCOE and the baseline coal LCOE. To bridge the viability gap, additional support in the form of GBI of INR 1.39/kWh would be required for solar power plants commissioned in 2015-16, which would reduce to INR 0.07/kWh for plants commissioned in 2019-20.For wind power plants commissioned in 2015-16, an AD of 58% would be required which would reduce to 17% for the plants commissioned in 2019-20. No additional GBI would be required for the viability gap.

Viability gap funding



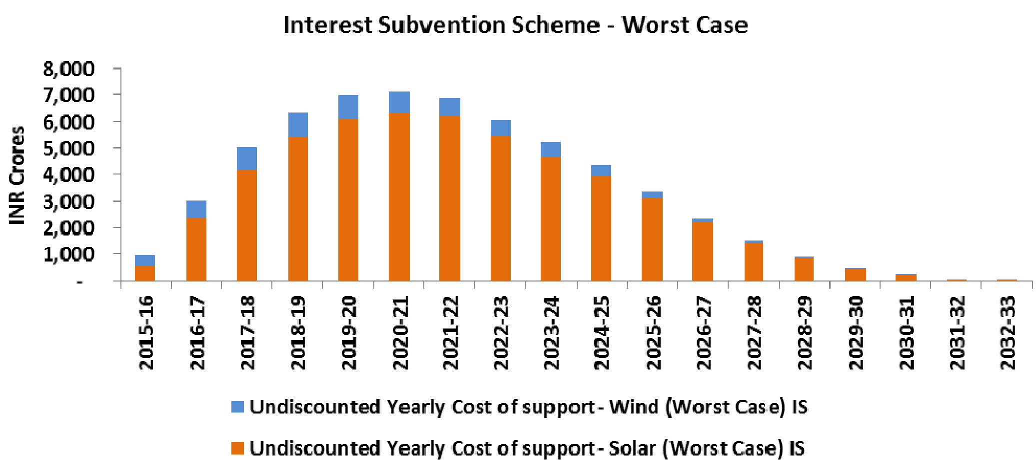
Viability Gap Funding is disbursed completely in the first year of the operation of the power plant. In 2015-16, the VGF requirement would be INR 5,509 crores which would peak to INR 13,386 crores in 2017-18 and would reduce to INR 3,400 crores in 2021-22. VGF of INR 1.91 crores/MW would be required for solar power plants commissioned in

2015-16 and would reduce to INR 0.40 crores/MW for the plants commissioned in 2021-22. VGF of INR 0.65 crores/MW would be required for wind power plants commissioned in 2015-16 and would reduce to INR 0.06 crores/MW for plants commissioned in 2019-20.



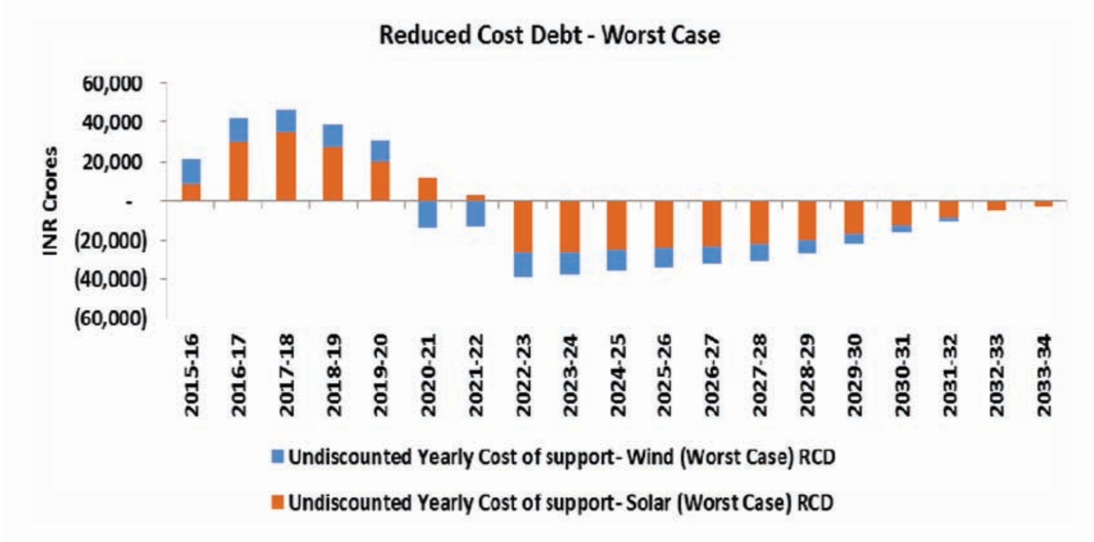
Subvention

The annual cash outlay for the GoI 2015-16 under the interest subvention scheme would be INR 934 crores which would peak to INR 7,124 crores in 2021-22, and the last payment would be INR 31 crores in 2032-33. The interest subvention for solar power plants commissioned in 2015-16 would be 9.90% pts and would reduce to 3.15% pts for plants commissioned in 2021-22. The interest subvention for wind power plants commissioned in 2015-16 would be 3.97% pts and would reduce to 0.45% pts for plants commissioned in 2019-20.



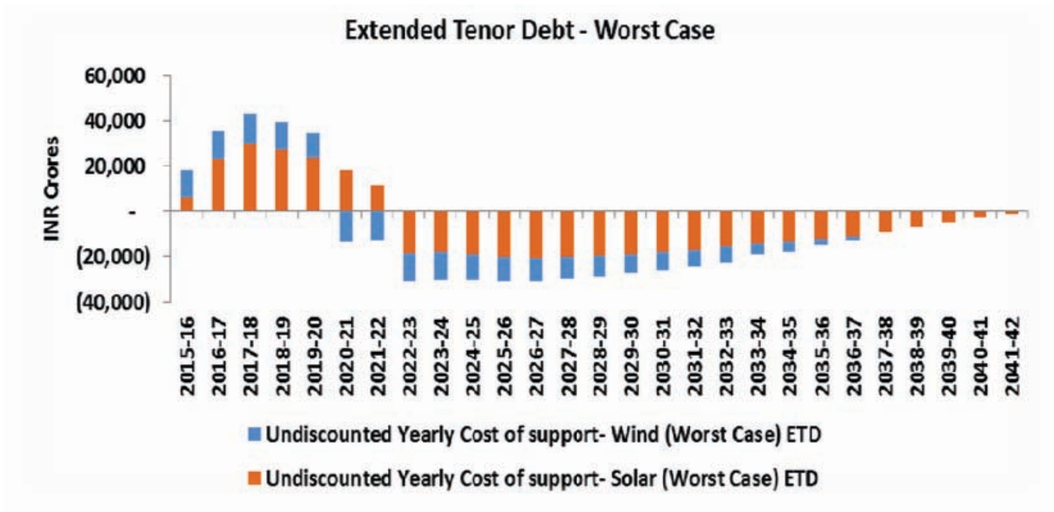
Reduced cost debt

The annual cash requirement under the reduced cost debt scheme would be INR 21,283 crores in 2015-16. From 2020-21, there would be net cash inflow due to the subsidy recovery in the form of debt repayments. The last net cash inflow would be in 2033-34. The debt cost for solar power plants commissioned in 2015-16 would be 2.1% and would increase to 8.85% for plants commissioned in 2021-22. The required debt cost for wind power plants commissioned in 2015-16 would be 8.03% and would increase to 11.55% for plants commissioned in 2019-20.



