175 GW

RENEWABLES BY 2022

Investment (2016-22)
~ ₹ 7.5 lakh crore

Generation
~ 350 Billion Units,
17 % of total

Capacity Addition (2016-22)
~ 3 MWs of RE for every
2 MWs of thermal

Jobs
~ 13 lakh
(Wind & Solar)

Avoided Emissions
~ 280 MillionTonnes
of CO2eq

Consumptive
Land use
~ 2.6 lakh hectares
(Wind & Solar), 0.08% of
land in India

Generation Capacity
~ 32 % of total

INDIA'S JOURNEY TOWARDS 175 GW RENEWABLES BY 2022

प्रयास
Prayas (Energy Group)

India's Journey towards 175 GW Renewables by 2022

Ashwin Gambhir | Rohil Jethmalani | Jatin Sarode | Nikita Das | Shantanu Dixit

October, 2016

Prayas (Energy Group)

About Prayas

Prayas (Initiatives in Health, Energy, Learning and Parenthood) is a non Governmental, non-profit organization based in Pune, India. Members of Prayas are professionals working to protect and promote the public interest in general, and interests of the disadvantaged sections of the society, in particular. Prayas (Energy Group) works on theoretical, conceptual regulatory and policy issues in the energy and electricity sectors. Our activities cover research and intervention in policy and regulatory areas, as well as training, awareness, and support to civil society groups. Prayas (Energy Group) has contributed in the energy sector policy development as part of several official committees constituted by Ministries and Planning Commission. Prayas is registered as SIRO (Scientific and Industrial Research Organization) with Department of Scientific and Industrial Research, Ministry of Science and Technology, Government of India.

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About the Cover
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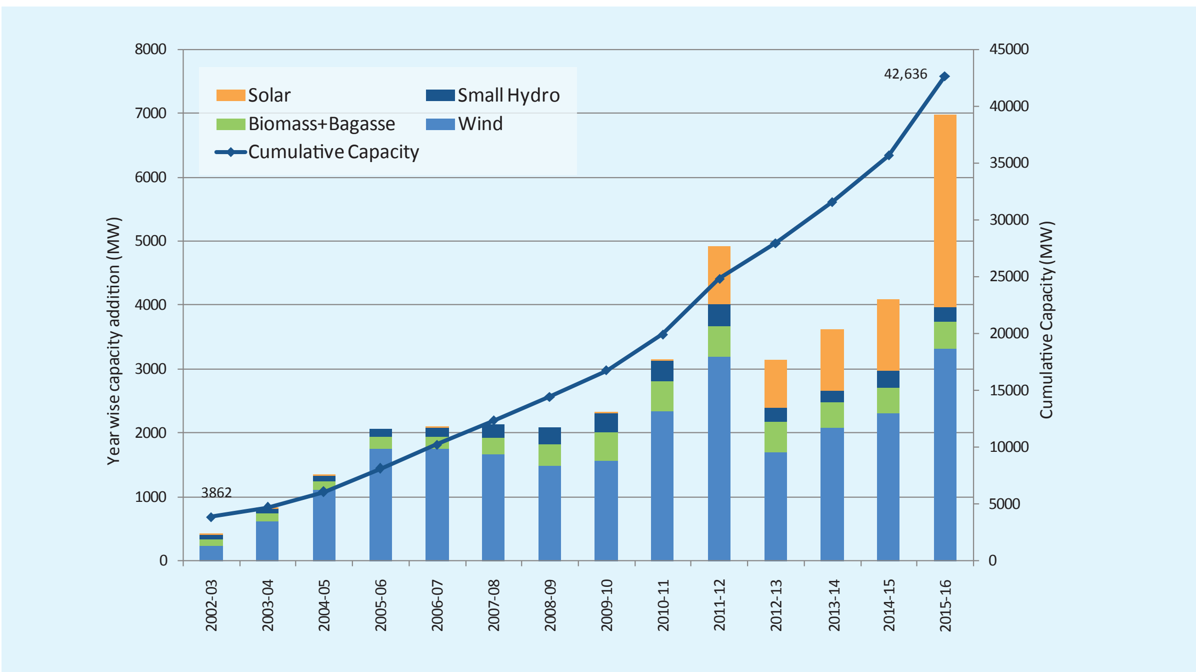
1. Introduction

Large scale grid connected renewable energy (RE) based power generation has come of age in India. A strong policy and regulatory support framework of the Government of India (GoI) and some states, especially since the passing of the Electricity Act, 2003 has built a solid foundation for the growth of renewables in the country. Further, significant cost reductions in renewables, especially solar PV, coupled with their vast resource potential, have finally made them a serious mainstream generation supply option. In 2002, renewable generation capacity (3.4 GW) constituted a very small share of 3.2% in the overall generation capacity in the country. However, from 2002 to 2016, the sector has seen an exponential growth resulting in 42.6 GW as on March 2016 (Figure 1). During this period, renewable generation capacity grew at a compound annual growth rate of 20%. In comparison, thermal and nuclear capacity grew at 7.7% and 5.6% respectively. Renewable energy's contribution to overall generation capacity[1] is now 14.1%, nearly 4.5 times the 2002 share. While the share of RE has increased from 3.4% to 14.1%, over this time, the share of large hydro reduced from 25% to 14%. The combined share[2] of large hydro and RE has remained more or less stable at 28% during 2002-16, though it went up to as high at 33% in 2007.

Figure 1: Past growth in renewable energy generation capacity (2002-16)



Source: Prayas analysis based on compilation from various Ministry of New and Renewable Energy (MNRE) publications.

However, what has really attracted attention with regard to renewables is the announcement of a medium term national target during the 2015 union budget speech. India's official renewable energy target now stands at an ambitious 175 GW

1. Without considering captive generation capacity

2. The combined share of large hydro and renewables could become important in the future, as there is a proposal being considered by the Ministry of Power for declaring large hydro power as 'renewable'.

by 2022 (PTI, 2015). While the bulk of this capacity would comprise of solar and wind power (100 and 60 GW respectively), the remaining 15 GW would be made up of biomass power (10 GW) and small hydropower (5 GW).

The 175 GW target was further noted as part of India's Intended Nationally Determined Contributions (INDC) submission to the UNFCCC, though not as part of the official pledge, but as part of the various mitigation strategies. Among other things, the INDC aims to reduce the emissions intensity of the country's GDP by 33% to 35% by 2030 from the 2005 level, and to achieve about 40% cumulative electric power installed capacity from non-fossil fuel based energy resources by 2030 (GoI, 2015) (GoI, 2015). No doubt renewables will provide the mainstay of such contribution, possibly even overtaking conventional capacity addition in the coming years. Renewable energy and energy efficiency are also an important part of India's commitment to achieving the Sustainable Development Goals (SDGs) during 2016-2030.

While the environmental benefits of renewables both for the local ecology as well as mitigating climate change are well known, some of their other macro-economic contributions have not been fully appreciated as yet. Their contribution towards increasing the country's energy security and reducing the Current Account Deficit[3] add to their value as supply resources. Absence of fuels (especially with respect to wind and solar) and minimal operation costs make renewables amenable to long term Power Purchase Agreements (PPAs) based on fixed levelised prices, thus reducing electricity price volatility and lowering future risks. Finally, renewables have very low gestation periods, as low as one year for wind and solar power, resulting in low Interest During Construction (IDC) costs.

In spite of these benefits, the high target has profound implications and can throw up myriad challenges for the Indian power sector, especially in the short run. The relatively higher upfront renewable energy tariffs act as a hindrance for large scale uptake by Distribution Companies (DISCOMs), especially for those in weak financial health. Secondly, a high percentage of variable renewable generation will fundamentally change the nature of the electricity grid planning and operation over the long run. Therefore, transmission planning and pricing, operation of conventional generators and their pricing mechanisms, grid codes etc., will have to change appropriately. Given the absence of fuels in wind and solar power generation, nearly all their cost constitutes upfront capital investments for generation and transmission equipment. Wind and solar power projects[4] would approximately need Rs. 7-8 lakh crores of capital investments during 2016-22.

Given these aspects, it is vital for the electricity sector policy makers and regulatory officials to critically look at the growth of renewables, given its various benefits and possible challenges for the sector as a whole. This report is an endeavour in this direction. It attempts to understand the growth of renewables in the past few years

3. RE helps avoid imports of costly fossil fuels (especially coal) and thereby contributes to macro-economic stability. This is particularly important given that India is one of the world's foremost coal importers with 200 MT of imports in 2015-16. The share of energy in India's total current account outflows was over 30% in 2013-14, while net energy imports were just below 8% of Gross National Product in 2013-14. (MoPNG, 2015) (CCO 2015) (MoF, 2015)

4. Considering both generation and transmission equipment.

and examine the country's progress towards reaching the policy goal of 175 GW by 2022. This is captured through various graphs and tables which the report focusses on, relying less on a narrative. This report is part of ongoing research by Prayas (Energy Group) looking at renewable energy developments in the country. The report analyses some of the important policy-regulatory instruments as listed in Figure 2 which have enabled the past and expected future growth in RE.

Figure 2: Significant policy and regulatory instruments analysed in the report

2. Renewable Energy Targets

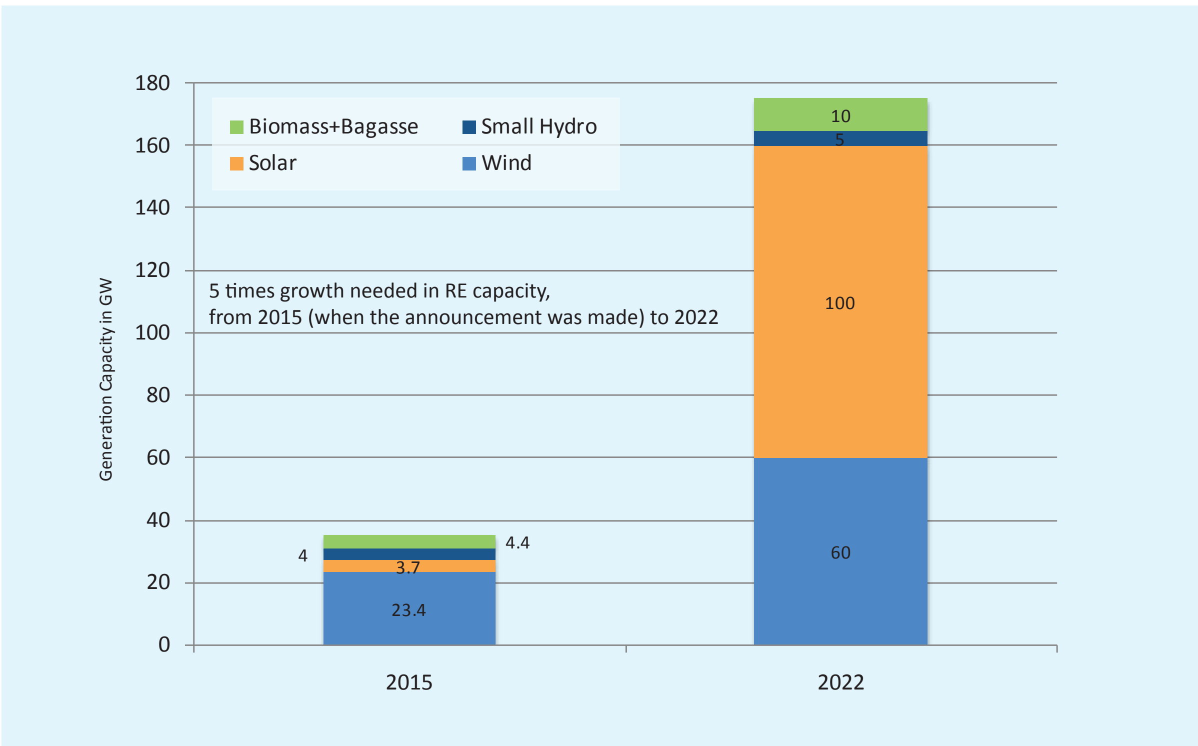
Electricity is part of the Indian Constitution' concurrent list. This has allowed the GoI as well as states to set national and state specific renewable energy targets respectively in the past.

2.1 National Targets

The earliest guideline for a national renewable energy target was outlined in the National Action Plan on Climate Change (NAPCC) in 2008, which recommended a 15% renewable penetration in energy terms by 2020. This was followed by the 2015 announcement of a national capacity target of 175 GW by 2022.

The 175 GW target implies a quintupling of RE capacity from 2015 to 2022 (Figure 3). While the mainstay of RE capacity growth in the past has been from wind power, solar power is rapidly increasing its share and is expected to grow much faster than wind in the coming years. While wind and solar power make up 63% and 16% of existing RE capacity (March, 2016), their capacity growth rates over the last four years have been 11.4% and 63.7% respectively. MNRE's flagship event in February 2015, 'RE-Invest' garnered massive support from private developers to develop a potential of 217 GW (Solar: 166 GW, Wind: 45 GW) in the next five years. (MNRE, 2015) (MNRE, 2015) Assuming that all of the 175 GWs would be in place by 2022, the share of RE capacity would sharply rise from 14.1% to 32.2 % in just six years (Figure 10).

Figure 3: RE generation capacity (GWs) as of March, 2015 and targeted by 2022



Source: MNRE .

While the year-wise and segment-wise (rooftop/utility-scale) breakup of solar capacity addition planned from 2015 to 2022 is available from MNRE, for all the rest of the resources (wind, biomass and Small Hydro Power (SHP)), only the final targeted capacity by 2022 is known. Based on an implicit CAGR needed from 2016-22 to achieve 2022 targets, we have estimated yearly capacity addition needed in wind, biomass and SHP. Thus, assuming that capacity addition in wind, biomass and SHP takes place at a steadily increasing rate, yearly capacity addition from all renewables would roughly need to be 19 GW (2017-18), 21.5 GW (2018-19), 23.5 GW (2019-20), 25 GW (2020-21) and a high of 26.3 GW in the terminal year, 2021-22 (Figure 4).

Evolving national solar targets

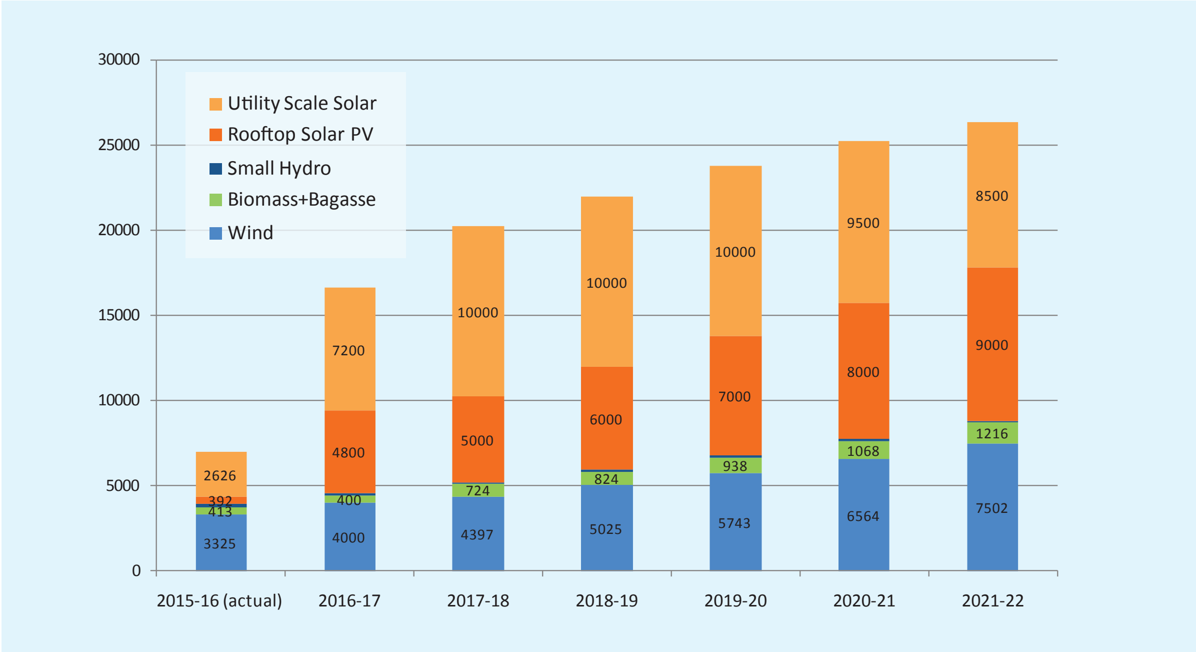
The national solar mission launched in 2009 had originally set the 2022 target at 22 GW. A subsequent amendment to the national tariff policy in 2011 recommended all states to have a 3% solar RPO by 2022, translating to a target of 34 GW by 2022 (Table 1). In 2015, the solar mission's target was significantly revised upwards to 100 GW. In line with this, the tariff policy was amended in 2016, recommending State Electricity Regulatory Commission (SERCs) to set solar RPOs to reach 8% of total consumption of energy, excluding hydro power, by March 2022 (MoP, 2016). This roughly translates to a capacity of 85 GW. At present, solar targets specified under state policies add up to only ~ 59 GW and not the 100 GW national target. One reason for this mismatch is that all state policies do not necessarily specify targets for 2022. Targets have been specified for years which range from 2017 to 2022.