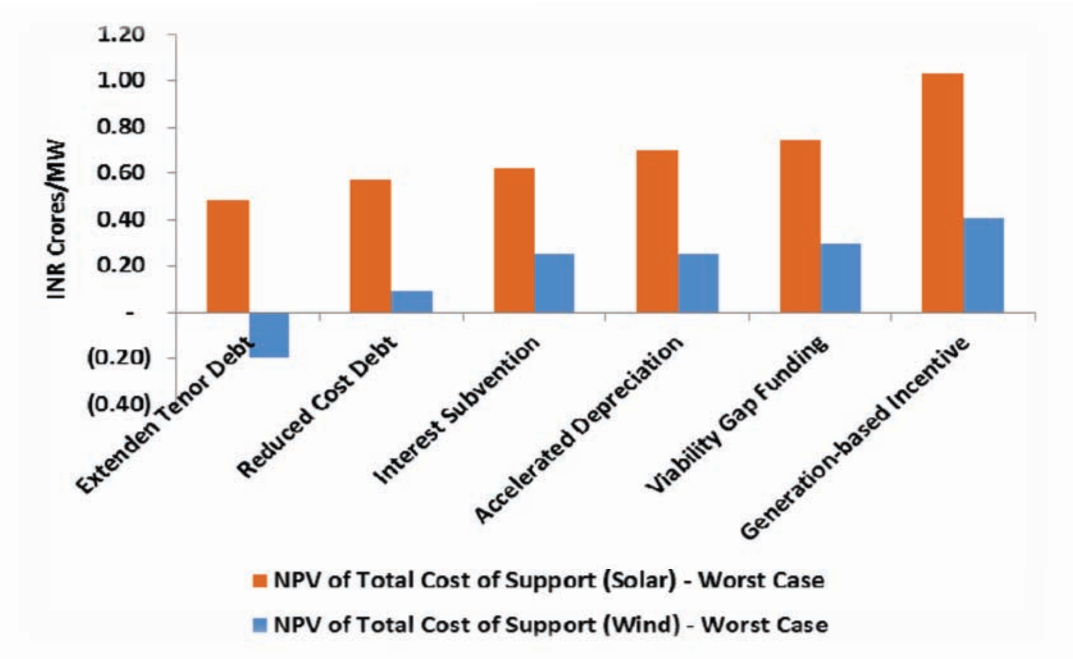
EXTENDED TENOR DEBT

The combined net cash outlay for wind and solar power under the extended tenor debt policy would be INR 18,316 crores in 2015-16, which would peak to INR 42, 959 crores in 2017-18 and then there would be net cash inflow from 2021-22 till 2041-42. The debt tenure for all solar projects commissioned between 2015 and 2022 would be 20 years. The additional GBI for solar power plants commissioned in 2015-16 would be INR 2.04/ kWh, which would reduce to INR 0.12/kWh for plants commissioned in 2021-22. The required debt tenure for all wind projects commissioned in 2015-16 would be 20 years and would reduce to 13 years for projects commissioned in 2019-20. The additional GBI for wind power plants commissioned in 2015-16 would be INR 0.32/kWh, which would reduce to INR 0.12/kWh for plants commissioned in 2016-17. No additional GBI would be required for the wind projects commissioned after 2016-17.



3.3 TOTAL (NET PRESENT VALUE OF) COST OF SUPPORT: COMPARING COST-EFFECTIVENESS

As discussed earlier, the only objective comparison for the cost-effectiveness of different policies is in terms of the total NPV (in 2015) of the cost of support, as represented by the chart below.



We determined the cost-effectiveness of a policy in terms of the NPV of the total cost of support required to bring down the unsubsidized LCOEs of all the renewable power plants to be commissioned under the target of 60 GW by 2021-22, to the LCOE of the baseline coal power plant. In general, lower the NPV of a policy support, better the cost effectiveness of the policy. We then get the following policy implications:

Policy Implication 1 (long-term): Extended tenor debt is the most cost effective policy whereas GBI is the least cost effective policy.

Policy Implication 2 (long-term): All debt based policies are more cost effective than existing federal support policies, namely GBI, VGF and AD.

To understand in detail about the cost effectiveness of federal policies, please refer to Shrimali et al, 2014.

3.4 COMPARING YEARLY UNDISCOUNTED COST OF SUPPORT – WORST CASE

As discussed earlier, given variability in annual cash flow profiles, it is not possible to compare the policies using the nominal cost of support. The total cost of support (in 2015 NPV terms) is the objective comparison. However, we realize that policymakers may be interested in comparisons based on annual profiles. One way to facilitate this comparison is via the cumulative (future present value of) annual cost of support until 2029-30. [37] The table below provides this comparison for the worst case scenario.

Cumulative (future value of) Annual Cost of Support															
(in INR billion)	15-16	16-17	17-18	18-19	19-20	20-21	21-22	22-23	23-24	24-25	25-26	26-27	27-28	28-29	29-30
Cumulative annual (FCF) VGF	55	187	335	466	575	668	752	809	869	934	1,005	1,080	1,161	1,248	1,342
Cumulative annual (FCF) AD	63	221	415	597	764	861	949	1,009	1,060	1,101	1,139	1,179	1,227	1,283	1,348
Cumulative annual (FCF) GBI	12	53	126	228	354	500	665	842	1,020	1,184	1,330	1,465	1,593	1,720	1,849
Cumulative annual (FCF) RCD	213	652	1,167	1,640	2,067	2,203	2,269	2,047	1,826	1,605	1,385	1,165	946	744	581
Cumulative annual (FCF) ETD	183	555	1,026	1,494	1,950	2,142	2,286	2,145	2,002	1,843	1,670	1,485	1,294	1,100	907
Cumulative annual (FCF) IS	9	40	93	164	246	336	430	523	614	704	790	873	954	1,035	1,117

We get the following policy implications:

- **Policy Implication 3 (until 2021-22)**: Interest subvention is the most cost-effective policy at an annual basis, followed by GBI, and then VGF. However, these policies would require longer term payments.
- **Policy Implication 4 (until 2029-30)**: There is no way to compare the policies on an annual basis, given the variability of annual profiles of the cost of support.

Yearly undiscounted cost of support under different policies: Best case scenario

Wind power projects would require no policy support under the best case scenario. So, here we present the cost of support for solar power plants only in the table below. The summary of policy support under various policies is below:

- GBI: The GBI required for the solar power plants commissioned in 2015-16 would be INR 1.05/kWh and would reduce to INR 0.23/kWh in 2016-17.
- AD: To bridge the viability gap even after 100% AD, an additional INR 0.06/kWh of GBI would be required for solar plants commissioned in 2015-16. For the plants commissioned in 2016-17, a 22% AD would be sufficient to bridge the complete viability gap between LCOEs.
- VGF: VGF of INR 0.84 crores/MW would be required for solar power plants that would commission in the year 2015-16 and would reduce to INR 0.18 crores/MW for plants that would commission in 2021-22.
- IS: The interest subvention for the solar power plants commissioned in 2015-16 would be 5% and would reduce to 1.35% for plants commissioned in 2016-17.
- RCD: The debt cost for the solar power plants commissioned in 2015-16 would be 7% and would increase to 10.65% (lesser subsidy) for plants commissioned in 2016-17.
- ETD: The debt tenure for solar power projects commissioned in 2015-16 would be 20 years, 15.5 years for plants commissioned in 2016-17. An additional GBI of INR 0.6/kWh would be required for the projects coming online in 2015-16 only.

37 We have shown cash profiles till 2029-30 due to the space constraint. The actual cash flows will be beyond 2029-30 as well.

Yearly Undiscounted Cost of Support under different Policies (Best Case Scenario)																					
(in Crores)	15-16	16-17	17-18	18-19	19-20	20-21	21-22	22-23	23-24	24-25	25-26	26-27	27-28	28-29	29-30	30-31	31-32	32-33	33-34	34-35	35-36
VGF	1,512	1,296																			
AD	3,069	476	206	21	(102)	(179)	(224)	(245)	(270)	(265)	(253)	(236)	(218)	(198)	(178)	(160)	(142)	(125)	(110)	(97)	(85)
GBI	331	621	621	621	621	621	621	621	290												
IS	256	463	421	379	338	296	254	212	171	129	52	14	12								
RCD	7,369	23,354	(5,634)	(5,374)	(5,114)	(4,854)	(4,594)	(4,333)	(4,073)	(3,813)	(3,553)	(3,293)	(3,033)	(2,175)	-	-	-	-	-	-	-
ETD	6,832	24,208	(5,450)	(5,215)	(4,981)	(4,746)	(4,512)	(4,278)	(4,232)	(3,998)	(3,764)	(3,529)	(3,295)	(3,060)	(2,826)	(2,591)	(2,357)	(1,324)	(437)	(397)	(357)

Yearly discounted (NPV) cost of support

The following tables present the yearly NPV of the cost of support for a) solar under the worst and best case scenarios; b) wind power projects under the worst case scenario.