Table 1: Evolving solar targets (in GW) for 2022

Original National Solar Mission target set in 2009	National solar requirement as per National Tariff Policy (NTP) amendment in 2011, requiring 3% solar by 2022	Addition of State Policy Targets as of Feb 2016	Revised national solar target announced in 2015 budget	Broad national solar requirement as per NTP amendment in 2016, requiring 8% solar by 2022 excluding large hydro (assuming demand as per 18th EPS)
22	34	59	100	85

Source: Prayas analysis based on various sources - MNRE, State solar policies, Central Electricity Authority (CEA), Ministry of Power (MoP).

Figure 4: Year-wise RE targeted capacity addition during 2016-2022



Source: Prayas analysis based on compilation from various MNRE publications. Rooftop capacity addition in 2015-16 is roughly estimated at 13% of total solar capacity addition in 2015-16.

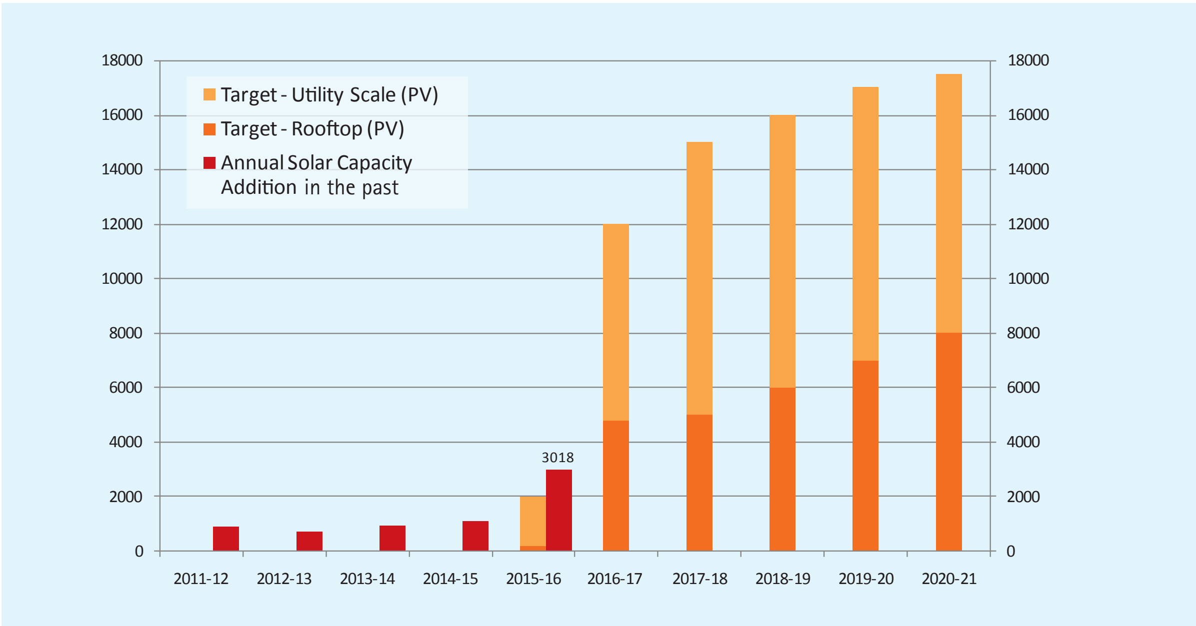
2.1.1 A closer look at solar targets within 175 GW

Of the 175 GW, the primary resource is solar, slated to contribute 100 GW (57%) of the total. Within this 100 GW, 60% is to come from large MW-GW scale solar projects, while 40% is to come from distributed rooftop solar PV projects (Figure 5). Most of large MW scale utility projects are expected to come up in solar parks. These parks will have appropriately developed land with all clearances, a transmission system, water access, road connectivity, communication network, etc. The Solar Energy Corporation of India (SECI) is developing these solar parks in collaboration with the respective state governments. The choice of implementation agency is left to the state governments. It could be done by a) the designated state PSU, b) a joint venture between SECI and the state PSU, c) SECI, d) private entrepreneurs. The implementation agency may sell or lease land plots to prospective developers. As of March 31st 2016, 33 solar parks across 21 states, totalling 19,900 MW, have received administrative approval (SECI, 2016) (See Fig 32 in Annexure for a state-wise breakup of solar parks). MNRE is considering a second phase of solar parks for twice the capacity, i.e. 40 GW to come up across 25 states (Chandrasekaran, 2016). The GoI is also promoting so called 'solar zones' which will be similar to solar parks except that the onus of land procurement would lie with private developers (Prasad, 2015).

2016-17 is a key milestone while progressing towards the 2022 target. MNRE has targeted a total RE capacity addition of 16.6 GW this year of which the bulk is from solar (12 GW) followed by wind (4 GW). The previous highest capacity addition in any year was in 2015-16 when 6.7 GW was added (Wind 3.3 GW; Solar 3 GW). To achieve 2016-17 RE targets, a growth rate of 138% over 15-16 capacity addition would be needed. In comparison, growth rate from 2014-15 to 2015-16 was only 71%.

Hence solar capacity addition would need to quadruple on a year-to-year basis while wind needs only a 20% growth. Annual solar capacity addition grew 168% from 2015 to 2016, while growth needed from 2016 to 2017 is 303%. Annual solar capacity addition for 2016-17 was estimated by MNRE in January, 2016 to be roughly 12.1 GW, of which 6.7 is with GoI support (including 1 GW rooftop projects), while the balance 5.4 MW is from state projects. Bidding is complete for most of this capacity while for some it is in process. (MNRE, 2016) (MNRE, 2016) However the breakup of the 2016-17 MNRE target notes that 4.8 GW is to come from rooftop PV, while only the balance, 7.2 GW is from utility scale projects. But a look at past performance (Figure 5), capacity already tendered and market estimates suggests that while India may be able meet the utility scale solar sub-target for 2016-17, it may fall short of the 2016-17 rooftop PV target.

Figure 5: Year-wise solar capacity addition and targets



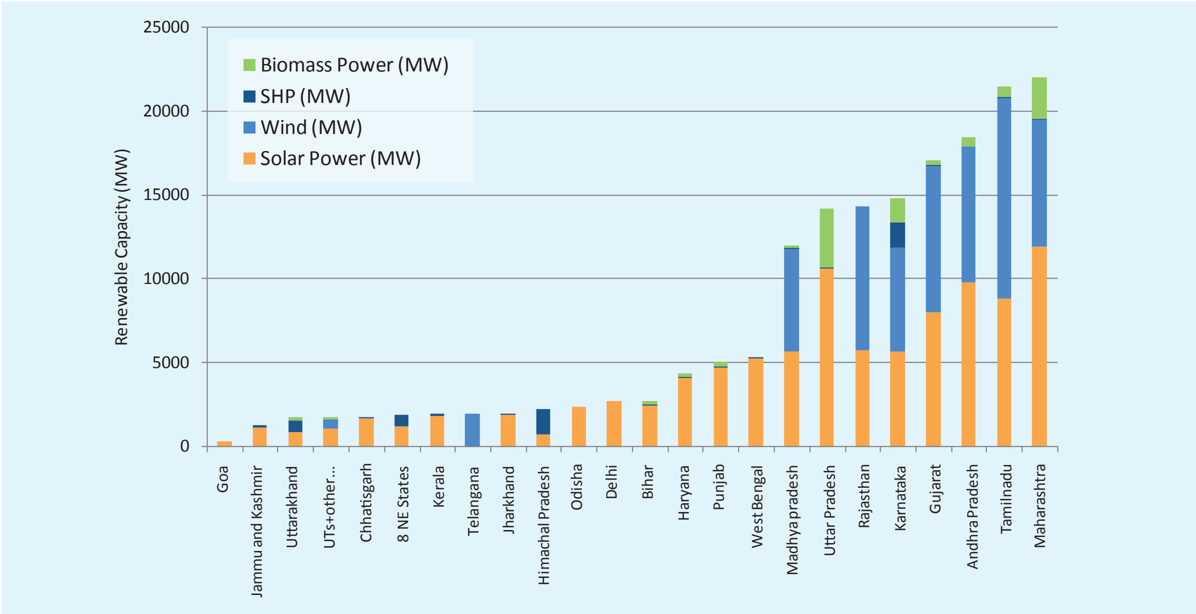
Source: Prayas analysis based on compilation from various MNRE publications.

2.1.2 State-wise allocation of national targets

The state-wise breakup of the 175 GW target as expected by MNRE is shown in Figure 6, while the state-wise and year-wise breakup of the 40 GW rooftop target is shown in Figure 7.

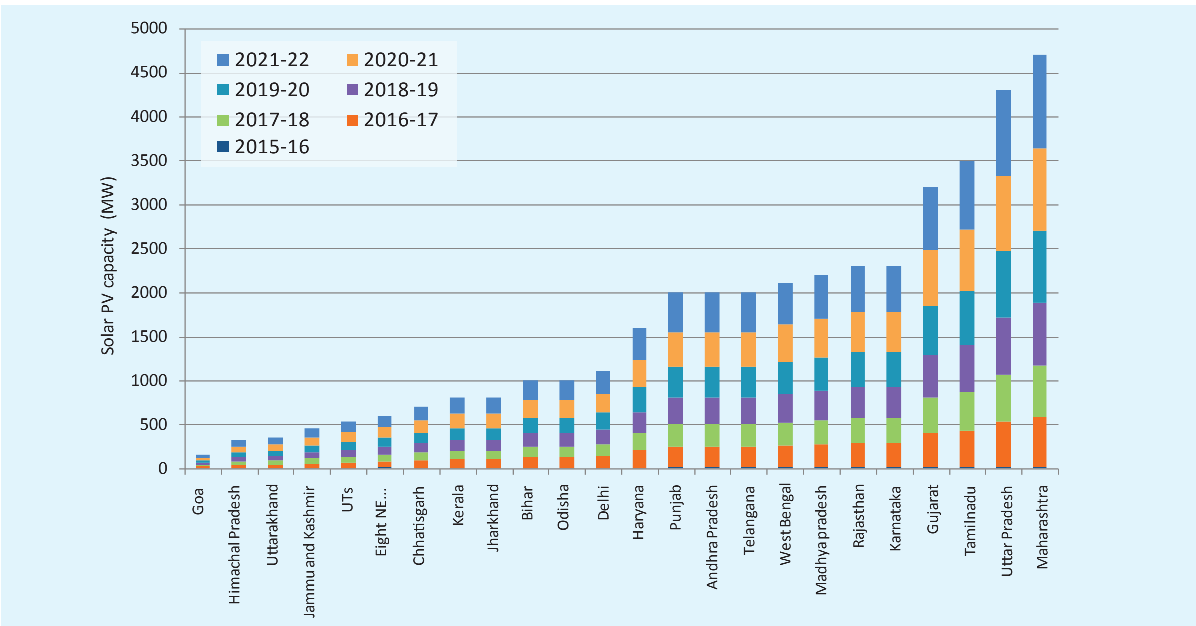
Just five states (Maharashtra, Tamil Nadu, Andhra Pradesh, Gujarat, and Karnataka) are expected to contribute 94 GW (54% of the total), while the top ten states (including Rajasthan, Uttar Pradesh, Madhya Pradesh, West Bengal, and Punjab) make up 145 GW (83% of the total). The bulk of the capacity is expected to be concentrated in the southern and western regions which are not only areas with higher consumption but also with better renewable energy resources. The state-wise rooftop solar allocation is not as concentrated as the 175 GW allocation. The top five states (Maharashtra, Uttar Pradesh, Tamil Nadu, Gujarat, and Karnataka) are expected to contribute 18 GW (45% of the total), while the top ten states (including Rajasthan, Madhya Pradesh, West Bengal, Tamil Nadu, and Andhra Pradesh) make up 28.6 GW (72% of the total).

Figure 6: State-wise allocation of the 175 GW target



Source: MNRE.

Figure 7: State-wise year-wise allocation of the 40 GW rooftop capacity



Source: MNRE.

2.2 State Renewable Energy Targets

2.2.1 State Solar Policy Targets

While MNRE has outlined a tentative state-wise allocation of the 100 GW national solar target (Figure 6), various state governments have over the last four to five years set their own solar/RE policies setting targets for their states. At present such state policy solar targets add up to roughly to 59 GW (Table 2).

Table 2: State-wise solar targets under state policies

Sr	Date	Policy/Scheme	Target (MW)	Target Year
1	13.08.2015	Gujarat solar policy	1170	2016-17 #
3	01.07.2012	Madhya Pradesh solar policy	550	2016-17 #
4	20.10.2012	Tamil Nadu solar policy	3000	2015
5	01.11.2012	Chhattisgarh solar policy	1000	2017
6	26.12.2012	Punjab (NRSE) policy	1000	2022
7	10.08.2015	Jharkhand solar policy	2600	2020
8	01.03.2013	Uttar Pradesh solar policy	500	2017
10	27.06.2013	Uttarakhand solar policy	500	2017
11	01.07.2013	Odisha solar policy	135	2015
12	25.11.2013	Kerala solar policy 2013	2500	2017
13	22.05.2014	Karnataka solar policy (2014-2021)	2000	2021
14	14.03.2016	Haryana solar policy 2016	3200	2022
15	08.10.2014	Rajasthan solar policy 2014	25000	Not specified
16	16.02.2015	Andhra Pradesh solar policy	5000	2020
17	05.06.2012	West Bengal policy on RE	500	2017
18	10.02.2015	Maharashtra RE policy	7500	2019
19	2015	Telangana solar policy	2000	2019
20	2016	Himachal Pradesh solar policy	776	2022
21	Sep. 2015	Delhi solar policy	1995	2025
		Total	**58,931**	

Source : Prayas analysis based on various state solar / RE policies and RPO regulations.

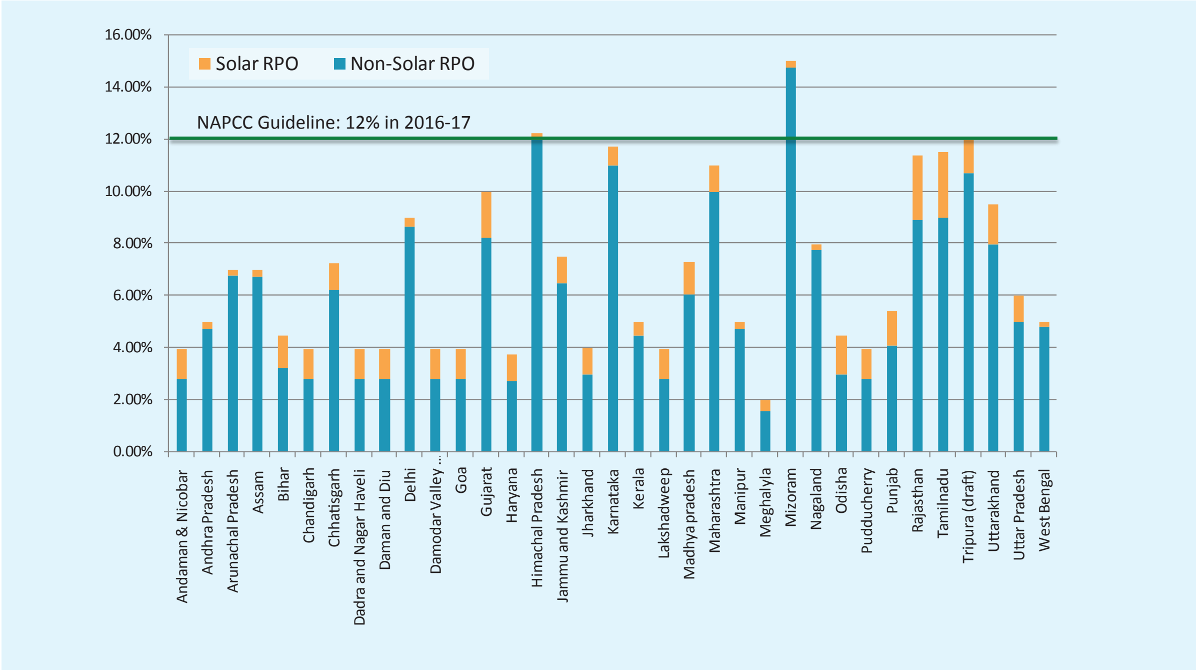
Note: Gujarat and Madhya Pradesh do not have fixed targets under their solar policies but mention that the RPO determined by SERCs will act as a target. 1170 and 550 MW is based on a solar RPO of 1.75% and 1.25% respectively.