Policy	Yearly (NPV of) Cost of Support (INR Crore) - Solar (Worst Case)						
	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
VGF	3,438	10,944	11,900	9,500	7,100	5,035	3,400
AD	3,784	11,395	11,698	8,516	5,453	3,766	2,660
GBI	4,726	15,012	16,437	13,128	9,818	6,917	4,688
IS	2,868	9,086	9,911	7,947	5,940	4,184	2,837
RCD	2,936	9,065	9,543	7,335	5,073	3,171	1,809
ETD	3,549	10,200	9,604	6,153	2,811	338	(1,423)

Policy	Yearly (NPV of) Cost of Support (INR Crore) - Wind (Worst Case)				
	2015-16	2016-17	2017-18	2018-19	2019-20
VGF	2,071	1,850	1,486	1,034	321
AD	1,554	1,462	1,208	864	708
GBI	2,855	2,551	2,013	1,443	478
IS	1,731	1,550	1,219	878	318
RCD	1,308	990	479	(62)	(877)
ETD	237	(782)	(1,567)	(1,524)	(1,382)

Policy	Yearly NPV of Cost of Support (INR Crores) - Solar (Best Case)	
	2015-16	2016-17
VGF	1,512	1,296
AD	1,143	1,133
GBI	2,085	1,827
IS	1,258	1,127
RCD	1,065	(133)
ETD	556	(1,956)

Yearly capacity addition targets of renewable power projects:

Following table presents the year wise capacity addition targets of utility scale renewable energy projects:

Capacity Addition (in GW)	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
Wind	3.2	3.6	4.1	4.7	5.4	6.1	6.9
Solar	1.8	7.2	10.0	10.0	10.0	9.5	8.5

ANNEXURE 4: SUPPORT REQUIRED FOR ROOFTOP SOLAR PV

Government of India targets to achieve 100 GW solar capacity by 2022. Out of this, 40 GW is planned to be deployed through grid-connected small-scale rooftop PV plants.

Based on tariffs of electricity for commercial consumers across various states, it is evident that solar rooftop is already at parity (see figure below)[38]. In cases, where the users can avail accelerated depreciation (AD), the cost of solar is lower than the commercial tariffs for at least 8 states. Hence, it is expected that no subsidy will be necessary for solar installations by commercial segments in such states.

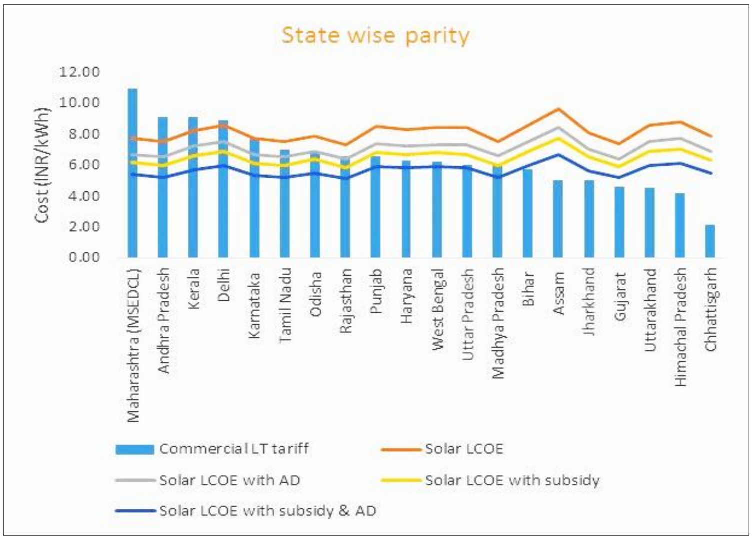


Figure 1: State wise parity of solar power

In fact, for some states that have telescopic tariffs structures for residential consumers, the solar rooftop rates are comparative to higher end of tariffs e.g. in Delhi, higher end of residential tariff is more than Rs. 9 per KWh, which is well above solar rooftop LCOE. However, the rooftop solar LCOE is still much above average residential tariffs, and also tariffs for institutions.

Considering that there is significant rooftop space available in commercial, industrial, institutional and residential sectors, none of these sectors can be ignored while designing policy and other supportive frameworks. We believe that the financial subsidies need to be targeted to the sectors where they are most needed, rather than offering equal level of subsidies to all consumer categories.

In view of this, we believe that in most states, financial support may be required for installations of rooftop systems in residential and institutional premises, where utility tariffs are still not at par with solar rooftop LCOE. As the solar LCOE reduces with time and experience, and utility tariffs hike, even they may not require direct financial support. Hence we should target to achieve about 25% of solar rooftop targets (10GW) from amongst these sectors.

Remaining 75% target (30GW) should be met by industrial and commercial consumers, who will require overall ecosystem level support, rather than direct financial subsidies. Such support includes and is not limited to product quality assurance, finance availability,

38 http://www.bridgetoindia.com/blog/solar-capacity-additions-a-vapid-year-for-jnnsm-while-the-non-policy-market-perks-up/

utility and regulatory facilitation (for net metering), etc. In addition, incentives like AD should be able to motivate them to go the solar way.

The potential

India's current potential for rooftop SPV has been estimated in terms of technical, economic, and market potentials (Figure 2). The estimated realistic market potential for rooftop solar PV in urban settlements of India is around 124 GWp. It may be noted that the current total installed power generation capacity is 280 GWp. Thus, roof top systems can play an important role in providing energy security and in multiple utilization of land, a scarce resource.

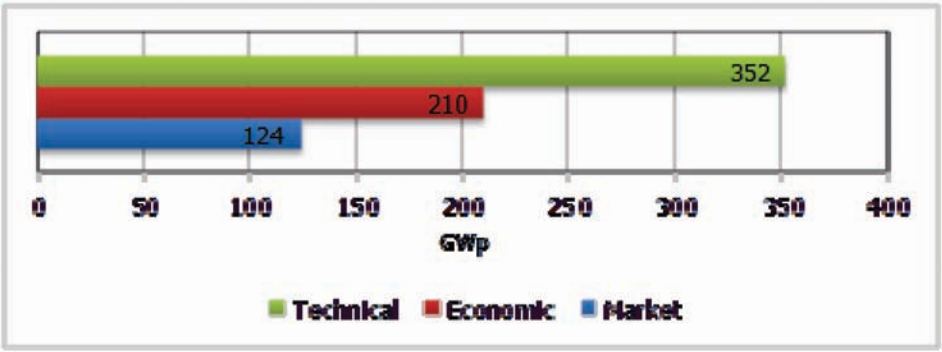


***Figure 2: India's potential for rooftop solar PV*[39]**

Subsidy estimation as per current scheme of the Government of India

As per existing scheme of the Government of India, 15% capital subsidy is allowed for residential and institutional segments. At Rs. 8 crore/MW, it is estimated that a Central Financial Assistance of a total of Rs. 12,000 crores may be required by 2022 to achieve 10 GW of rooftop capacity through residential/ institutional segments.

What could be the best use of additional government subsidies, if available?

In countries where distributed energy installations are rising, the utilities have been opposing this transformation. Their concerns stem from potential implications of such systems on their finances and operations. Direct financial impact have been stated to include pay-outs for surplus power fed to the grid and cost of maintaining and balancing the grid. The latter also poses operational challenges. At the same time, there are core systemic and legacy issues such as tariff design structures which do not reflect true costs and thus adversely impact the distributed clean energy sector. Some of the arguments that utilities raise are:

1. Distributed system installers (rooftop solar customers) do not pay a fair share of the costs that are incurred by the utility for maintaining the grid, even though the customers look to the grid for reliability
2. As a result, customers who do not have means or space to install such distributed systems, end up bearing higher costs

39 T E R I. 2014. Reaching the sun with rooftop solar. New Delhi: The Energy and Resources Institute. 62pp. Available at: http://shaktifoundation.in/wp-content/uploads/2014/02/Reaching-the-sun-with-rooftop-solar_web.pdf

3. In addition, utility ends up paying higher tariffs for surplus power fed back to the grid costs compared to the cost that is avoided by not purchasing equivalent amount of power from wholesale markets.