2.3 SERC Notified Renewable Purchase Obligations (RPOs)

RPOs are minimum renewable energy targets which are specified in percentage terms in proportion to total electricity consumption. Such RPOs are applicable to three types of obligated entities which are DISCOMs, Open Access consumers and Captive consumers. SERCs are mandated to specify year wise RPOs in accordance to section 86 (1) (e) of the Electricity Act, 2003. Figure 9 shows how these have evolved over the last three years. For FY 2016-17, the weighted average of total (solar and non-solar) RPO targets of states is around 6.6%, considerably less than 12% as was expected under the National Action Plan on Climate Change (NAPCC). Only two small states, Himachal Pradesh and Mizoram, exceed the NAPCC benchmark. In 2008, NAPCC had outlined a vision of reaching 15% RPO by 2020, beginning with 5% in 2010.

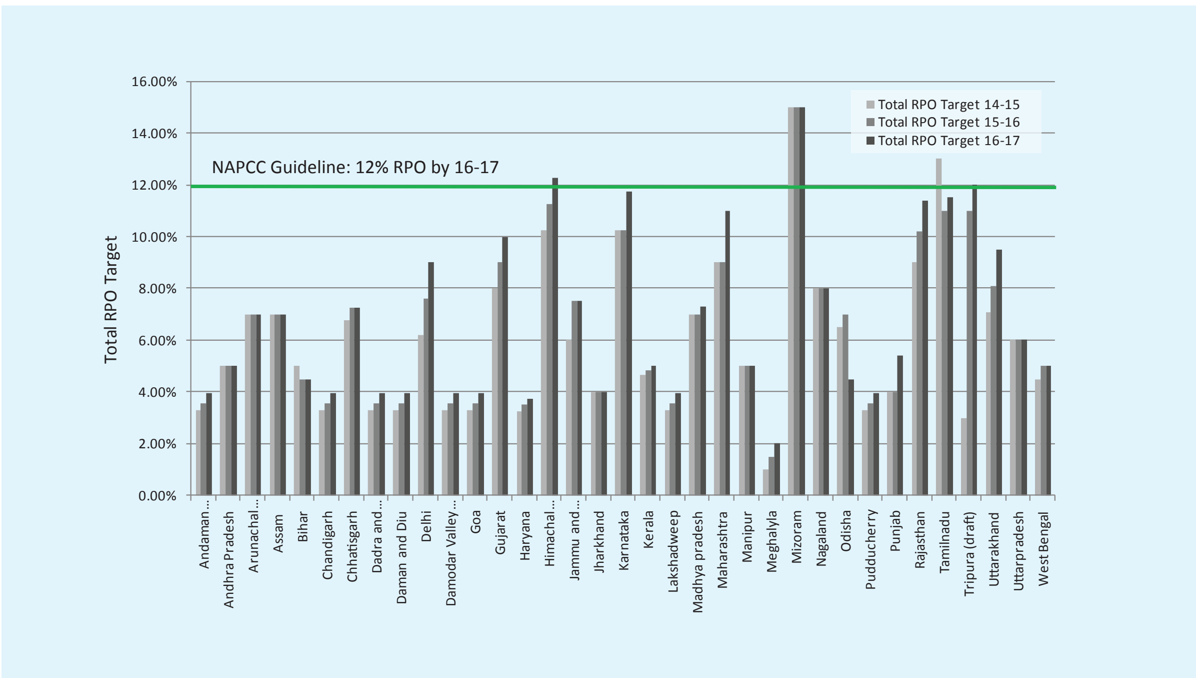
Solar RPOs presently specified by SERCs are significantly lower than those expected under the National Solar Mission. Of the large states, only Gujarat, Rajasthan and Tamil Nadu have a sizeable solar RPO, at 1.75%, 2.5% and 2.5% respectively for 2016-17 (Figure 8). Tamil Nadu has set its solar RPO to a high of 5% for 2017-18. The weighted average of all state solar RPOs for 2016-17 is only 1.2%, and will need significant upward revision to come in line with the desired 8% by 2022 as per the NTP.

Figure 8: State-wise solar and non-solar RPOs in 2016-17



Source: Various ERC regulations, REConnect Newsletters.
Note: Karnataka non-solar RPO varies by DISCOM, 11% non-solar RPO shown in table is applicable for three of the six DISCOMs.

Figure 9: Year-wise evolution of total RPOs in states in comparison to NAPCC guideline



Source : Various ERC regulations, REConnect Newsletters.
Note: Karnataka non-solar RPO varies by DISCOM, data shown above is representative.

2.3.1 RPO Compliance

State nodal agencies are expected to monitor RPO compliance, but credible and timely availability of such data in the public domain is critically missing. Some states did not have data for 2012-13 even in 2015. (APTEL, 2015) The most comprehensive RPO compliance data available in the public domain is for Maharashtra DISCOMs as noted in Table 3.

Table 3: RPO compliance for all DISCOMs in Maharashtra (2010-11 to 2014-15)

FY	RPO Targets		RPO Compliance							
			MSEDCL		BEST		TPC		Rinfra	
	Non Solar	Solar	Non Solar	Solar	Non Solar	Solar	Non Solar	Solar	Non Solar	Solar
2010-11	5.75%	0.25%	5.77%	0.00%	4.52%	0.00%	4.74%	0.00%	6.79%	0.00%
2011-12	6.75%	0.25%	7.14%	0.01%	4.52%	0.00%	6.78%	0.07%	4.69%	0.01%
2012-13	7.75%	0.25%	7.02%	0.03%	11.07%	0.00%	8.41%	0.07%	8.73%	0.82%
2013-14	8.50%	0.50%	7.69%	0.21%	8.65%	0.51%	8.62%	0.08%	8.55%	0.93%
2014-15	8.50%	0.50%	7.91%	0.25%	8.50%	1.08%	8.58%	0.83%	8.45%	0.77%

Source: Maharashtra Electricity Regulatory Commission (MERC, 2016).

For states in which compliance data is available, it suffers various problems like incomplete data for some years, non-availability of data for non-utility obligated entities (OA and CPP), lack of uniform format for accounting of RPOs across all states, lack of breakup of compliance through power purchase and RECs, etc. Some examples of problems with the data are noted below.

1. Maharashtra State Electricity Distribution Company's (MSEDCL) RPO compliance estimation for FY 10-11 and FY 11-12 had included the RE power wheeled through its network under OA, a case of double counting. For FY 11-12, if one drops the OA part, compliance drops sharply to 4.49% from 7.14%, much below the target of 7%. MSEDCL calculated RPO compliance by the MSLDC's Interim Balancing Settlement Mechanism (IBSM) report which does not differentiate between OA and utility RE procurement. The MERC has corrected this methodological error while checking RPO compliance in subsequent years.

2. A recent audit of the renewable energy sector by the Comptroller and Auditor General of India (CAG) noted an RPO compliance in Tamil Nadu of 20% (2013-14), though the TNERC reported a much lower compliance of 10.34% for TANGEDCO for the same year. (Comptroller and Auditor General of India, 2015) (TNERC, 2014)

Weak RPO compliance is partly a result of the weak enforcement of RPO regulations by SERCs which includes reduction in RPO targets in contrast to the NAPCC (which mandates yearly increasing RPO targets), incorrect RPO compliance accounting, postponing the deadlines for RPO compliance, allowing carry forward and cumulative compliance of non-complied RPO, using excess solar RPO compliance to adjust non-solar RPO non-compliance, not exploring the REC mechanism for RPO compliance, lack of penalty enforcement on obligated entities, neglecting the RPO compliance validation of OA and CPP consumers, etc.

While the SERCs of some states (Bihar, Uttarakhand and Jharkhand) have enforced penal provisions to a certain degree for RPO non-compliance, most have waived this provision. According to the CAG, the total combined RPO non-compliance from all states from 2010 to 2014 was about 28,231 MU which translates to a penal amount of Rs 4,234 crores (assuming a penal price as the REC floor price of Rs. 1500/non-solar REC).

Two important reasons why utilities continue to favour conventional thermal generation procurement over renewables are

a. Though competitive bidding has resulted in sharp decline in solar tariffs, the direct and upfront prices of solar and wind power are still not lower than existing coal generation (Datta, 2016). However, this situation is changing fast with the latest solar prices being comparable or even lower than those from new coal power plants. (CERC, 2016)
b. Lack of effective forecasting and scheduling regulations along with an associated penal mechanism for deviation imbalance settlement puts the entire onus of renewable grid integration on the host utility where the plant is located. This is expected to change in the coming years as appropriate regulations are put in place.

2.3.2 Medium Term RPO targets

According to the January, 2016 National Tariff Policy (NTP) amendment, *"Long term growth trajectory of Renewable Purchase Obligations (RPOs) will be prescribed by the Ministry of Power in consultation with MNRE."* Subsequently, the MoP issued such guidelines on 22nd July, 2016. These guidelines "notify" long term growth trajectories of RPO for states/UTs for the years 2016-17, 2017-18 and 2018-19 and are shown in the Table 4.

Table 4: RPO guidelines for states

Year	Non-Solar RPO	Solar RPO	Total RPO
2016-17	8.75%	2.75%	11.5%
2017-18	9.50%	4.75%	14.25%
2018-19	10.25%	6.75%	17%

Source: Ministry of Power.

However, unlike earlier RPOs which were specified as a percentage of total consumption, these *"obligations will be on total consumption of electricity by an obligated entity, excluding consumption met from hydro sources of power".* This appears to be in contradiction to the Electricity Act, 2003 which clearly specifies that RPOs should be specified in proportion to total electricity consumption. The MPERC has amended its RPO regulations in line with the MoP guidelines (MPERC, 2016). Similarly Andhra Pradesh has proposed a RPO of 25% on total consumption (excluding hydro power) by 2021-22 (APERC, 2016). Chattisgarh has proposed new RPO and REC regulations which have specified RPO targets upto 2020-21. Percentage targets specified by Chattisgarh upto 2018-19 are slightly lower than those proposed in the MoP guidelines, though since they apply as a percentage of total consumption (including large hydro), they are effectively higher than the MoP guidelines. (CSERC, 2016)

Additionally, the guidelines expect that the SERCs will set uniform RPOs across all states and UTs. This is somewhat contentious for various reasons listed below.

1. The financial health and consumer mix of DISCOMs varies widely across India. Most of the DISCOMs are making losses, while some (including the loss making ones) have a very low industrial/commercial consumer base. Hence the paying capacity/ability of each DISCOM for the relatively higher priced renewable power is quite different. Expectedly, some states are already resisting these new guidelines and are demanding more resource flexibility. (Shreya Jai, 2016) It is unlikely that states will agree to such uniform RPOs, especially given the history where solar and non-solar RPOs set by SERCs varied widely and even those have not been fully complied with.

2. Secondly, since the new RPOs have to be calculated on total consumption excluding hydro sources, states with a significantly higher share of hydro consumption (for example, Kerala, Karnataka) would effectively have proportionately lower RPOs even if their paying capacity may be high.

3. Hydro is one of the best balancing resources to manage peak load, as well as some short term potential additional imbalance due to renewables. By placing more renewables in states with lower hydro consumption, grid integration of renewables may become that much harder.

4. Lack of appropriate power procurement planning is already resulting in significant backing down of high cost thermal capacity in states like Maharashtra, Gujarat and Madhya Pradesh. High RPOs in such states could exacerbate this situation.

Finally, from an operational point of view, the above guidelines were released on July 22, 2016, though they specify RPOs for 2016-17. SERCs have fixed RPOs for 2016-17 before the beginning of the financial year and hence are unlikely to revise their RPOs mid-year.

With prices of utility scale solar PV now in the range of Rs 4.5-5/kWh, the erstwhile price differential between solar PV and wind/biomass/small hydro has disappeared. All indications are for solar PV prices to further drop in the coming years, making it possibly the cheapest renewable electricity option by 2020. Hence, the very basis for continuing the differentiation between solar and non-solar RPOs is debatable and will need to be addressed soon. Obligated entities should ideally be able to procure the cheapest form of renewables subject to technical grid constraints.

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

At present, there are at least four different avenues wherein state-wise solar targets are specified. These are a) State 'Power for All' (PFA) Plans, b) Solar RPOs notified by SERCs, c) State solar/RE policies, and d) MNRE allocation of national target to states. While the PFA plan and RPO regulations specify year-wise targets, state policy targets and MNRE allocated targets are for one terminal year. State targets have been specified for various years from 2015 to 2022, while the MNRE state-wise allocation is known only for 2022. To compare these four estimates for any one year, say 2015-16, one would need to break up the state policy target and MNRE allocation into year-wise targets. This can be roughly estimated based on an implicit CAGR needed from 2015-22 to achieve the MNRE state-wise 2022 targets. A similar method can be used to estimate the rough year-wise state policy target. These results from our analysis are presented in Table 5. The large variation in these estimates is striking. It is particularly true in the case of Madhya Pradesh, Andhra Pradesh, Rajasthan and Karnataka. A similar comparison for the year 2016-17 is presented in Table 6.

This mismatch between state policy targets, SERC notified RPOs and national requirements will have to be reconciled quickly. This calls for a concerted effort for greater coordination and consensus building between states, centre as well as other important institutions involved in the solar sector. MNRE has already initiated steps asking states and SERCs to come out with an action plan for this purpose. (MNRE, 2016c) This is aptly captured through a quote by the Minister for Renewable Energy, recently speaking on the issue of solar targets. The Minister noted that, *"… going forward, there was a need to reconcile the interests of the state distribution companies, consumers, and the central government. One will have to balance political compulsions and the economies of the DISCOMs when it comes to giving a thrust to renewable energy. So, in that sense, there must be a great deal of interaction between regulators, state DISCOMs, consumers and the government."* (The Hindu Businessline, 2016)

Table 5: Comparing state-wise 2015-16 solar targets

Solar capacity (MWs)	Actual installed (May, 2015)	Expected at the end of March, 2016 as per PFA Plan	Estimated at the end of March, 2016 as per SERC's RPO requirements	Estimated at the end of March, 2016 as per MNRE state targets	Estimated at the end of March, 2016 as per state policy	Actual installed (May, 2016)
Maharashtra	364	379	426	599	666	386
Gujarat	1000	1097	933	1346		1119
Madhya Pradesh	564	1055	375	784		780
Andhra Pradesh	247	907	76	419	456	864
Rajasthan	1047	2230	810	1336	1648	1285
Karnataka	78	1578	97	144	134	146
Haryana	13	133	108	29	28	15
Punjab	195	724	57	308	247	430
Tamil Nadu	148		1169	266	3000	1267
Uttar Pradesh	71		639	146	189	143

Source: Prayas analysis based on state PFA plans, state RPO regulations, state RE/solar policies and MNRE.

Note: The Tamil Nadu Solar Policy targeted 3000 MW by 2015. The analysis assumes the same target for 2016 and 2017. Year-wise state targets through MNRE allocation and state policy have been estimated based on average growth rates needed to achieve targeted capacity in final year. Capacity needed under solar RPO is estimated based on a CUF of 19% for solar, assuming all the capacity would come up in the same state. This is not strictly true since states could fulfill their RPO through purchase of RECs. Gujarat and Madhya Pradesh don't have specific state policy targets. Tamil Nadu and Uttar Pradesh do not have PFA plans.

Table 6: Comparing state-wise 2016-17 solar targets

Solar capacity (MWs)	Actual installed (May, 2016)	Expected at the end of March, 2017 as per PFA Plan	Estimated at the end of March, 2017 as per SERC's RPO requirements	Estimated at the end of March, 2017 as per MNRE state targets	Estimated at the end of March, 2017 as per state policy
Maharashtra	386	1194	896	683	810
Gujarat	1119	1142	1171	1554	
Madhya Pradesh	780	2105	547	1086	
Andhra Pradesh	864	2107	65	1296	1357
Rajasthan	1285	3730	1039	1650	2107
Karnataka	146	2328	299	269	247
Haryana	15	478	291	39	37
Punjab	430	1474	397	642	495
Tamil Nadu	1267		1484	1753	3000
Uttar Pradesh	143		659	294	500

Source: Prayas analysis based on state PFA plans, state RPO regulations, state RE/solar policies and MNRE.

Note: Similar to Table 5.

2.5 Tentative Capacity Targets beyond 2022 and up to 2032

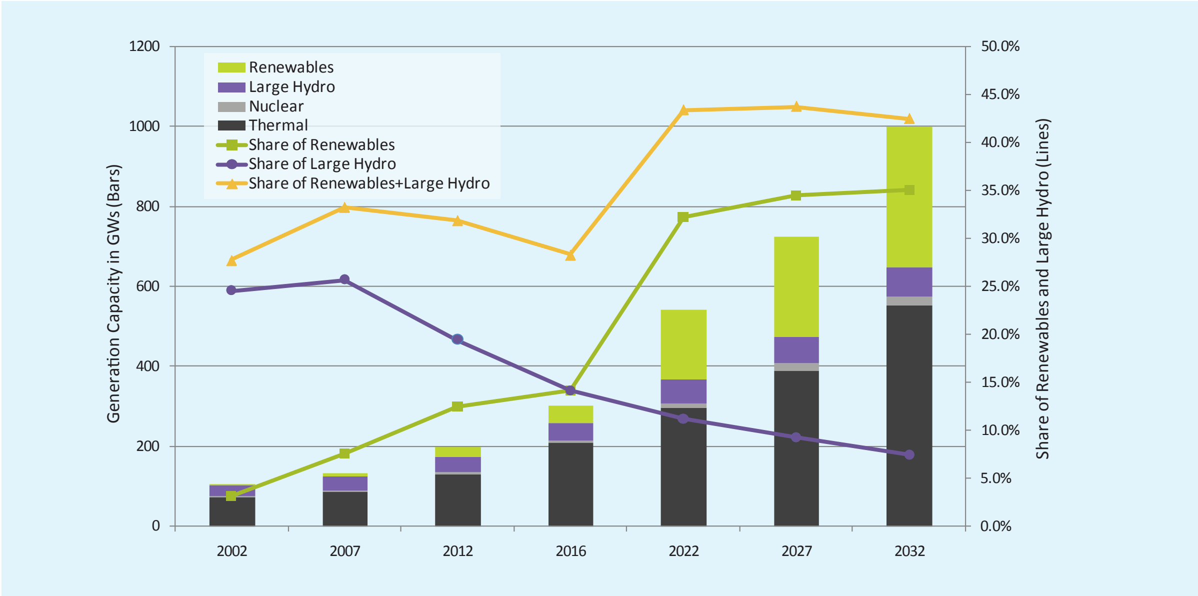
Even though no firm renewable energy targets have been announced beyond 2022, one can mostly expect the uptake of RE to keep increasing given the falling costs and increasing environmental and climate considerations. India's INDC aims to achieve about 40% cumulative electric power installed capacity from non-fossil fuel based energy resources by 2030 (GoI, 2015). Recently, the CEA has published a perspective transmission plan which lays down some indicative generation targets for 2032 (CEA, 2016). An analysis based on these indicative numbers (shown in Figure 10) gives a rough idea of the picture in 2032.

The capacity share of RE is expected to sharply rise from 14% in 2016 to 32% in 2022 and 35% in 2032, indicating that the CEA expects RE growth to slow down after 2022. In the same time period, share of large hydro capacity[5] is expected to drop from 14% in 2016 to 11% in 2022 and 7.5% in 2032. The combined share of RE and large hydro is expected to remain stable at 43% from 2022 to 2032. It is important to remember that data beyond 2022 is merely indicative and that the above percentages could change significantly based on assumptions about the future.

Another metric to understand capacity addition in the future is shown in Figure 11. It plots RE and thermal capacity addition from 2002-16 (actual) and 2016-32 (expected) in terms of Five Year Plan periods. The red line indicates the ratio of RE to thermal capacity addition in this time. In spite of the high RE capacity addition from 2002-16, the ratio actually reduced from a high of 0.59 (2002-07) to 0.23 (2012-16). The 175 GW target requires this ratio to make a stark reversal to 1.55 (2016-22) beyond which it reduces to 0.81 (2022-27) and 0.61 (2027-32). The 2016-22 time period clearly stands out in this 20 year period.

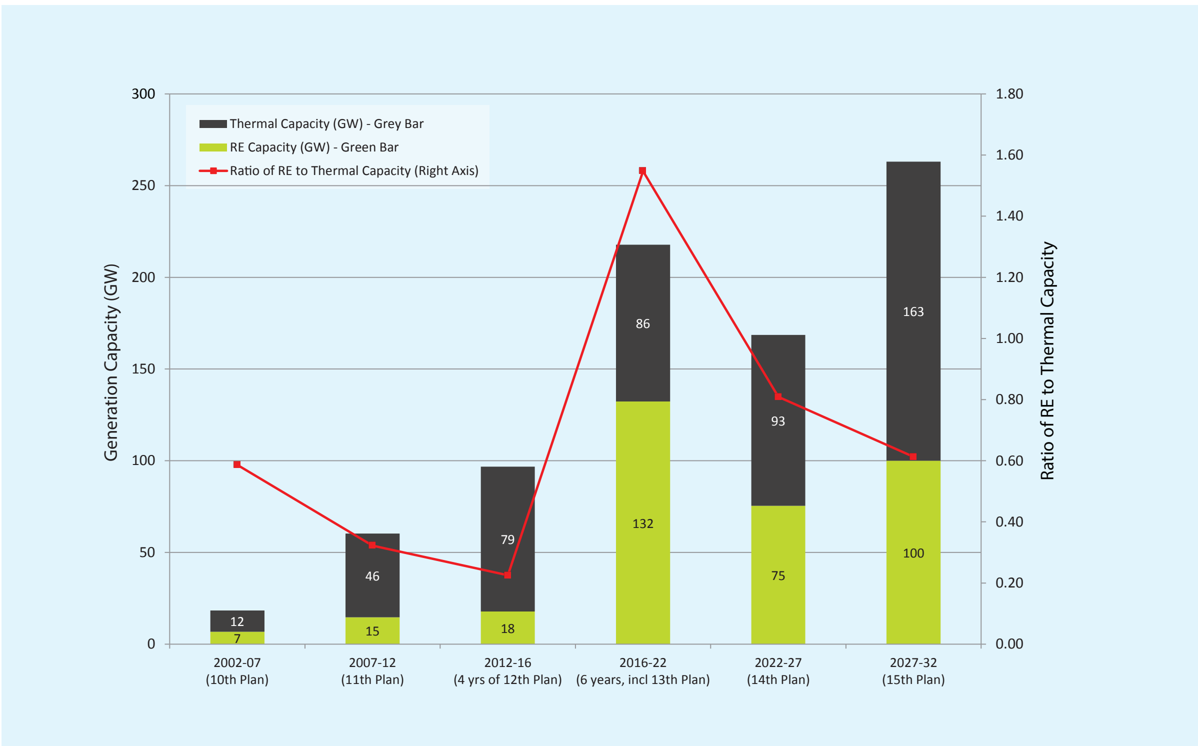
5. There is a proposal being considered by the Ministry of Power for declaring large hydro power as 'renewable'.

Figure 10 : Five Year Plan-wise generation capacity and percentage shares of renewables and large hydro



Source: Prayas analysis based on CEA data (monthly executive summaries of past years), projections from 2022-32 are based on CEA's perspective Transmission Plan.

Figure 11: Five Year Plan period-wise renewables and thermal generation capacity additions



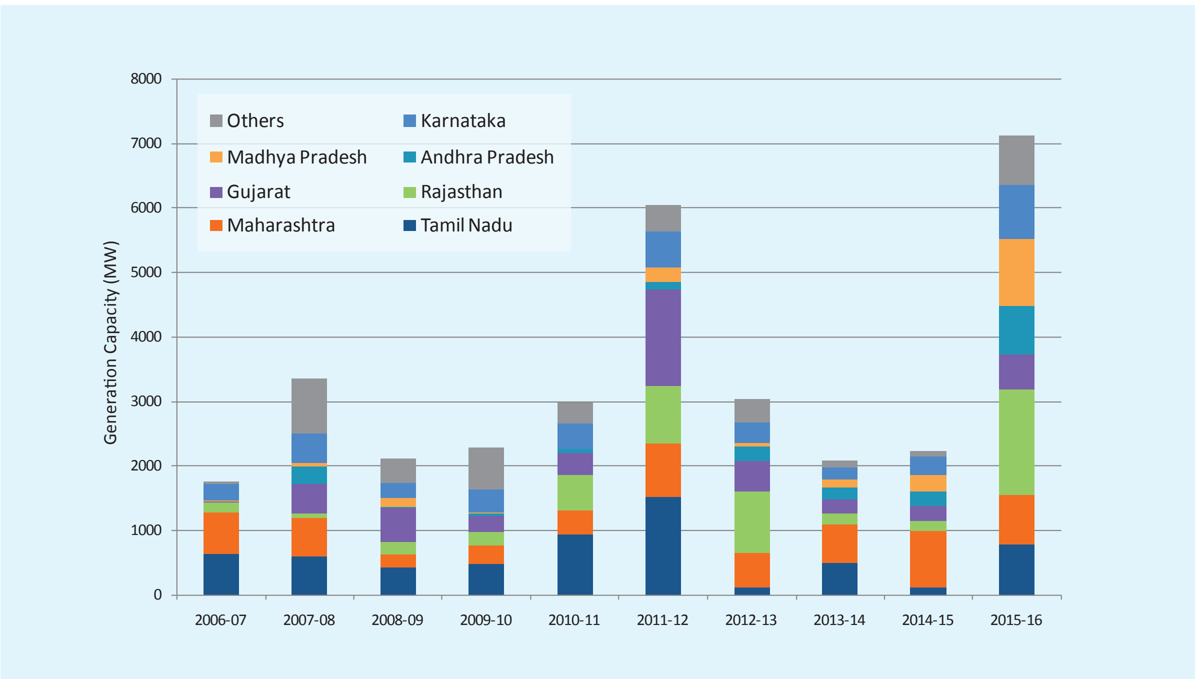
Source: Prayas analysis based on CEA data (monthly executive summaries of past years), projections from 2022-32 are based on CEA's perspective Transmission Plan.

3. Renewable Capacity Addition and Generation

While the previous section detailed the various renewable energy targets at the national and state levels, this section looks at the actual capacity addition and renewable electricity generation in the past few years. Figure 12 shows the year-wise, state-wise annual RE capacity addition in the country. 2011-12 and 2015-16 clearly stand out, with just over 6 GW and 7 GW installed in these two years. Tamil Nadu has the highest installed RE capacity in the country followed by Maharashtra. Wind power contributes the most to Tamil Nadu's RE capacity, while Maharashtra is the leader in terms of biomass (biomass+bagasse) based generation. Karnataka leads the states in terms of SHP capacity followed by Himachal Pradesh. Finally Gujarat, Rajasthan and Tamil Nadu are the leading states when it comes to solar power, accounting for just below 50% of the total solar capacity.

While wind power was by far the most dominant contributor to RE capacity addition until 2010-11, solar power has been steadily increasing its contribution in the last five years. 2016-17 will be a turning point for solar, when its annual capacity addition is surely expected to significantly overshadow wind power. Over the last few years, biopower capacity addition has been roughly 400 MW/ year while SHP capacity addition has been falling for the last few years after a high in 2011-12. (Figure 1). For more detailed information on state-wise, source-wise capacity addition, see Figure 28 to Figure 31 in the Annexure.

Figure 12: Year-wise state-wise RE capacity addition

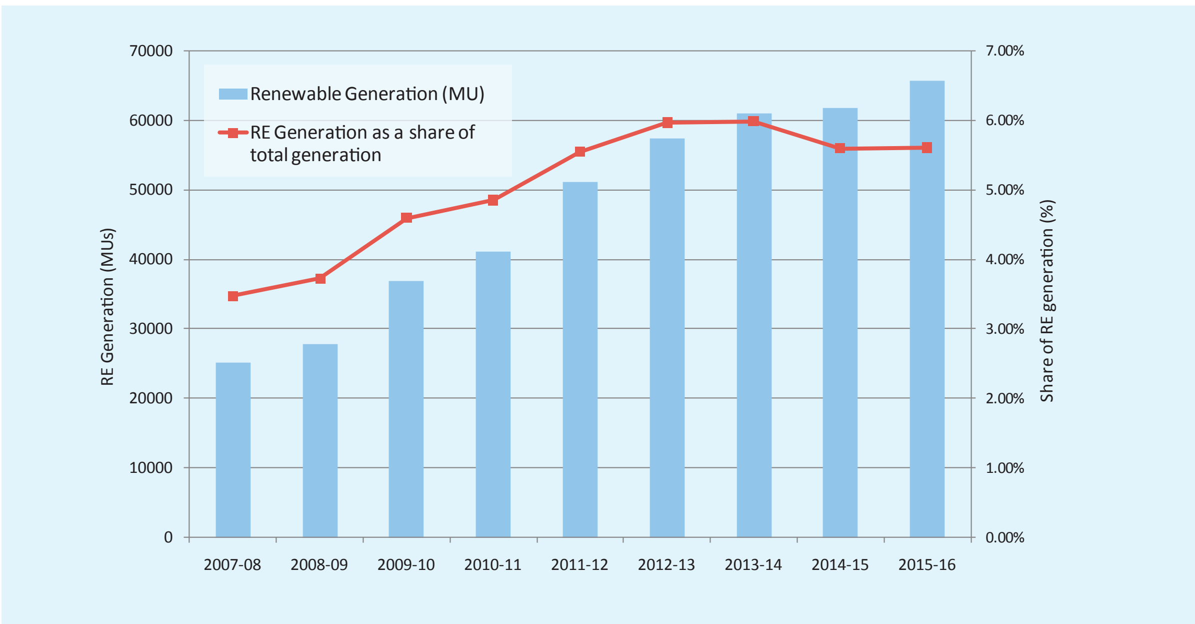


Source: Prayas analysis based on various CEA monthly review reports.

As renewable energy capacity has grown in the country, so has the actual electricity generation from RE. In absolute terms, it has increased from 25 BU to 65 BU from 2007-08 to 2015-16[6]. As a share of total electricity generation in the country, it has increased from 3.5% to 5.6% in the same time period after reaching a high of ~ 6% in 2012-13 and 2013-14 (Figure 13). The fall in the relative share of RE electricity is due to the faster growth of thermal generation in the last four years, when it grew by 7.4% in comparison to 6.5% for renewables. However over the last eight years, growth in RE generation (12.7%) has outpaced thermal generation (6.8%).

Figure 14 shows the seasonal variation in RE generation for 2015-16, while Figure 15 captures the state-wise variation for the same year. The monsoon-linked seasonality of wind power and SHP with a national peak in July and August respectively is quite obvious. The seasonality in bagasse based cogeneration coincides with the sugarcane crushing season (~ November – April). Output from biomass and solar power is fairly stable throughout the year. Seven states contribute nearly all of the wind power output with Tamil Nadu, Gujarat and Maharashtra leading the way. The output from bagasse cogeneration is also heavily concentrated in four states, namely Karnataka, Maharashtra, Uttar Pradesh and West Bengal. SHP is similarly concentrated in few southern (Karnataka, Kerala) and northern (Himachal Pradesh, Haryana, Punjab, Uttarakhand) states.