A counter-argument obviously is the value that any distributed system could offer in times of peak load.

India's target to deploy 40 GW of grid-connected rooftop PV systems by 2022 will be difficult to achieve unless the concerns of distribution utilities are addressed. Solar PV sector could hit a situation similar to Tamil Nadu's wind sector, where utility is opposing any additional wind installations. These debates have been rising in even in other countries. For example, the United Kingdom, which to a great extent inspired the injection of free-market principles into electric power systems, generally does not allow or encourage net metering.

For Indian utilities part of the solution lies in cost-reflective and transparent tariff design mechanisms that can ensure a healthy equation between prosumers, utilities and consumers, thus facilitating a sustained growth of the sector. Utilities would also need to assess the value proposition of rooftop PV generation in light of actual demand and supply profiles of their distribution areas.

In addition, we believe that it best to use any additional government subsidies available, to make the distribution utilities supportive of installation of rooftop systems. The specific mechanism for same would need to be worked out.

ANNEXURE 5: SUPPORT FOR RURAL ELECTRIFICATION THROUGH RE-BASED MINI-GRIDS

Providing adequate and quality power to domestic and other consumers remains one of the major challenges before the country. There is also an increasing concern to reduce reliance on fossil fuels in meeting power needs and opting for cleaner and greener fuels instead. As a major initiative in this direction the Govt. of India has up scaled the National Solar Mission target to 100 GW to promote ecologically sustainable growth. It has also rolled out "Power for All" programme to address India's energy security challenge which seeks to provide round the clock electricity to each household by 2019. However, the programme of "Power for All" of the Government of India prove to be ambitious when as of today approximately 400 million people don't have access to electricity.

The recent statistics shows that the total no. of un-electrified villages in India as on 31.03.2015 are 1,845,2 [40]. In fact, in addition to these un-electrified villages there also exists a large section of hamlets/paras/bastis in electrified villages which doesn't have access to electricity. The reason could be power shortage, forced load shedding or simply the unwillingness of the Distribution Licensees to reach out these areas due to financial unviability.

Presently, the need of these section of population is being met partially through variety of decentralized off-grid applications (viz. solar, biomass, small hydro, etc). The RE based applications are playing an important role in servicing the rural demand, thereby making the RE based mini-grids systems increasingly relevant for this sector. In such a scenario, it is felt that the current upward trend in the mini-grid solutions and the concurrent efforts of the Government could lead a way to harness the underlining potential in this segment. To achieve the larger objective of rural electrification, there is a need to focus on such potential which could pave the way to achieve the target envisioned by Government of India for addition of 175 GW solar capacity by 2022.

The Ministry through various central and state level programmes is providing budgetary as well as technical support to this sector. To provide clean, economical and reliable energy to the households for lighting and other productive uses, MNRE, through its channel partners is providing capital subsidy through various programmes. One of such programme is "Off-grid and Decentralized Applications Programme" implemented under National Solar Mission in which Mini/Micro grids are one of the key segments. However the propagation of this segment is lagging behind due to the nature of risk involved with such type of projects. To overcome such challenges and to give more thrust on the mini-grids the Ministry has started empaneling the energy service companies as Rural Energy Service Providers (RESP) based on specific eligibility criteria. Further, MNRE has also specified the benchmark cost for Mini Grid system (of size >10 to 250 kWp) as Rs. 300/Wp which majorly consists of solar power generation cost and associated public distribution network (PDN) cost. In order to support these segment, Ministry is providing Central Financial Assistance to SPV Micro/Mini grid systems ranging from Rs. 85/Wp to Rs. 115/Wp depending on the category of state, size and mode of the project.

In fact, the remaining 18,452 un-electrified villages could be electrified through SPV based mini grid systems, considering the average system size of 30 kW the potential for this segment would be around 0.5 GW. Further, it is also felt that there also exists a

40 Source: http://www.rggvy.gov.in

potential to the tune of 4 GW in un-electrified areas (viz. basti/paras/hamlets) of electrified villages where the grid is yet to reach or had inadequate supply hours. Additionally, the excess investment pertaining to establishment of Public Distribution Network (PDN) could be avoided in these areas by leveraging the existing infrastructure of the Discoms.

To achieve the above capacity addition (i.e. 0.5 GW), the total investment required would be within a range[41] of Rs. 10,000 Crore to Rs. 15,000 Crore which majorly depends on the size and nature of the project. Further, if subsidy of Rs. 90/Wp as specified by MNRE is considered, the level the subsidy/central finance assistance required for these projects would be Rs. 4,995 Crore. Similarly, the investment required to achieve the target of 4 GW through SPV based system, where electrification[42] has already been done, would be around Rs. 73,000 Crore to Rs. 1,10,000 Crore and the subsidy requirement to fund these projects would be Rs. 36,000 Crore considering the same level of support from MNRE (i.e. Rs. 90/Wp).

A transition solution could be to provide immediate access to basic electricity needs by RE-based tail-end generation with or without the need to create new distribution infrastructure (mini-grids). The table below provides the year wise target and cost differential envisaged for such mini-grid systems. The Expert Group acknowledges that such interventions would also require consideration of technical aspects of generation systems, distribution infrastructure, and even storage systems so that integration with the utility grid is possible whenever utility grid reaches and becomes reliable.

Particulars	Year-wise Target									
	2015-16		2016-17		2017-18		2018-19		Total	
	Target Addition (In MW)	Cost differential (In Rs. Crore)	Target Addition (In MW)	Cost differential (In Rs. Crore)	Target Addition (In MW)	Cost differential (In Rs. Crore)	Target Addition (In MW)	Cost differential (In Rs. Crore)	Target Addition (In MW)	Cost differential (In Rs. Crore)
Un-electrified Villages as per Census	1	9	114	1,026	170	1,530	270	2,430	555	4,995
Un-electrified areas of electrified villages	5	45	795	7,155	1200	10,800	2,000	18,000	4,000	36,000
Total	**6**	**54**	**909**	**8,181**	**1,370**	**12,330**	**2,270**	**20,430**	**4,555**	**40,995**

However, it is very likely that, with the above cost differential, the tariff for the end consumers may remain at a higher side. Alternatives may be worked out to make these tariff more favorable, possibly by increasing the existing level of subsidy or leveraging the financial assistance of other schemes such as DDG (under DDUGJY) where grant to a level of 90% is provided to such kind of projects. In this regard, it is also to be noted that the subsidy requirements are computed on incentive arrangement as on today. However with reducing trend in cost of RE generation and with more proven technology the aggregate financial requirement for this sector may get reduced in longer run. Though as of now the budgetary requirement to support this sector seems very high but the broader objective of rural electrification that could be achieved through these segments

41 MNRE benchmark cost of Rs. 300/Wp has been considered for smaller size plants while Rs. 200/Wp has been considered for larger ones.

42 It also included the area where supply hours are not adequate. PDN cost is not considered where grid already exists.

cannot be oversighted. As lack of energy access has been a major impediment to socio-economic development, particularly in rural areas, efforts need to be made to achieve national objective of energy access for all.

Apparently, to scale-up of mini-grid systems there is also a need to create an enabling environment and supportive eco-system. In the area of Mini/Micro grid segment, financing of projects is currently driven more by "impact investors" than "financial investors". In order to ramp-up investments in these segment, there is a need for policy and regulatory reforms as well as adaptation of new financing approaches. As part of its initiative in this direction, the Govt. of India is extending Capital Subsidy/Grants/Central Financial Assistance through various State and Central level schemes (viz. JNNSM, DDUGJY, NSGM). Further, recently the Govt. has also revamped the Priority Sector Lending norms by extending the support to small and large scale RE projects. Additionally, it is also important to note that several social enterprises, practitioners, philanthropic institutions and bilateral/ multilateral agencies have stepped in to develop workable business models for mini-grid arena. Projects based on such models have also been successful in attracting investor interest in DRE projects. Thus, it is crucial to understand potential size of the mini-grid market in India, both in terms of capacity as well as capital requirement.