Figure 13 : RE generation from 2006-07 to 2015-16



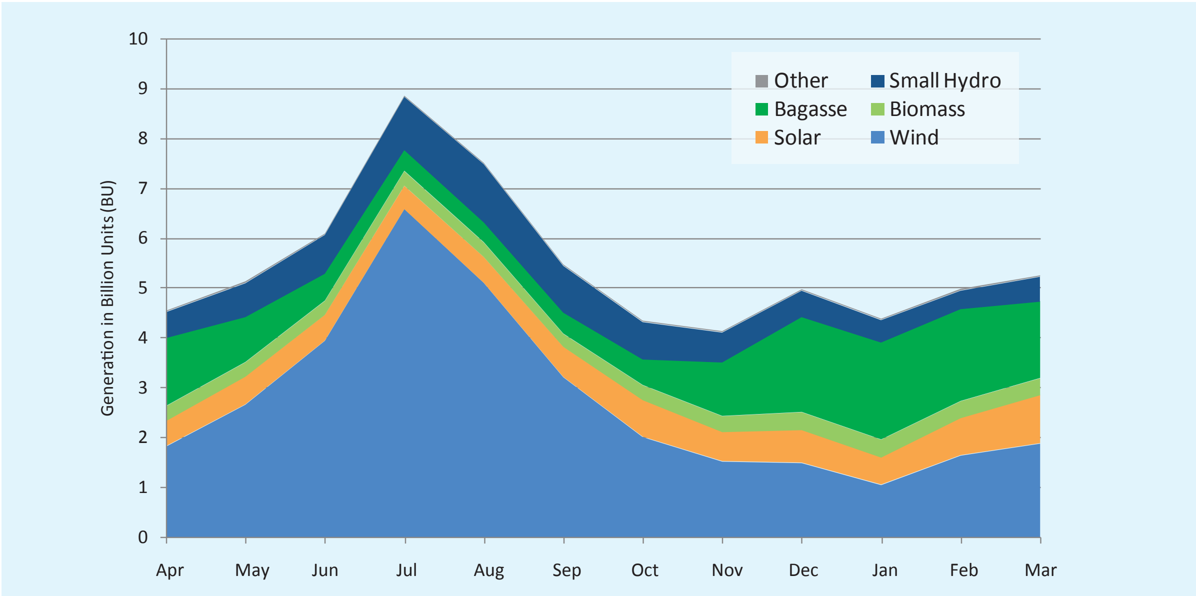
Source: Prayas analysis based on various CEA publications (All India Electricity Statistics, General Reviews, Monthly Executive Summaries), MoSPI Energy Statistics and CEA information obtained via RTI.
Note: CEA disclaimer for RE data:
1) All figures are tentative.
2) Data as received from SLDC of the respective states or from the electricity department.

6. This estimate of RE generation may be slightly on the lower side since it possibly may not include generation from solar rooftop PV as well as RE projects connected to the 11/33 kV grid, all of which may not be tracked by SLDCs.

Given the 175 GW target, MNRE is expecting renewables to contribute 17% of total electricity generation by 2022 (MNRE, 2016c). This is a tall task, since the share is presently only 5.6% and needs to treble in the next six years if it has to meet the above goal.

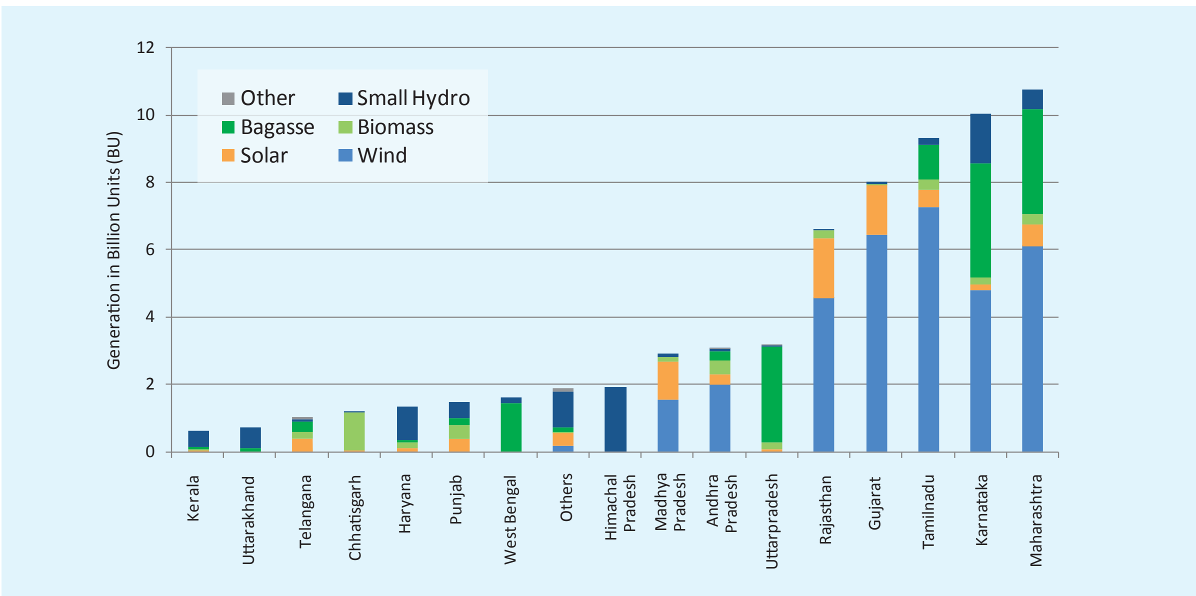
Finally, data availability with regard to renewable electricity generation is extremely weak. Disaggregated, state-wise and technology-wise generation data is completely missing in the public domain. This significantly hampers the verification with respect to RPO compliance while reducing public confidence in the RE program as a whole.

Figure 14: Month-wise RE generation in 2015-16



Source: CEA; CEA disclaimer for this data: 1) All figures are tentative 2) Data as received from SLDC of the respective states or from the electricity department.

Figure 15: State-wise RE generation in 2015-16



Source: CEA; CEA disclaimer for this data: 1) All figures are tentative 2) Data as received from SLDC of the respective states or from the electricity department.

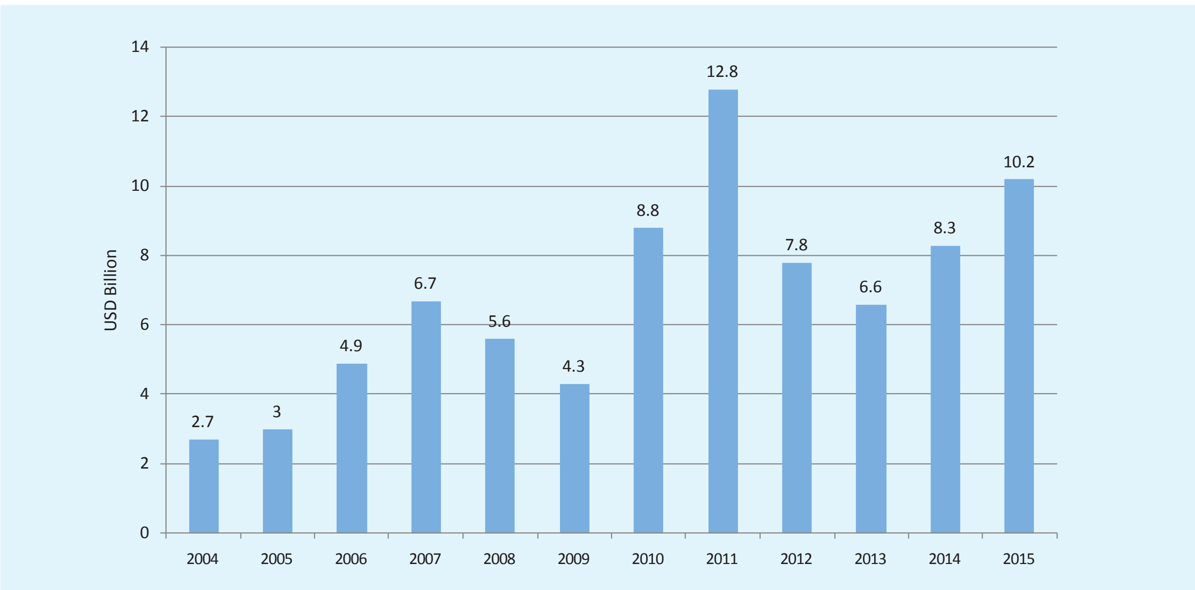
4. Investments in Renewable Energy

Nearly all the cost for non-fuel renewables like wind, solar and SHP constitutes upfront investments in equipment and EPC. Hence it is obvious to expect investments in renewables to closely track the growth in capacity addition. To the best of our knowledge, the MNRE does not routinely report RE specific investment data. The MNRE estimates that the RE sector received 86,000 crore in investment in the 2013-16 period (Gupta, 2016). The UNEP has been publishing a 'Global Trends in Renewable Energy Investment' report for over 10 years. Based on their assessment, Figure 16 depicts investments made in renewable energy in India for the last 12 years. India's RE sector brought in investments to the tune of $10 billion (~ Rs 65,000 crores) in the 2015.

The capital requirements/investment opportunities for realising the 175 GW plan are quite high. Wind and solar power projects (generation and transmission) would need approximately Rs. 7-8 lakh crore of capital investments from 2016-22. During the RE-Invest meeting in February, 2015, 40 major banks and Non-Banking Financial Companies committed to provide debt for ~ 78.5 GW of RE capacity over the next five years. From February, 2015 to March, 2016, they have sanctioned Rs 71,201 crores (18.63% of commitments made) of which Rs. 29,529 crores has been disbursed. (MNRE, 2016) To put these numbers in context, the estimated cost for the Deendayal Upadhyaya Gram Jyoti Yojana (DDUGJY) for feeder separation and strengthening sub-transmission and distribution infrastructure in rural areas including metering is ~ Rs 43,000 crores. (MoP, 2014)

Part of the funding of the renewable energy specific intr-state transmission lines is expected to come from the National Clean Energy Fund, which was set up in 2010 through a levy of a coal cess. While the coal cess was fixed at Rs 50/ton for four years from 2010-11 to 2013-14, it has been doubled every year since, and now stands at Rs 400/ton in 2016-17. With rising consumption of coal, we estimate that the 2016-17 collection in the National Clean Energy Fund would be in the range of Rs 34,000-36,000 crore.

Figure 16: Estimated Renewable Energy Investments in India



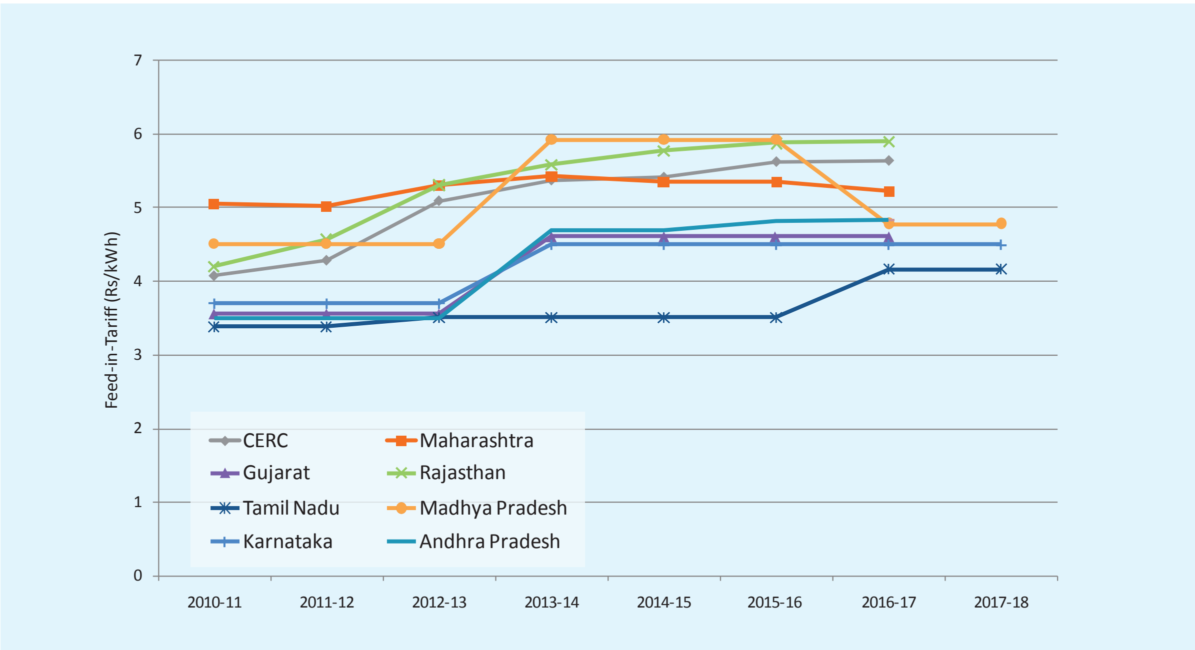
Source: Prayas compilation from various UNEP - Global Trends in Renewable Energy Investment Reports.

5. Pricing and Tariffs – Focus on Wind and Solar

SERCs have been notifying year wise feed-in-tariffs (preferential tariffs), both for wind and solar power for most states for the past several years. This is in line with the national electricity policy recommendations.

With regard to wind power, all DISCOM procurement happens at these notified rates. While some states have adopted a norm of a single state-wise wind tariff (Gujarat, Tamil Nadu, Karnataka, Madhya Pradesh, etc.), some states like Maharashtra have wind zone-wise tariffs. These vary according to the wind resource in a particular location. A comparison of state-wise wind tariffs is shown in Figure 17. Tariffs have been slowly increasing (in nominal terms) over the past few years. Most states starkly revised their wind tariffs upwards in 2013-14. MP is the only state which drastically reduced its tariff last year, from a high of Rs 5.92/kWh to Rs 4.78/kWh.

Figure 17: State-wise levelised wind feed-in-tariffs



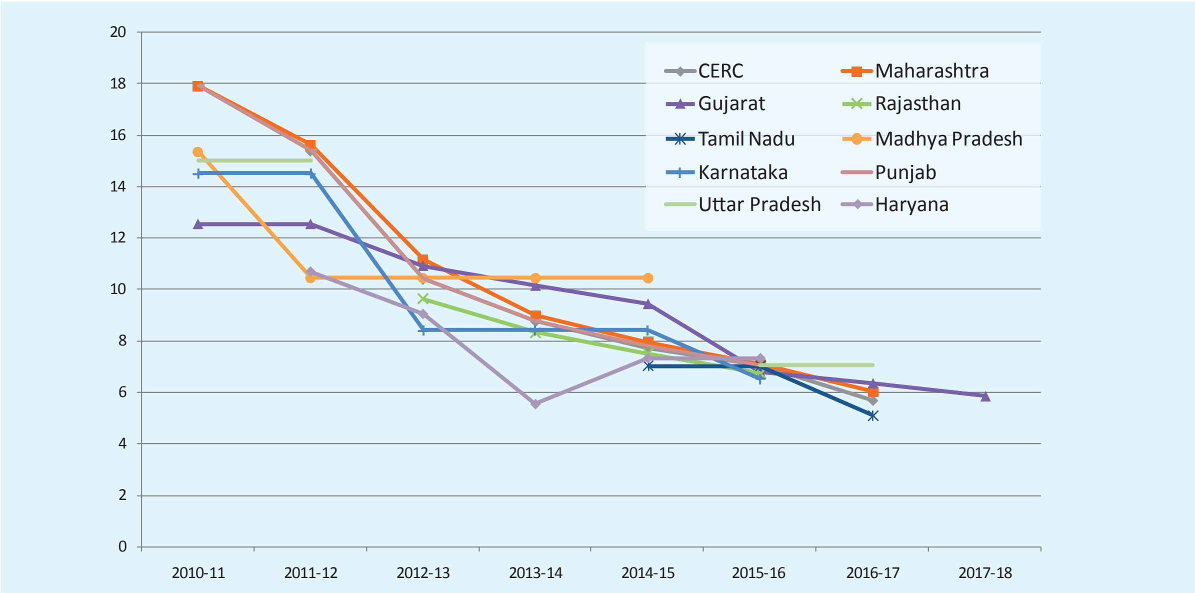
Source: Various ERC orders.

Note: CERC wind tariff is the average of Zone 2 and Zone 3 (CUF 22-25%). Maharashtra wind tariff is the average of Zone 1 and 2 (CUF 22-25%). Rajasthan wind tariff is the average of tariffs for CUF 20-21%.

However, the case with regard to solar PV is strikingly different from wind power. While SERCs have been notifying year wise feed-in-tariffs (Figure 18), nearly all DISCOM procurement (barring the exception of initial procurement for Gujarat and Maharashtra) has taken place at prices discovered through reverse competitive bidding (Figure 19). Price discovery has clearly benefitted consumers since discovered prices have been significantly lower than notified feed-in-tariffs. It is also pertinent to note that wind and solar prices have now converged and in some cases, discovered solar PV prices are lower than state wind feed-in-tariffs. Latest solar PV bids have settled in a price range of Rs 4.4 – 4.8/kWh. The figure also clears shows the diminishing difference between the lowest and the highest winning bid for any tendered capacity over the years.

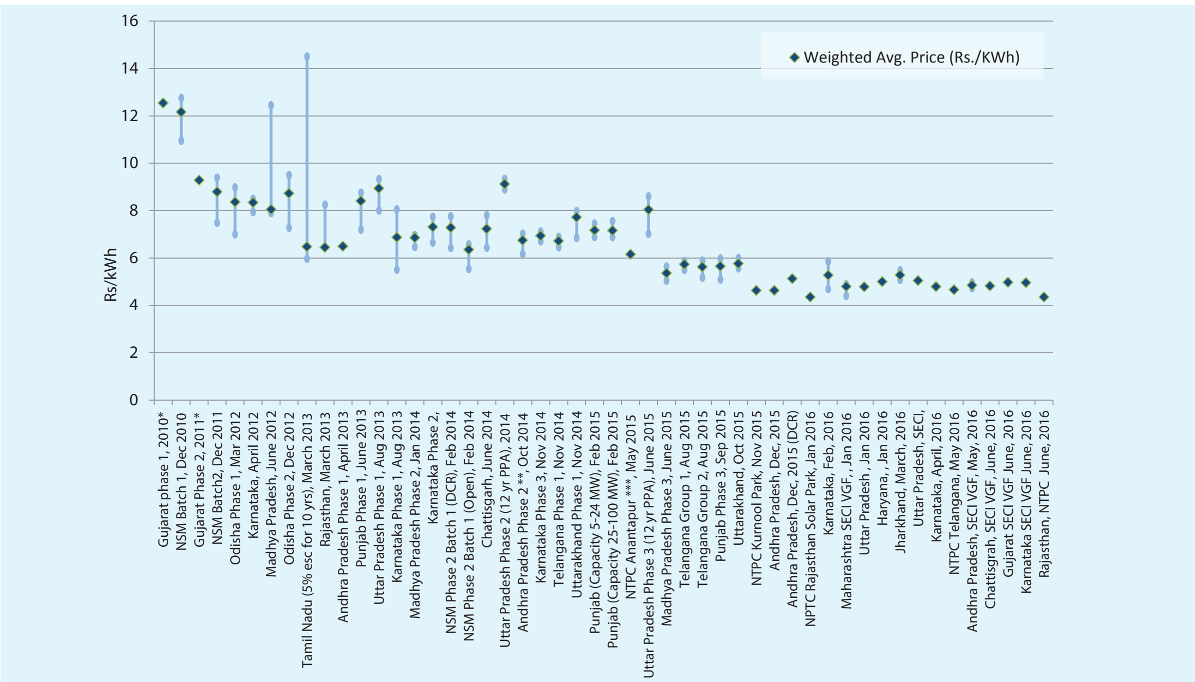
Figure 20 shows the solar supply curve in India, based on an analysis of 50 solar bids across states. These bids range over a period of six years from December 2010 to June 2016, with tariffs coming down from just over Rs 12/kWh to just above Rs 4/kWh. The weighted average solar tariff from these 50 bids, considering their total capacity of 16.4 GW, is Rs 6.16/kWh.

Figure 18: State-wise levelised solar PV feed-in-tariffs



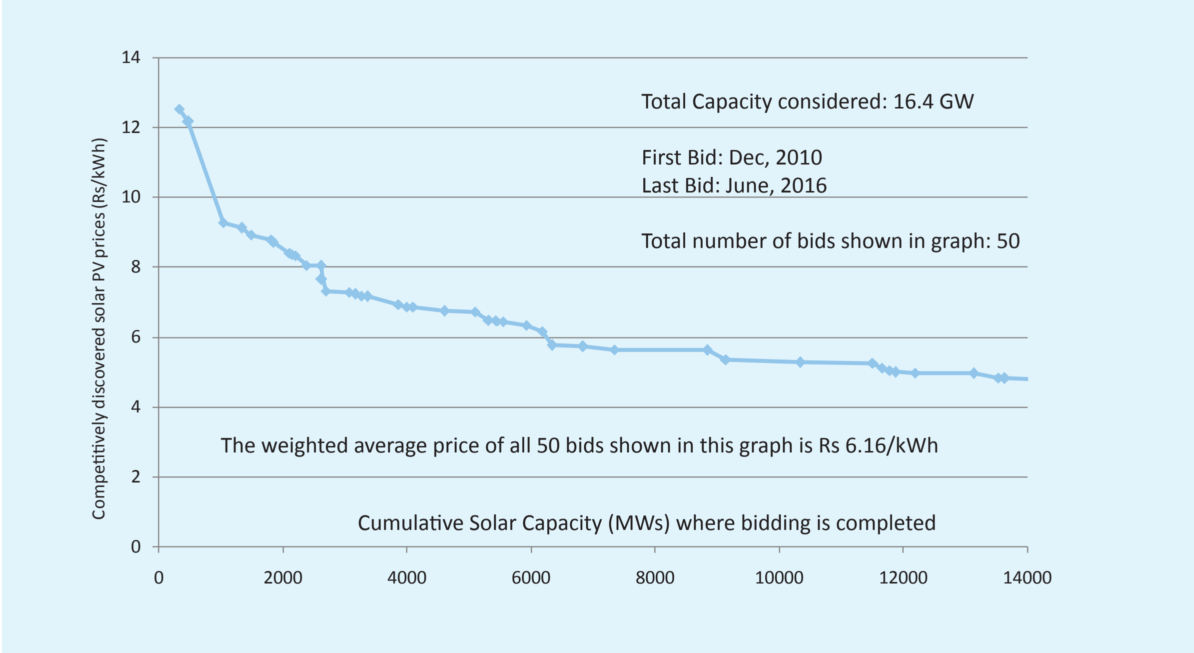
Source: Various ERC orders.

Figure 19: Year-wise evolution of competitively discovered solar PV tariffs



Source: Prayas analysis based on information from MNRE, (Bridge to India, 2015) (Bridge to India, 2015), various news items and (Bridge to India, 2016) Note: All SECI Viability Gap Funding (VGF) based bids for 2016 have a ceiling price of Rs 4.43/kWh. Tariffs shown here are inclusive of the VGF support.

Figure 20: Solar PV supply curve

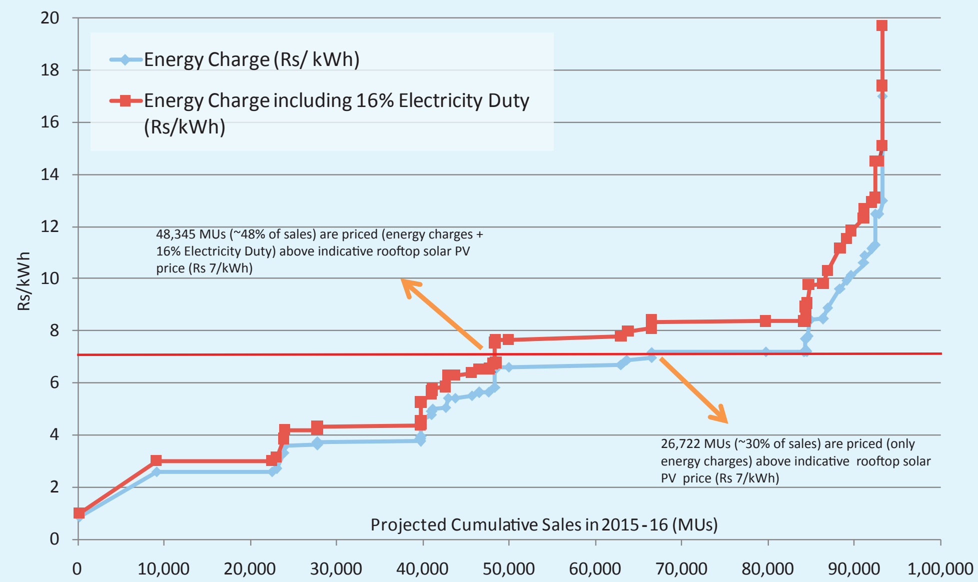


Source: Prayas analysis based on data from MNRE, (Bridge to India, 2015), various news items, (Bridge to India, 2016). Note: All SECI VGF based bids for 2016 have ceiling price of Rs 4.43/kWh. Tariffs shown here are inclusive of the VGF support.

6. Rooftop Solar PV

With regard to rooftop solar PV, various ERCs have notified feed-in-tariffs, but hardly any DISCOM procurement is taking place in this segment. This is because most of the rooftop capacity is set up either as captive projects for self-consumption, or through the net metering route which is more profitable for consumers. However, DISCOMs have not been particularly supportive in operationalising 'net-metering', especially for commercial and industrial consumers. (MNRE, 2016) They are rightly worried that this may increase the financial stress on the DISCOMs over the coming years, as their most lucrative consumers move towards adopting rooftop solar (wherever possible) in a large way. This is especially so since this transaction does not attract any cross subsidy surcharge payment to the DISCOM. A case in point is the Maharashtra State Electricity Distribution Company (MSEDCL). Figure 21 shows that nearly 50% of MSEDCL's sales can cost-effectively move to rooftop PV provided such roof space exists.

Figure 21: Potential MSEDCL sales with tariffs above rooftop solar costs



Source: Prayas analysis based on MERC consumer tariff orders, MSEDCL petitions

6.1 Net Metering

Net metering is a billing mechanism which allows energy banking and credit for excess solar electricity fed into the distribution grid by the project. At the end of the billing period, the consumer has to pay for the 'net' electricity consumed (difference between electricity consumed from the grid and the electricity fed into the grid from the solar project). If the amount of electricity fed into the grid is more than that consumed from the grid, the excess is carried forward to the next billing period. This has proved a crucial incentive for consumers to adopt RTPV systems and now 21 states have some form of net metering system in place. (Bridge to India, 2016) See Table 7 for details on net metering in some states.

The net metering regulations of almost two thirds of the states allow for rooftop systems up to a cumulative Distribution Transformer (DT) capacity of 15-30%. Gujarat however, has allowed a much higher limit of 65% of rated DT capacity, indicative of the state's eagerness to ensure wide acceptance and use of this mechanism. Madhya Pradesh and Haryana allow a maximum of 10 MW and 200 MW respectively as the cumulative solar rooftop capacity for each DISCOM. More than half of the states allow for rooftop systems with capacity ranging from 1 kWp to 1MWp, barring Delhi, which has only defined a minimum capacity of 1 kWp. All states have allowed solar generation to qualify for meeting the Distribution Licensee's RPO targets in case the consumer is not an obligated entity. Haryana introduced a novel way of incentivising those opting for net metering. In the first amendment to its regulations, dated July, 2015, Haryana introduced an incentive of Rs 0.25/kWh for every unit of solar energy generated by the system owner in a billing cycle which can offset billing of additional consumption. Delhi gives and additional incentive of Rs 2/kWh as a GBI for domestic rooftop installation between January, 2016 to December, 2018. Kerala allows for a form of aggregate net metering by permitting consumers to offset excess solar electricity from one system against consumption at some other prmises by paying 5% of energy as wheeling charges.

Implementation of net metering across states in the true spirit of the regulations will surely allow exponential growth in this sector.

Table 7: Net-metering regulations in some states

Net Metering Regulations	Cumulative capacity allowed at distribution transformer (% of capacity)	Min – Maximum Capacity (RTPV system level)	Metering and Interconnection Costs borne by	Settlement or Banking Period	Billing period	Units bought by DISCOM at the end of settlement period	Rate at which excess injected energy bought by DISCOM
Maharashtra (Sept 2015)	40%	up to 1 MW	DISCOM	April - March	Monthly	All surplus	APPC
Gujarat (June 2016)	65%	1 kW - 1 MW (maximum upto 50% of consumer's sanctioned load.)	Consumer	1 billing cycle	Monthly	Not mentioned	Fixed APPC for whole life of system (for all non-obligated consumers). 85% of APPC for C&I obligated consumers
Rajasthan (Feb 2015)	30%	1 kW - 1 MW (maximum upto 80% of consumer's sanctioned load.)	Consumer	Not mentioned	Monthly	All electricity excess injected, if greater than 50 kWh/month	ERC determined FiT
Tamil Nadu (Nov 2013)	30%		Consumer	August - July	Monthly - Domestic; Bimonthly - Industrial	All energy injected up to a maximum of 90% of consumption during settlement period	Not mentioned

Delhi -2014	20%	1 kWp minimum	Solar meter – licensee; Net meter - consumer	April - March	<11kW - Bimonthly, 11kW+ = Monthly	All surplus	APPC of respective year
Madhya Pradesh (Oct 2015)	15%	Max 112 kW at LT	Consumer	April - March	Monthly	All surplus	APPC
Punjab (May 2015)	30%	1 kWp - 1 MWp (maximum upto 80% of consumer contracted load)	Consumer	October - September	Monthly- industrial; Bimonthly - Domestic	All energy injected up to a maximum of 90% of consumption during settlement period	Not mentioned
Haryana (Nov 2014) 1st Amendment (July 2015)	30% (LT), 15% (HT)	Max 1 MWp	Consumer	April - March	<20kW - bimonthly, >20kW - monthly	All energy injected up to a maximum of 90% of consumption during settlement period	Equal to or lower than FiT for solar PV
Kerala (June 2014)	up to 80% of average minimum load of feeder from 8 AM to 4 PM	1 kWp -1 MWp	DISCOM	October - September	Bimonthly	All surplus	APPC of respective year

Source: Prayas analysis based various state net metering regulations.
Notes: Except for Gujarat and Rajasthan all states allow for carry forward of excess generation to next billing cycle. Gujarat allows none, while Rajasthan allows only up to 50 units/month. Kerala allows its DISCOM to recover metering costs from the consumers (as decided by the ERC).

GoI is aggressively pushing all government departments and ministries to adopt rooftop solar and lead by example in contributing to the 40 GW national target. The MNRE has collated data from up to 50 ministries/departments, which shows that nearly 5.9 GW of solar potential exists on their building rooftops and surplus areas available to them. This could help them save nearly Rs. 830 crores annually. (MNRE, 2016)

Additionally, the MNRE's data collection with regard to rooftop projects also seems to be at some variance with market estimates, especially with respect to installed capacity. The MNRE's latest estimate of status of grid connected rooftop solar PV systems sanctioned (including in principle approval) to States/UTs/SECI/PSUs and other government agencies stands at 2.5 GW as on February, 2016, of which only 166 MW is actually installed and deployed. This includes 11 MW of projects completed without subsidy by MNRE's channel partners and new entrepreneurs. However BridgetoIndia, a leading solar energy consultancy in India, reported an installed capacity of 740 MW of rooftop capacity as of March, 2016 (BTI, India Solar Handbook, 2016). This variance needs to be reconciled through better data collection and more frequent reporting in the public domain.

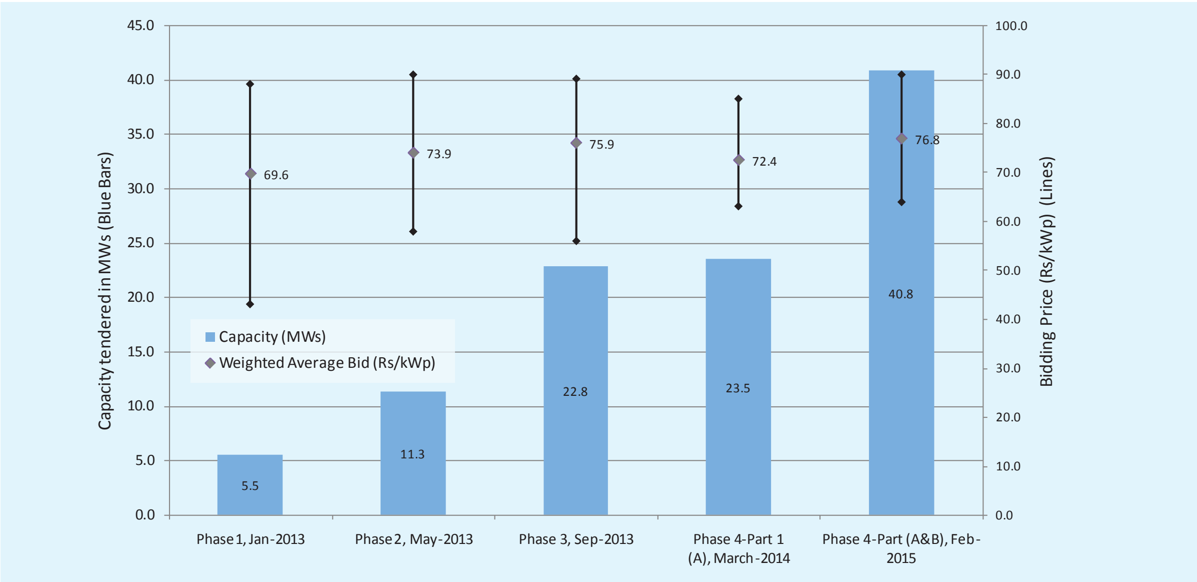
BridgetoIndia's market projections also underscore the need for more emphasis on the rooftop segment. They predict 6.8 GW of rooftop capacity addition during 2016-2020, while MNRE is targeting to reach 23 GW in the same time frame. Rooftop solar PV seems like the weakest link in the build up to 175 GW.