Further, the following challenges needs to addressed that are presumably proving to be major barriers and deterring the progress of mini-grid sector – (1) Regulatory uncertainty with respect to unregulated tariff (2) project bankability (3) Lack of interest from developers under the DDG Scheme (4) performance monitoring is a challenge for the government due to the remoteness of the area (5) lack of clarity on the compensation mechanism/exit mechanism for the developer in case of grid extension before the expiry of the project duration (6) unpredictable power consumption patterns (7) low creditworthiness of off-takers (8) lack of scalable business models, etc.

ANNEXURE 6: SUPPORT FOR MANUFACTURING AND SKILL DEVELOPMENT

The manufacturing sector in India has been growing at a Compound Annual Growth Rate (CAGR) (constant prices) of 7.3% over the past decade. But, the manufacturing output growth rate declined in 2012 and 2013 (MOSPI, 2014a). Poor domestic and external demand, high interest rates and infrastructure bottlenecks are the primary reasons for the reduced growth rate (Das, 2014)(KPMG, 2015). In 2013-14, manufacturing's share in GDP was 14.9%, which was a 90 basis point decrease as compared to the previous fiscal year (MOSPI, 2014b).

Despite this business leaders, and the industry in general share, a positive outlook. The Index of Industrial Production exhibited a growth of 2.1% in 2014-15 (April–December), in addition to the 0.1% increase during the same period last year. Manufacturing output too increased by 3.9% and 0.4% respectively in the first and second quarters of 2014-15 (KPMG, 2015).

NATIONAL MANUFACTURING POLICY

To support the domestic renewable industry, the Government has declared a number of measures. In 2011, the Government of India (GoI) announced the National Manufacturing Policy (NMP) which aims to increase the share of manufacturing in GDP to 25% by 2021, and in the process create 100 million jobs (PIB, 2011). NMP is considered as one of the most comprehensive and significant policy initiatives by the government for the manufacturing sector (PwC, 2012). NMP declared solar and wind energy as strategic industries and categorized them under special focus sectors (DIPP, 2011).

Last year, NMP was merged with the 'Make in India[43]' initiative and a host of incentives were announced specifically for PV module and Balance of Module[44] manufacturers. Exemption from custom and excise duty comprises the bulk of incentives. The exemptions were also extended to equipment purchased for manufacturing the afore-mentioned components. Full exemption from Special Additional Duty is provided on parts and components used in the manufacture of wind generators.

MODIFIED SPECIAL INCENTIVE PACKAGE SCHEME

In addition, under the Modified Special Incentive Package Scheme (M-SIPS), announced by the Department of Electronics and Information Technology (DeitY), 20% and 25% subsidy on capital expenditure has been announced for entities establishing cell and module lines in Special Economic Zones (SEZ) and Non-SEZs, respectively. Reimbursement of Excise Duty and Counter Vailing Duty is also applicable for capital equipment purchased for Non-SEZ units. Further, for high technology units, such as fabrication units (wafer manufacturing facility), reimbursement of central taxes and duties have also been provided.

SOLAR AND WIND MANUFACTURING SUPPLY CHAIN IN INDIA

India has a good manufacturing base of solar and wind component manufacturers. Approx. 3,000 MW of module and around 1,400 MW of cell manufacturing is present in

43 Make in India encourages companies to manufacture their products in India. The initiative focuses on job creation and skill enhancement in 25 sectors, including electronic systems and renewable energy.

44 Glass, Interconnect Ribbon, Encapsulant, Backsheet, Aluminum Frame, Sealant and Junction Box are some of the salient balance of module components.

India (Refer Figure 1). In Wind, India, has approximately 12,000 MW of Wind Turbine and Generator (WTG) manufacturing/assembly capacity (Refer Table 1).

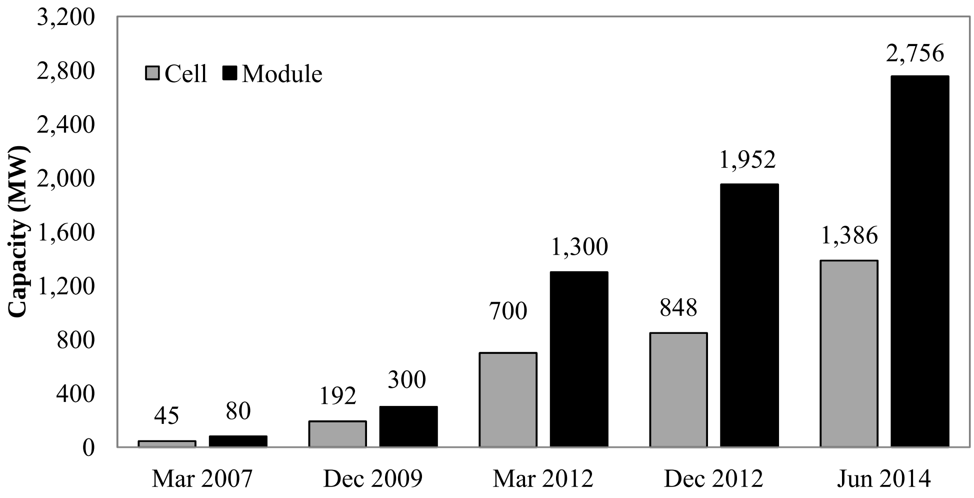


Figure 1 : Domestic PV Cell and Module Manufacturing Capacity in India

Table 1: Annual WTG Manufacture/Assembly Capacity of the Indian Manufacturer

S. No.	Manufacturer Name	Manufacturing Capacity per annum,MW	Product portfolio, WTG rating, kW
Megawatt scale			
1	Gamesa Wind	1,500	850/2000
2	Global Wind Power	600	750/1500/2500
3	GE India	450	1500/1600
4	Inox Wind	800	2000
5	Kenersys	400	2000/2400/2500
6	Leitwind Shiram	250	1500/1800
7	NuPower Technologies	Not available	2050
8	ReGen Powertech	750	1500
9	RRB Energy	300	500/600/1800
10	Suzlon Energy Ltd	3,700	600/1250/1500/2100
11	Vestas India	1,000	1800/2000
12	WinWinD	1,000	1000
Sub-Megawatt scale			
13	Chiranjeevi Wind Energy	Not available	250
14	Garuda Vaayu Shakti	Not available	700
15	Pioneer Wincon	200	250/750
16	Shriram EPC	Not available	250
17	Siva Wind	15	250
18	Southern Windfarm	Not available	225
19	Wind World (Enercon)	960	800
Total		**11,925**	

Glass, encapsulant, ribbon, backsheet, junction box and frame are other major Balance of Module (BOM) components that go into manufacturing PV modules. Table 2 provides a list of major Tier-I[45] suppliers of these products along with their production capacity in India. Despite this, a bulk of the components for manufacturing a PV module in India is imported (FICCI, 2012). This comprises gases, silver paste, ethylene vinyl acetate, etc. (ESMAP/World Bank, 2013).

Table 2: List of Tier-I Suppliers of Major BOM Components in India

Material	Suppliers	Annual Capacity	Unit	Quantity in MW
Junction Box	Volex	7,20,000	Nos.	169
	Yukita	28,80,000	Nos.	678
Encapsulant	Lucent	1,00,00,000	m^2	711
	Renewsys	80,00,000	m^2	500
	Brij Footcare	12,00,000	m^2	80
	Allied	50,00,000	m^2	355
Backsheet	Polycom	7500000	m^2	1000
	Renewsys	11250000	m^2	1500
Glass	Borosil	4200000	m^2	600
	Allied	4,80,000	m^2	69
Ribbon	G and G	165	tonnes	200
	Sukriti	120	tonnes	150
Frame	Alom	2400	tonnes	2000
	Valco	1600	tonnes	1200
	Hindalco /Century	6250	tonnes	5000
	Banco	2000	tonnes	1600

A few wind Original Equipment Manufacturers (OEM) have identified major components and indigenized them. They have established facilities for manufacturing blades, towers and generators in various parts of India and there are also a few foreign manufacturers who have set-up component manufacturing facilities in India. An overview of the major wind component manufacturers/suppliers in India is given in ***Table 3.***

Table 3: Tier-I WTG Component Suppliers in the Indian Wind Industry

Sl. No.	Component	Tier-I Supplier	Profile
1	Bearing	FAG	▪ Origin- Germany ▪ Clients- Suzlon, ReGen Powertech, Wind World, Kenersys, Leitwind ▪ Product- Rotor shaft and gearbox bearings ▪ Location- Savli, near Vadodra, Gujarat

45 Tier-I companies are direct suppliers to Original Equipment Manufacturers. Hence, major component manufacturers are Tier-I suppliers.