6.2 Rooftop PV prices

Since most of the rooftop capacity is set up under a captive mode or under net-metering, the SERC is not involved in determining feed-in-tariffs for these routes. However, the MNRE publishes 'benchmark costs' from time to time since their subsidies are linked to such notified costs. These benchmarks are also used as an upper ceiling while conducting reverse bidding for rooftop solar projects. Benchmark costs have reduced over the years from Rs. 130/Wp (2012-13), to Rs. 90/Wp (2014) and now stand at Rs. 75/Wp (2016). (SECI, 2016) (MNRE, 2014) (MNRE, 2016)

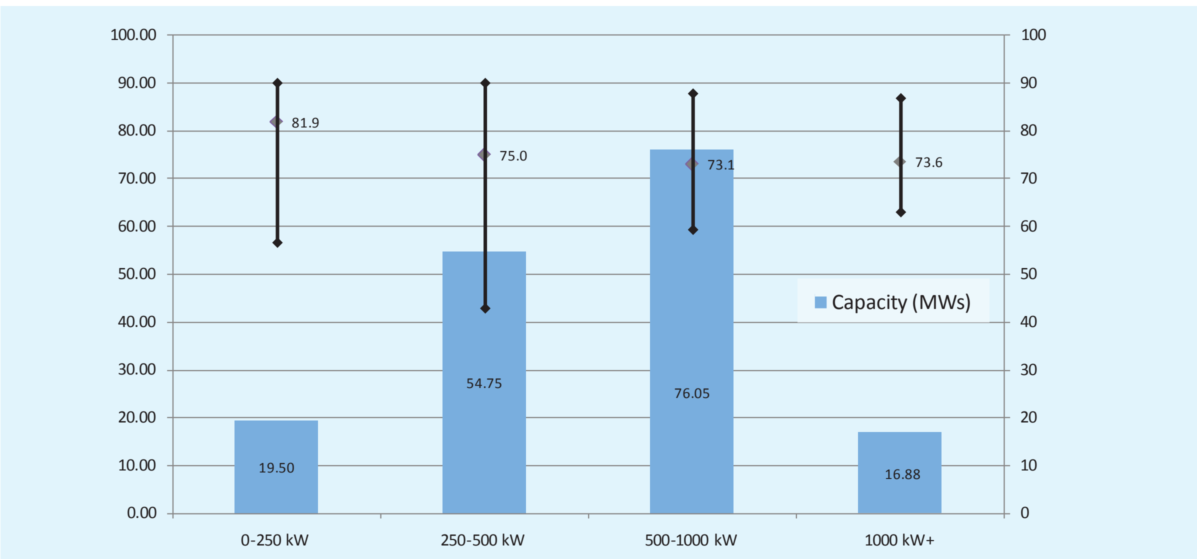
The Solar Energy Corporation of India has been regularly conducting competitive bidding based price discovery for rooftop solar projects. Figure 22 and Figure 23 capture the price discovery in this segment under the four phases wherein bidding has taken place and data is available in the public domain. Prices seem to have settled between Rs 70-75/Wp. Figure 24 captures the price discovery under the RESCO model.

Figure 22: Evolution of competitively discovered rooftop solar PV prices by SECI



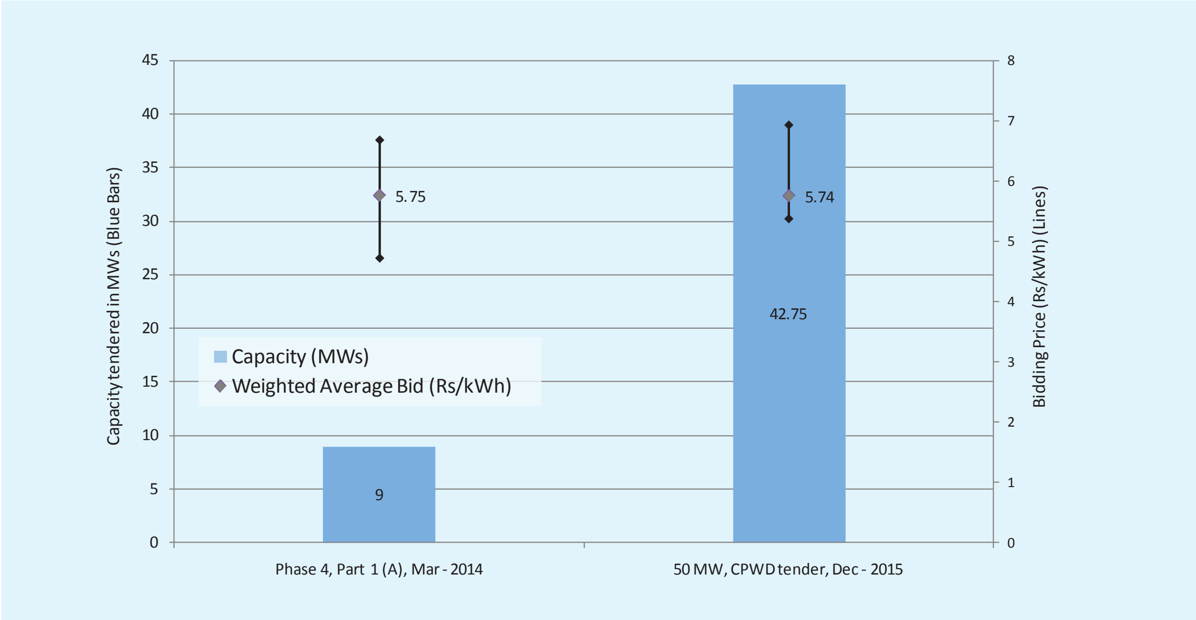
Source: Prayas analysis based on data from SECI.

Figure 23: Size-wise evolution of competitively discovered rooftop solar PV prices



Source: Prayas analysis based on data from SECI.

Figure 24: Competitively discovered rooftop solar PV tariffs, under SECI's RESCO Model



Source: Prayas analysis based on data from SECI.

7. Concessional Open Access for Renewable Energy

Various SERCs offer concessions/waivers in open access charges if the project is based on renewable energy. These concessions could be in the form of reduced transmission or cross subsidy surcharge charges, energy banking, etc. Concessions given by some states are noted in Table 8. Additionally, in line with the NTP recommendation, inter-state transmission charges and losses have been fully waived by CERC for solar projects commissioned until June, 2017 and for wind projects commissioned until March, 2019. However this is only applicable to projects selected through competitive bidding.

Table 8: Open Access charges and banking framework for renewables in some states

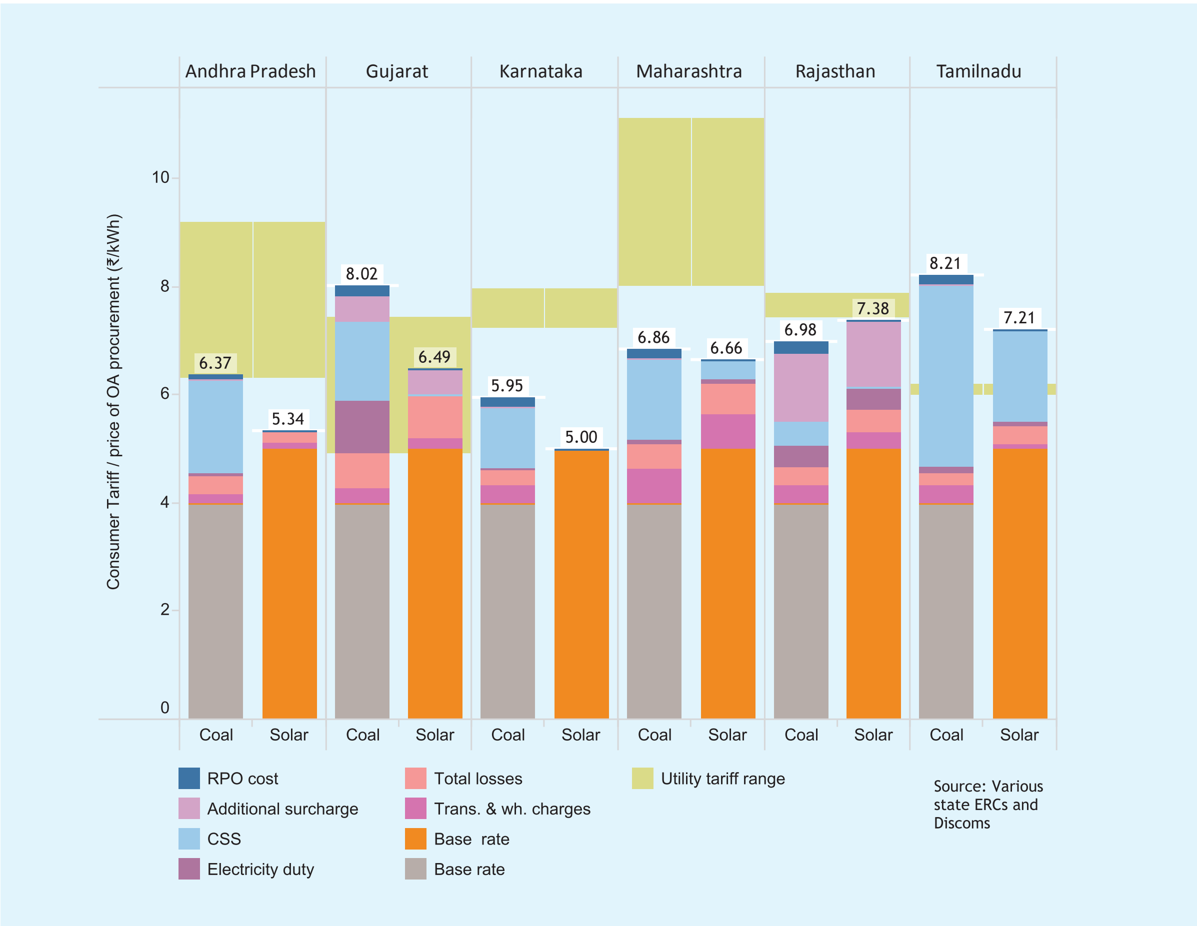
States	Tamil Nadu	Maharashtra	Rajasthan	Gujarat	Karnataka	Andhra Pradesh	Madhya Pradesh
State Transmission	30% for solar, 40% for wind	No concession	No concession	No concession except for non REC CPP projects (50%)	5% in kind as wheeling charge for wind; 0% charges for solar OA/ CPP plants commissioned between 2013-2018 for 10 years, but normal charges for Captive REC projects.	0% for both CPP and OA projects	No concession
Distribution (Wheeling)	30% for solar, 40% for wind						2% in kind
Cross Subsidy Surcharge	50%	25%	0%	0% (OA and CPP), no concession for REC		0% (only for solar) for 5 year period after commissioning of projects.	0%
Banking Charge (% of input energy)	12% (Wind)	2%	2%, only for CPP	no charges	2%	2% of energy drawal	2%
Banking Period	1 year	1 year, but crediting not allowed in April, May, Oct, Nov	1 month only for CPP	1 month for CPP, none for OA	1 year for non-REC; 1 month for REC projects	1 year, but no drawal in Apr-June, Feb-March and in peak hours.	1 year, drawal has several seasonality constraints
DISCOM buy back rate for excess energy beyond banking period	All excess at 75% of applicable tariff for wind and solar respectively; or 75% of APPC for REC projects	All excess, limited 10% of total yearly generation at APPC	Only 10% of excess energy @ 60% of large industrial tariff	@ 85% of the wind tariff & at APPC for REC projects; @ 85% of APPC for Solar REC projects	APPC for captive REC and 85% of respective RE tariff for non-REC projects	50% of pooled cost of power purchase	APPC (solar); Rs. 2.5/kWh (wind) for inadvertent flow into system

Source: Various SERC Orders & Regulations, MNRE, (PWC, 2015).

Figure 25 shows the estimated landed cost of coal and solar power through open access in various states in comparison to their utility tariffs for commercial and industrial consumers. The analysis assumes that the coal and solar plants are located in the same state as the potential consumer and hence no inter-state transmission charges have been considered. The utility tariff considered for comparison comprises of the energy charge as well as the electricity duty and fuel adjustment charge wherever applicable.

Apart from Gujarat and Tamil Nadu, industrial and commercial consumers in all these states will find it economically prudent to procure power through Open Access, in comparison to their utility energy tariffs. Strikingly, apart from Rajasthan, landed cost of solar is cheaper than coal, given the various concessions and waivers from SERCs in these states (outlined in Table 8 above). Calculations in Figure 25 assume a base price of coal and solar power to be Rs 4/kWh and Rs 5/kWh respectively. These are purely financial calculations and do not include the various potential challenges in actual implementation of projects in terms of permissions, etc. Due to various concessions offered for renewable energy based Open Access, such transactions have already become economically attractive for consumers. The challenge now is to reduce administrative and procedural issues in RE Open Access. That will determine the extent to which such Open Access can really grow. SERCs also need to consider the extent to which these concessions should be kept in place as such transactions will end up having a high financial impact on the DISCOM.

Figure 25: Comparing open access procurement with utility tariffs



Source: Prayas analysis based on regulations and tariffs orders from respective SERCs.
Note: Utility tariff range includes electricity duty and FAC for states where applicable.

8. Renewable Energy Certificate (REC) Mechanism

The REC mechanism was established in 2010 by the CERC. By allowing the environmental attribute (represented by the RE Certificate) to be separated from the electricity and traded separately, it attempted to address the mismatch between state-wise RE resource availability and RPO compliance. Two categories of RECs, solar and non-solar (which include wind, biomass, bagasse, SHP) were instituted with each REC having a denomination of 1 MWh. The electricity is treated in the same way as conventional electricity, and the generator is assumed to be compensated at the pooled cost of power purchase of the buying utility. The environmental attribute represented by the REC is to be compensated at a market-determined price by trading these on the power exchanges within a price band (a floor and forbearance price) determined by the CERC, which ensures sufficient compensation to the generator.

Looking back at the REC trades from the Indian Energy Exchange the last five and a half years (Figure 26, Figure 27) shows that there are a significantly high number of unsold RECs remaining. For non-solar RECs, the first year (2011-12) saw prices steadily increase each month from April, 2011 to March, 2012. This was expected given that a financial year is the time period for RPO compliance. However, whatever non-solar REC trade has happened subsequently has consistently been at floor prices for the last four and a half years. With regard to solar REC trade, 2012-13 saw traded prices being very close to the forbearance price all through the year, given the low volume of available solar RECs under this mechanism. Again, this reversed with a huge influx of solar RECs from July, 2013.

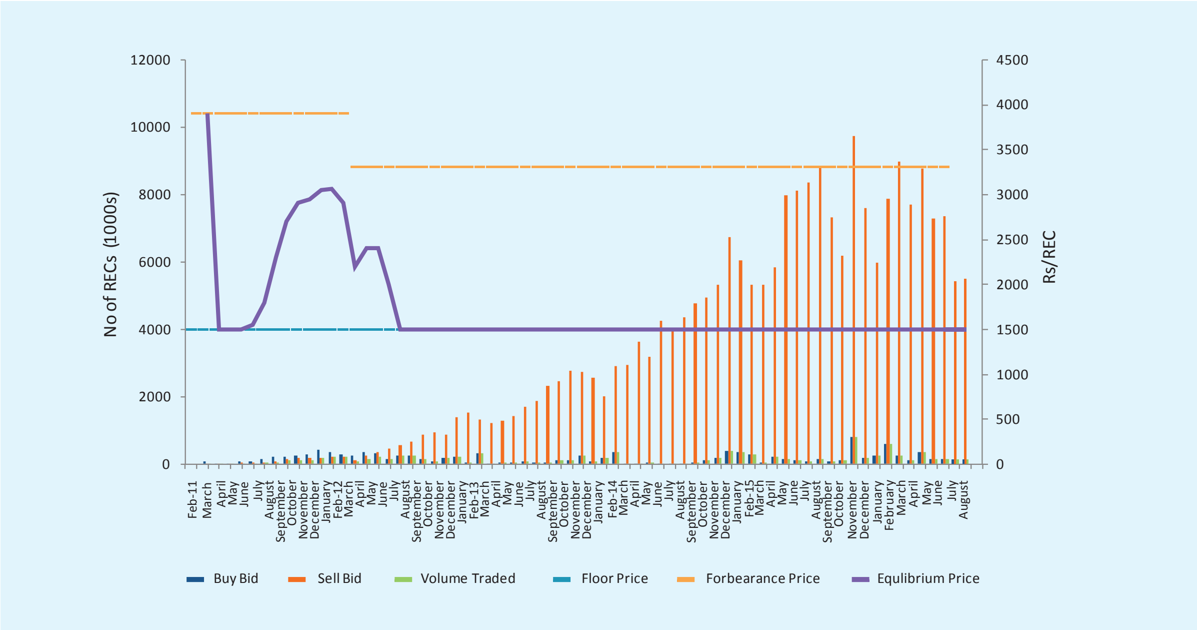
While one obvious reason for the poor REC demand, leading to depressed prices, was weak RPO compliance from most states, two other design shortcomings also contributed equally. a) Old projects (set up prior to this mechanism coming into force) and projects set up as captive and open access transactions under the REC route opened up windfall profit possibilities for such generators at the expense of new investments under this route, and b) a mismatch between solar REC prices and market price of solar electricity without dynamic and more frequent solar REC price band corrections undermined solar REC demand. CERC's fourth amendment to its principal regulations has finally ensured that OA and CPP projects which avail incentives will be disallowed under the REC mechanism. (CERC, 2016)

Judged by the mechanism's intended objectives, namely promoting additional investments and setting up alternative cost recovery business models, the REC framework has not lived up to its expectations. This is clear from the lack of new investments under this route as well as the huge inventory of unsold RECs lying with the developers.