Sl. No.	Component	Tier-I Supplier	Profile
		SKF	▪ Origin- Sweden ▪ Clients- Suzlon, Kenersys and others ▪ Product- Bearings for rotor shaft, pitch and yaw, gearbox and generators ▪ Location- Pune, Bangalore, Ahmedabad
		NTN	▪ Origin- Japan ▪ Clients- Kenersys, others ▪ Product- Bearings for rotor shaft, gearbox and generator ▪ Location- Chennai and Haryana
		Timken	▪ Origin- USA ▪ Clients- Wind World, others ▪ Product- Bearings for rotor shafts and gearboxes ▪ Location - Chennai and Jamshedpur
2	Blade	Gamesa	▪ Origin- Spain ▪ Production Capacity- 200 MW/annum ▪ Location- Vadodra, Gujarat ▪ Miscellaneous- Uses pre-pregtechnology, rather than the commonly used infusion technology
		Inox Wind	▪ Origin- Mumbai, India ▪ Production Capacity- 700MW/annum ▪ Location- Ahmedabad, Gujarat
		Kemrock	▪ Origin- Vadodara, Gujarat ▪ Production Capacity-Not Available ▪ Location- Vadodara, Gujarat ▪ Miscellaneous- Largest manufacturer of thermosetting resins in India and first manufacturer of carbon fibre in India
		Leitner Shriram	▪ Origin- Chennai, India ▪ Production Capacity- 375 MW/annum ▪ Location- Gummidipundi, Tamil Nadu

Sl. No.	Component	Tier-I Supplier	Profile
		LM Wind	▪ Origin-Denmark ▪ Clients- Regen Powertech, Gamesa, Kenersys, Others ▪ Production Capacity- 1850-1950 MW/ annum ▪ Location- Dabaspet near Bangalore and Rajasthan ▪ Miscellaneous- Largest blade manufacturer in the world with about 25% global market share
		RRB Energy	▪ Origin- Chennai ▪ Production Capacity-700MW/annum ▪ Location- Poonamallee, Chennai
		Nu Power	▪ Origin- Mumbai, India ▪ Production Capacity- Not Available ▪ Location- Bhuj, Gujarat
		Suzlon	▪ Origin- Pune, Maharashtra ▪ Production Capacity- 4,324 MW/annum ▪ Location- Pondicherry, Daman, Padubidri (Karnataka), Dhule (Maharashtra) and Bhuj (Gujarat)
		Wind World	▪ Origin- Enercon GmbH (Germany) ▪ Production Capacity- 10 blades a day or approximately 1,216 MW/annum ▪ Location- Daman
3	Forging and casting	Bharat Forge	▪ Origin - Pune, India ▪ Clients - Wind World, Kenersys ▪ Product – Open die forging ▪ Production Capacity - 3 lakh tonnes per annum (not limited to wind segment only) ▪ Location - Pune

Sl. No.	Component	Tier-I Supplier	Profile
		L&T (Forging)	▪ Origin- Mumbai, India ▪ Clients – Wind World, Gamesa ▪ Production Capacity - 40,000 tonnes per annum (not limited to wind segment) ▪ Location - Surat, Gujarat
		L&T (Casting)	▪ Origin- Mumbai, India ▪ Clients – Wind World, Gamesa ▪ Production Capacity – 30,000 tonnes per annum ▪ Location - Coimbatore, Tamil Nadu ▪ Miscellaneous- Can cast up to 25 tonnes of single piece for wind generators
		SE Forge (Casting)	▪ Origin- 100% subsidiary of Suzlon Energy Ltd, Pune ▪ Clients – Suzlon Wind Energy, Ltd ▪ Product - Hub, Main Frame, Planet Carrier, Torque Arm, Housing ▪ Production Capacity – 1,20,000 tonnes per annum ▪ Location - Coimbatore, India ▪ Miscellaneous- Can cast up to 25 tonnes of single piece for wind generators
		SE Forge (Forging and Machining)	▪ Origin- 100% subsidiary of Suzlon Energy Ltd, Pune ▪ Clients – Suzlon Wind Energy Ltd ▪ Product –Tower Flanges ,Bearing Rings , Gear rings and Blanks , Other Rings ▪ Production Capacity – 42,000 forged rings per annum ▪ Location - Vadodara, Gujarat

Sl. No.	Component	Tier-I Supplier	Profile
		Premier	▪ Origin- Mumbai, India ▪ Clients – Wind World, Regen Powertech, Kenersys ▪ Product – Casting and forging parts for Stator Ring, Stator Carrier, Disc Rotor, Generator, Supporting structure, Brake disc, Rotor hub, Main Carrier, Axle Pin, Blade adaptor, Hub and Main frames. ▪ Location - Pune
		Patel Alloy	▪ Origin- Ahmedabad, India ▪ Clients – Suzlon, Vestas, Regen Powertech ▪ Product – Casting for manufacturing hub, main frame, shaft, base frame, main bearing housing, nacelle components ▪ Production Capacity – 40,000 tonnes/annum ▪ Location - ▪ Miscellaneous-
4	Gearbox	Winergy	▪ Origin- Germany ▪ Clients – Major players including Suzlon, Gamesa, Kenersys ▪ Location - Chennai
		ZF Wind Power Antwerpen	▪ Origin- Germany ▪ Clients – Major players including Suzlon, Gamesa, Kenersys ▪ Location - Coimbatore, India

Sl. No.	Component	Tier-I Supplier	Profile
5	Generator	ABB India	▪ Origin- Switzerland ▪ Clients – Gamesa, Inox and others ▪ Product - Doubly fed and convertor type, also manufactures PMSG ▪ Production Capacity – 2,400 MW per annum ▪ Location - Vadodara, Gujarat ▪ Miscellaneous- Major generator supplier in India to wind industry and otherwise
		Leitner Shriram	▪ Origin- Chennai, India ▪ Product - Asynchronous generators ▪ Location - Gummudipundi near Chennai
		Regen Powertech	▪ Origin- Chennai , India ▪ Product – PMSG Generators ▪ Location - Mamandur near Chennai
		Suzlon	▪ Product - SFIG and DFIG ▪ Production Capacity – 5,000 MW per annum ▪ Location - Coimbatore (Tamil Nadu) and Chakan (Maharashtra)
		The Switch	▪ Origin- Finland ▪ Product - PMSG ▪ Location - Chennai, India
		WindWorld	▪ Product - Annular generators suitable for direct drives ▪ Production Capacity – 1,075 MW per annum ▪ Location - Daman
6	Tower	Gestamp	▪ Origin- Spain/Bangalore ▪ Location - Sricity (Andhra Pradesh), ▪ Kolhapur (Maharashtra)

Sl. No.	Component	Tier-I Supplier	Profile
		Global Wind Power	▪ Origin- Mumbai/Hong Kong ▪ Product - WTG assembly as well as tower manufacturing ▪ Production Capacity – 600MW per annum ▪ Location - Silvassa, India
		Inox Wind	▪ Product - Towers of 68 meters, 78 meters and 98 meters in height ▪ Production Capacity – 150 towers per annum ▪ Location - Ahmedabad ▪ Miscellaneous-
		Premier	▪ Clients – Wind World, Regen Powertech, Kenersys ▪ Product – Tubular tower ▪ Location - Pune
		Suzlon	▪ Product - Tubular tower, lattice tower, hybrid towers ▪ Production Capacity – 1,000 MW per annum ▪ Location - Gandhidham, Gujarat
		Tool Fab	▪ Origin- Trichy, India ▪ Clients – Suzlon, Regen Powertech, Leitwind Shriram, Gamesa and Wind World ▪ Product - Lattice, hexagonal, tubular towers ▪ Miscellaneous - Tool Fab has over 2 decades of experience in tower manufacturing
		Windar	▪ Origin- Spain ▪ Clients – Suzlon, Gamesa and other major players ▪ Product – Tubular towers ▪ Production Capacity – 900 MW/annum ▪ Location - Vadodara, Gujarat
		WindWorld	▪ Product - Tubular towers ▪ Location - Jamnagar, Gujarat

JOBS

Solar and Wind technology is expected to add approximately 85,000 full time jobs and over 3.3 million job years equivalent of construction and manufacturing jobs. This is based on solar and wind targets proposed by the MNRE. Rooftop PV is expected to add the highest number of jobs. Table provides an estimate of the total number of jobs that would be generated based on the proposed wind and solar targets. Table 5 lists the employment factors used to estimate the number of jobs.

Table 4: Estimate of jobs to achieve the solar and wind targets

Supply Source	Construction & Manufacturing	Operation & Maintenance
	Job Years	***Jobs***
Solar PV - Utility	9,60,800	21,000
Solar PV - Tail End	2,18,500	4,600
Solar PV - Rooftop	15,24,000	39,500
Solar Thermal	78,100	2,200
Wind Onshore	5,10,500	16,500
Wind Offshore	51,300	1,000
Total	**33,43,200**	**84,800**

Table 5: Employment factors engaged for different supply sources

Supply Source	Construction	Manufacturing	Domestic Manufacturing	Operation & Maintenance
	Job Years/MW	Job Years/MW	%	Jobs/MW
Solar PV - Utility	17.533	10.998	40%	0.478
Solar PV - Tail End	17.533	10.998	50%	0.478
Solar PV - Rooftop	32	10.998	60%	1
Solar Thermal	16.689	7.501	50%	0.563
Wind Onshore	6.156	14.743	60%	0.483
Wind Offshore	11.655	18.057	30%	0.328

GAPS TO BE PLUGGED

India continues to be placed very low in various global surveys in terms of 'ease of doing business'. For instance, obtaining a construction permit is a very time-consuming process in India. According to the World Bank and International Finance's 'Doing Business 2013', India ranks 182[46] out of 185 countries in terms of dealing with construction permits. In India, 34 procedures are involved as compared to 8 in Thailand, Colombia and Spain and 6 in Hong Kong and New Zealand. Further, it takes 196 days to get construction permits in India as compared to 26 in Singapore, 27 in USA, 43 in Bahrain and 46 in UAE (World Bank, 2013). Moreover, India ranks a low 173 in terms of procedure and time taken in starting a new business and ranks 184 in enforcing contracts. (FICCI, 2013c)

Interestingly, on the renewable front, India has made good strides and is ranked 9 out

46 Overall rank in ease of doing business is 132, last among South Asian countries and only above Philippines among fast developing countries.

of 40 countries in a renewable energy country attractiveness index published by E&Y (E&Y, 2013). In the wind index it ranked 6th; in onshore it ranked 10th and in offshore it ranked 22nd. Moreover, in the overall solar index it ranked 3rd, with 8th and 6th positions respectively for solar PV and CSP. The demand and supply side measures put forth by GoI are the prime reasons for India's performance.

However, domestic renewable manufacturing, especially in solar PV has been slow over the past few years. A bulk of cell and module manufacturing capacity remains idle (PV Magazine, 2013e) (Subramaniam, 2013). Different sources place this value at 50-80% range (Limaye, 2012). Although, the Indian government has various support incentives for the renewable manufacturing sector, the performance has not been as expected. Skewed policy which left out thin films from DCR ambit in the JNNSM, the global supply glut in c-Si cells and modules, poor infrastructure (quality of electricity supply) and high costs of electricity and fuels are some of the major challenges affecting the PV industry (Johnson, 2013) . Some of the major gaps that are hampering the domestic RE manufacturing industry are highlighted below:

FINANCING

High costs and shorter tenure of financing and general skepticism in technology (especially in the case of solar) are major challenges for both manufacturing as well as deployment of renewable energy in India (FICCI, 2013b) (CEEW & NRDC, 2012) (CSPToday, 2013). Bankability of PPAs, lack of experience of (solar) developers, uncertainty in implementation of regulatory mechanisms such as enforcement of RPOs and the REC mechanism and absence of reliable irradiation and plant performance data are some of the factors which act as barriers to obtain finance. Moreover, the cost of financing in India is very high. This leaves very small margins for project developers who are already working with some of the lowest renewable tariffs in the world (Mercom Capital, 2012). This has led to many project developers looking for long-term, low-cost and more reliable sources of project finance internationally.

In addition to higher interest rates (12-14%), which leads to viability issues in a project, while financing RE projects, especially wind power, banks don't take an exposure of more than 60% on non/limited recourse project financing. Most banks are reaching a sectoral cap in the power sector and renewable energy technologies do not have any specific sectoral limits sanctions by the Reserve Bank of India. The working capital requirement is high in case of wind power projects. The higher interest rates (12-14%) for working capital make Indian products less competitive in the global market, which offers borrowing rates of 3-4%. Wind turbine suppliers are also involved in infrastructure creation for projects and need to stay invested for longer durations, even up to 4-5 years. Costly working capital creates a lack of a level playing field with global players.

TAX

The wind energy manufacturing industry faces issues linked to CVD (Countervailing Duty) which is levied in lieu of and equivalent to Excise Duty (ED) on basic value of imports. CVD is levied equivalent to ED to bring import prices at parity with domestic market prices. As per Excise Notification 6/2006, Clause 84, List 5, there is a provision for ED exemption for wind operated generators and its components. However, the tower is not considered as part of the generator and hence if it is imported, a CVD of 12.36% becomes an additional cost for the manufacturer (CBEC, 2012). In the set-up of excise also, certain equipment like parts of sub-parts for wind turbines do not qualify. Hence, the manufacturer has to pay ED for input goods but it cannot claim it on the output as ED is exempted. This becomes an additional cost for the manufacturer. There is a lack of a stable and consistent tax/duty structure that could support manufacturers.

The domestic industry continues to suffer from cost disadvantage of higher local taxes such as VAT, Octroi, and entry tax. With the implementation of the Goods & Services Tax (GST), manufacturers could get relieved from multiple tax regimes but there is still no clarity about the benefits which are applicable for RE component manufacturers and developers.

R&D AND OTHERS

The promotional measures for R&D and workforce development need to evolve. The operational incentives for workforce recruitment, training support and wage subsidies, and subsidies for R&D projects at the national level, during various stages have to be awarded. RE technologies require large investment in R&D and hence seek government facilitation. This is a critical area for development in India. In countries like China, R&D expenditures on big turbines have been earmarked for VAT refunds and the Ministry of Science and Technology (MoST) has subsidized wind energy R&D expenditures at varied levels over time through initiatives like the establishment of a renewable energy fund (Lema, Berger, & Schmitz, 2013). Such incentives directed at R&D would be required for the growth and development of renewable energy manufacturing in India.

Although, India has created NCEF in 2011 with an objective of funding research and innovative projects in clean energy technology, it is observed that the utilization of funds from NCEF has been rather low and disbursements, so far, are aligned more with on-going programs/missions of various ministries/departments than with the stated objectives of the fund. This poses a potential risk of diluting the focus of NCEF with adverse implications for research and innovation in India's clean energy sector (NIPFP, 2013).

Budget 2013-14 has proposed an investment allowance[47] at the rate of 15% to a manufacturing company that invests more than Rs 100 crore in plant and machinery during the period April 1, 2013 to March 31, 2015. However, according to FICCI, "The threshold for minimum investments needs to be reduced from Rs 100 Crore to Rs 10 Crore to encourage investments by smaller investors and MSMEs. Further, the allowance should be increased from two years to five years" (FICCI, 2013c).

SKILL AND CAPACITY DEVELOPMENT

The availability of skilled manpower and capacity building are areas which need to be adequately addressed. Although, the National Skill Development Commission (NSDC) affiliated skill development institutions which were included in the negative list of service tax in 2011-12, the provision was removed in 2012-13 (FICCI, 2013c).

The recent notification from the Central Board of Direct Taxes (CBDT) on the approval of weighted deduction for skill development under section 36CCD is a welcome step to encourage participation in skill development. But, it excludes corporates that are conducting in-house training in facilities that are not approved by the National Council

47 A tax incentive to encourage capital investment in which the deduction of specified percentage of capital costs, including depreciation, from taxable income is allowed.

for Vocational Training (NCVT) or State Council for Vocational Training (SCVT).

Further, as the definition of "company" provided in the guidelines does not include "companies engaged in skill development", stand-alone skill development providers are not eligible for the deduction. Thus, only company programs offering training become eligible. Besides, the definition of "training institutes" excludes NSDC's training partners, Sector Skill Council (SSC) certified institutes and any private institution conducting training for the sector which are not certified by NCVT or SCVT.

In addition to the gaps mentioned above, the regulatory and procedural complexities have also led to delays in setting up manufacturing facilities and renewable power development, thus discouraging investors.

WAY FORWARD

Financing of renewable energy is a critical challenge due to high cost of debt, high risk perception and less awareness on renewable technologies. It is therefore essential to ensure that funds are made available to OEMs and for purposes of research, development and induction of new and disruptive technologies. Financing to manufacturers can be provided on the lines similar to China where a subsidy to the tune of 600RMB/kW (equivalent to INR 61 lakhs /MW [48]) for the first 50 MW size wind turbine produced by a company is provided. Similarly funds are available to manufacturers in the US as well, such as the Edison Innovation Clean Energy Manufacturing Fund in New Jersey State. These grants can be used for site identification, procurement, design and permits. Moreover, construction and project completion loans are available at low rates of 2% (New Jersey Economic Development Authority, 2012). A Renewable Energy Manufacturing Fund for India can also be proposed on similar lines.

Export promotion, especially for wind which is now a mature technology in India should be provided through EXIM Bank by providing long-term export finance at LIBOR+1% to 2% with 3 years moratorium period and payback period of 10 to 15 years. Lines of credit should be project-specific, depending on the specific project requirements of the recipient country and procedures must be simplified. More funds need to be allotted to the banking sector to finance exports from India. For wind power, it is often noticed that the existing EXIM's line of credit is inadequate for export. For China, the line of credit extended goes up to $2 billion for 4-5 years period, while for India it is only $200 million for one year. Indian exporters also have to incur extra logistics cost, since the shipping route is via Dubai/Singapore. To increase wind turbine export from India establishing portfolio fund like US-EXIM or China–EXIM may prove helpful.

India does not have its own standards and specifications for wind technology suited to the Indian climatic conditions; the National Institute of Wind Energy (NIWE) neither has the capacity or expertise for certification of new turbine model. For certification of new turbine model NIWE needs a global certification of turbine model, which renders a re-certification by NIWE redundant. Even after international certification, NIWE takes a long time to certify it again and include it in Revised List of Models and Manufacturers (RLMM) list. Indian wind turbines need to be developed according to Indian climatic conditions, for this there is a need to develop indigenous standards and benchmarking for wind turbines. For Solar technology, the National Institute of Solar Energy (NISE) is the

48 1 RMB = INR 10.21 as of Jan 2015

body identified by MNRE for testing and certifying PV modules. CBTL, TUV Rheinland and UL are also approved by MNRE for testing modules and balance of system. It costs approx. Rs. 25-27 lakhs per project for testing which acts as a deterrent. Also, India doesn't have India specific standards for PV modules. In addition, Certification of modules which is currently not mandatory should be mandated.

Availability of skilled manpower and capacity building are areas which need to be adequately addressed. As per Construction Industry Development Council (CIDC) estimates, only 3-5% of the total blue collared workers in the Indian power sector have received formal training. A Power Sector Skill Council (PSSC) has been proposed to ensure adequate capacity of skilled and certified manpower in various segments of the power industry including renewables. The PSSC will identify critical roles where major skill gaps exist, develop curriculum and courses, execute training of instructors and build affiliation and accreditation processes to impart skills that increase employability and technical expertise (Global Peers Management Group). Key institutions such as NIWE and NISE can be strengthened through capacity building programs in cooperation with private sectors. Renewable sector specific courses for technicians, engineers as well as master's and doctorate level courses can be introduced for ensuring availability of skilled manpower in this sector.

ANNEXURE 7: CONSTITUTION OF THE EXPERT GROUP – TERMS OF REFERENCE

P-11071/8/2015-RE (P&E)

NITI Aayog

NITI Aayog, Sansad Marg

New Delhi, dated June 02, 2015

OFFICE MEMORANDUM

Subject: Setting up an Expert Group for exploring the possibilities of Grid connected Rooftop Systems and various business models which can be implemented in the country.

In pursuance of MNRE's D.O. No. JS)NSM)/MNRE/2015 dated 22.04.2015 on the above subject and the minutes of the EFC issued vide Department of Expenditure's O.M. No. 59(06)/PFII/2009 (Part) dated 12.05.2015, the Competent Authority has approved constitution of an Expert Group for exploring the possibilities of Grid connected Rooftop Systems and various business models which can be implemented in the country as per following composition:

Sl. No.	Name and Organisation	Status
1.	Sh. Anil Kumar Jain, Adviser (Energy), NITI Aayog	Chairman
2.	Sh. Ashwin Gambhir, Prayas Energy Group, PUNE	Member
3.	Sh. Anshu Bhardwaj, CSTEP, Bengaluru	Member
4.	Sh. Deepak Gupta, Shakti Sustainable Energy Foundation	Member
5.	Sh. Rajnath Ram, Joint Adviser	Convener

2. The Expert Group will also recommend the overall enabling policy framework for achieving the target of 175 GW of Renewable Energy capacities by 2022.

3. The Expert Group will be assisted by Sh. Gireesh Shrimali, Faculty Fellow, CPIISB Energy and Environment Program at the Indian School of Business.

4. The Group will consult Department of Renewable Energy in three RE resource rich States i.e. Rajasthan, Andhra Pradesh and Maharashtra.

5. The Group will submit its report in six weeks' time from the date of constitution and will have option to co-opt other members to assist the Group.

(Rajnath Ram)

Joint Adviser

1. Sh. Anil Kumar Jain, Adviser (Energy), NITI Aayog , Sansad Marg, New Delhi
2. Shri Ajay Jain, Secretary (in-Charge), Energy Department , FDC Complex, Opposite Mahaveer Hospital, A C Guards, Hyderabad, Andhra Pradesh, Hyderabad 500 001
3. Sh. Sanjay Malhotra Pr. Secretary to Government, Energy Department Government of Rajasthan, Room No. 8340, SSO Building, Government Secretariat, Jaipur, Rajasthan.
4. Shri Mukesh Khullar, IAS, Principal Secretary- Energy, Main Building Mantralaya, Mumbai400032
5. Sh. Ashwin Gambhir, Prayas Energy Group, Unit III A & B, Devgiri, Near Sangam Press, Kothrud Industrial Area, Joshi Railway Museum Lane, Kothrud, Pune, Maharashtra 411038
6. Sh. Anshu Bhardwaj, CSTEP, No.18, Mayura Street, 10th Cross, Papanna Layout, Nagashettyhalli, RMV 2nd Stage, Bengaluru, Karnataka 56009
7. Sh. Deepak Gupta, Shakti Sustainable Energy Foundation, Capital Court, 104 B/2, 4th Floor, Munirka Phase -III, New Delhi 110067.
8. Sh. Gireesh Shrimali, Faculty Fellow, CPI-ISB, 450 Serra Mall, Stanford, CA 94305, Stanford University ,United States

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10. PPS to CEO, NITI Aayog
11. Secretary, Ministry of Power, Sham Shakti Bhawan, New Delhi
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13. Secretary, Ministry of New Renewable Energy, CGO Complex, Block 14, Lodhi Road, New Delhi