Clearly, the mechanism is in need of a paradigm change to keep it relevant and effective. RPO compliance continues to be weak, and solar PV prices continue to fall further undermining the differentiation between solar and non-solar RECs. Additionally, the MNRE in conjunction with the Power Trading Corporation of India

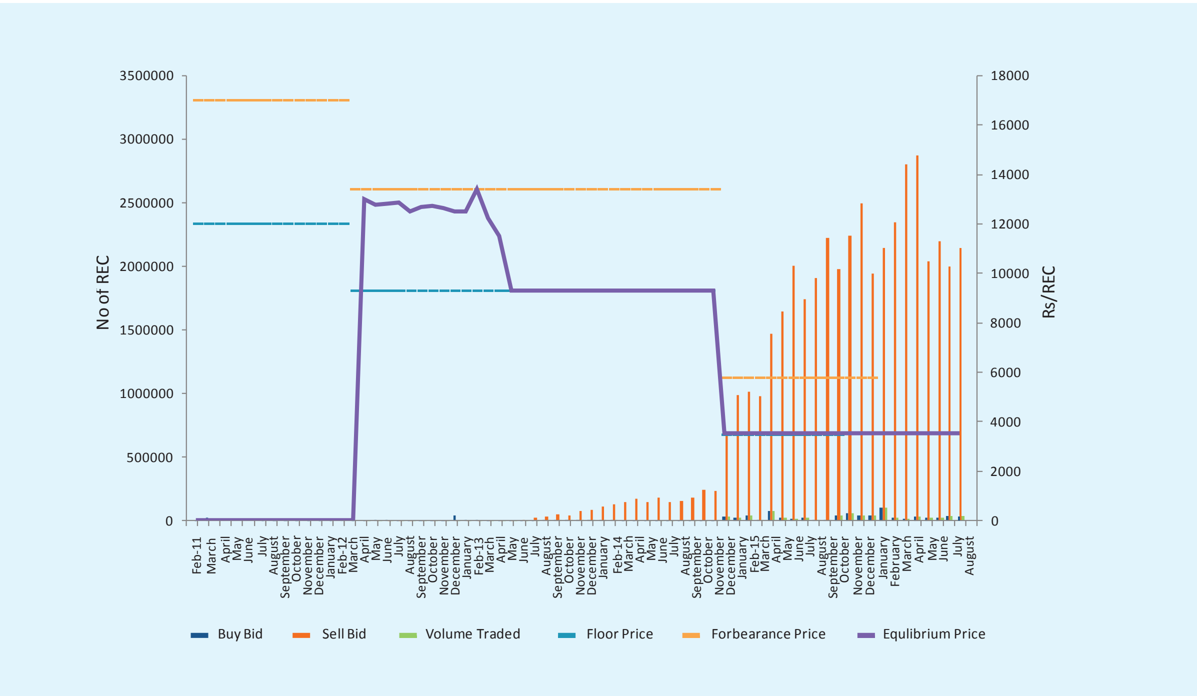
(PTC) is developing a trading platform exclusively for renewables, wherein states can buy, sell and trade RE power. (Shreya Jai, 2016) Considering these developments, CERC should prepare a comprehensive white paper for public consultation on the possible design changes needed in the REC mechanism. A new REC framework should ideally be in place by April, 2017, till which time the existing REC price bands have been specified.

Figure 26: Non-solar REC trading results from Indian Energy Exchange (2011-2016)



Source: CERC, Indian Energy Exchange.

Figure 27: Solar REC trading results from Indian Energy Exchange (2011-2016)



Source: CERC, Indian Energy Exchange.

9. Observations

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

2. The rooftop solar PV segment seems to be the weakest link in the build up to 175 GW. 40 GW of rooftop capacity by 2022 may be too big a hurdle to overcome in spite of the best efforts of various stakeholders. In fact, the MNRE itself has written to all its rooftop PV channel partners with regard to commercial and industrial consumers, noting that *"the role of DISCOMs for operationalising net metering regulations appears to be very challenging."* (MNRE, 2016) Depending on the rooftop capacity addition in the next 2 years, the MNRE may possibly have to consider revising the rooftop target downwards if necessary. Increasing consumer awareness while easing procedural issues can go a long way in galvanising demand.

3. The mismatch between state policy targets, SERC notified RPOs and state allocations of the national target need to be reconciled quickly. This calls for a concerted effort for greater coordination and consensus building between states, GoI, ERCs as well as other stakeholders involved in the RE (especially solar) sector.

4. Granular and up-to-date data in various segments of the renewable energy sector is still weak and not available in the public domain in many cases. This is especially true with regard to renewable electricity generation, where further synergy between CEA and MNRE might be needed. Similarly, as this report points out, the MNRE needs to reconcile the difference between their estimates of existing rooftop capacity in the country (166 MW by February, 2016) with other market estimates (740 MW by March, 2016). Transparency and pro-active disclosure with regard to RE data is a must going forward.

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

6. The erstwhile price differential between high cost solar PV and wind/biomass/small hydro has all but vanished. In fact, solar PV may be the cheapest RE option in the future. Hence, the very basis for continuing the differentiation between solar and non-solar RPOs and RECs needs to be revisited and addressed soon. Obligated entities should ideally be able to procure the cheapest form of

renewables, subject to technical grid constraints. Similarly, solar REC prices need to be revised downwards to be reflective of market prices without which there is little hope for solar REC demand to pick up.

7. The recent MoP RPO guidelines for states may be in contradiction to the existing Electricity Act, 2003 since the Act clearly specifies that RPOs should be specified in proportion to total electricity consumption, while the guidelines explicitly exclude hydropower from total consumption. Additionally, the guidelines expect uniform RPOs across all states. This is somewhat contentious considering the varying starting points for different DISCOMs based on their existing financial health, consumer mix (which translates into ability/willingness to pay) and share of hydro power in their consumption.

8. Concessional open access for renewables has made it financially attractive for consumers, though various administrative and procedural hurdles remain. In the medium term, SERCs will need to consider the extent to which such concessions should be kept in place, as such concessional transactions will end up having a high financial impact on the DISCOM.

9. Finally, reliable and cost-effective RE grid integration is a key requirement for the success of the 175 GW plan. Some SLDCs, especially in states with high RE (Tamil Nadu, Gujarat, etc.) are already facing some integration issues which need careful coordination and multi-government and appropriate institutional responses. CERC and some states have already started implementing one key element of the solution, forecasting and scheduling requirements for wind and solar plants. However as detailed out in a recent Prayas (Energy Group) report, 'Grid Integration of Renewables: An Analysis of Forecasting, Scheduling and Deviation Settlement Regulations', a lot more work is required for a complete solution to be in place. (Prayas (Energy Group), 2016).

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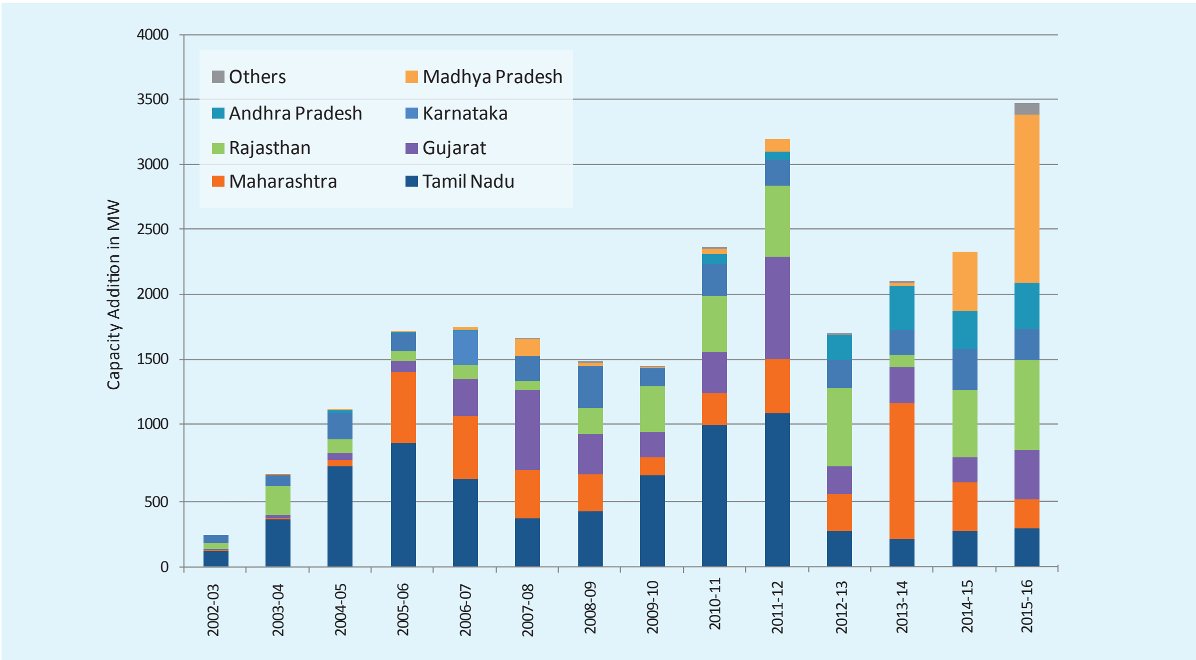
11. Annexure

Tamil Nadu, Maharashtra and Gujarat are the three leading states with regard to wind power capacity, however capacity addition has slowed down in these states over the last few years. Newer states like Rajasthan and Madhya Pradesh, which had a high feed-in-tariff of Rs 5.92/kWh in 2015-16 have seen strong growth in recent years. At nearly 1.3 GW in 2015-16, Madhya Pradesh installed the highest wind power capacity by any state in a single year. Andhra Pradesh which was nearly non-existent in the wind sector in the early years has seen steady installations of ~ 300 MW/year in the last our years.

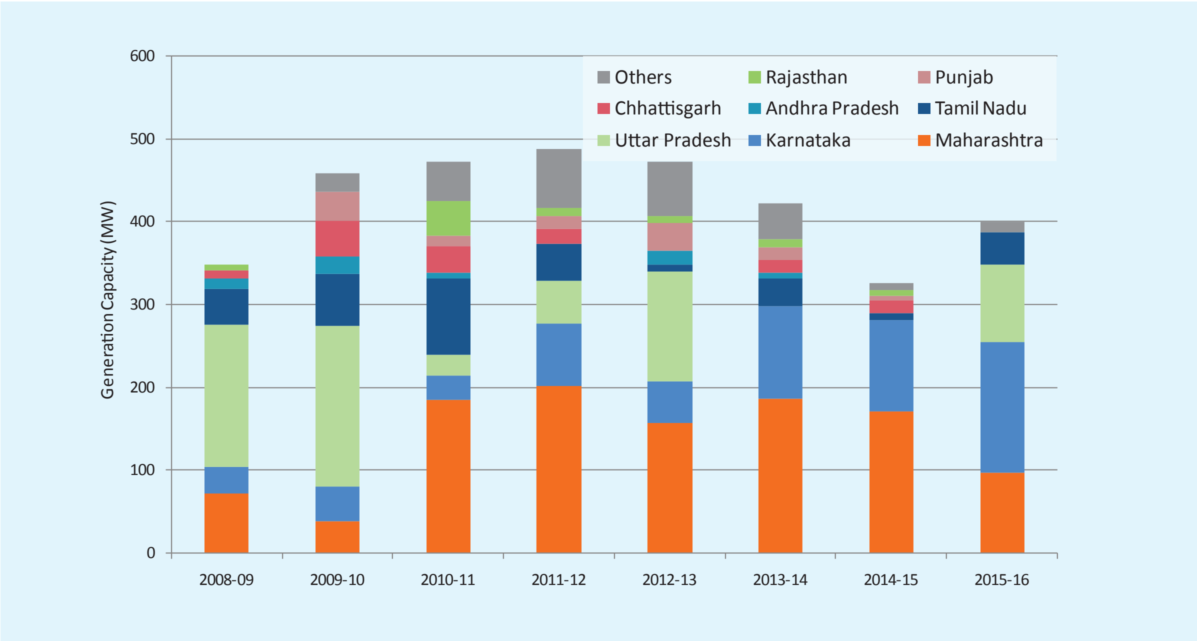
Figure 28: Year-wise state-wise wind capacity addition



Source: National Institute of Wind Energy.

Maharashtra, Karnataka, Uttar Pradesh and Tamil Nadu are the leading states for biopower (biomass, gasification and bagasse cogeneration) power capacity. While the average yearly capacity addition in the country from 2009-10 to 2013-14 was ~ 460 MW, it has surprisingly fallen in the last couple of years. To reach the modest goal of 10 GW biopower by 2022, there is a need for a much faster growth in this sector. With the 2016-17 national target set at 400 MW, the sector would need to add ~ 1 GW/year from 2017-2022 to meet the target.

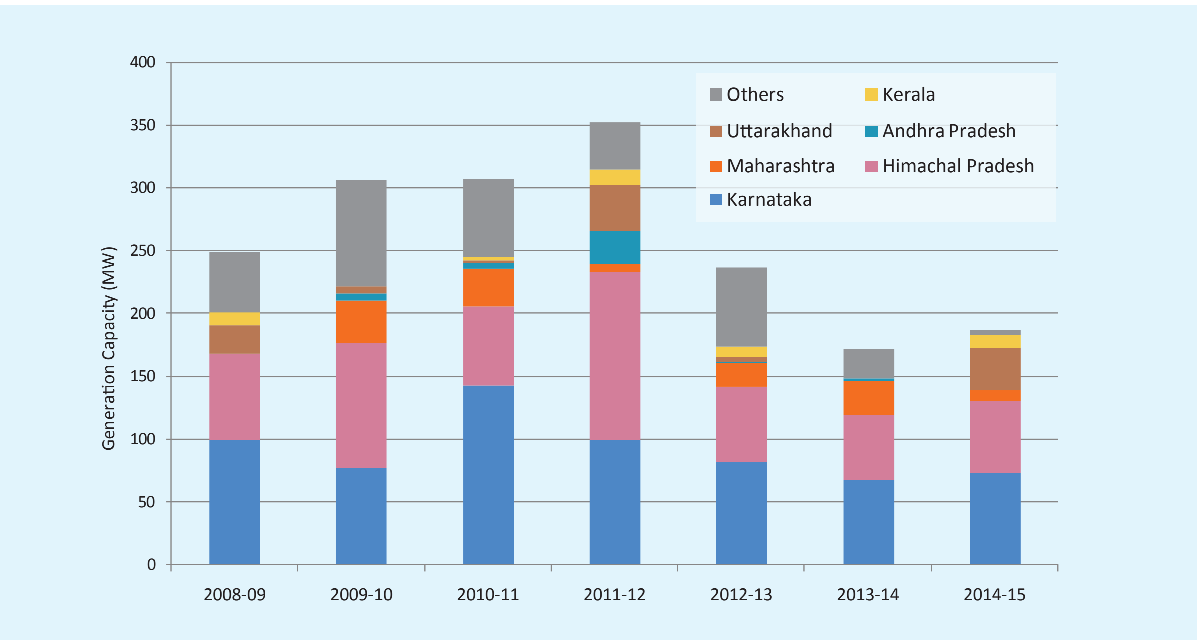
Figure 29: Year-wise state-wise biopower (biomass + bagasse cogeneration) capacity addition



Source: MOSPI, MNRE.

Karnataka has the highest installed SHP capacity in country followed by Himachal Pradesh and Maharashtra. Year wise capacity addition hit a high of over 300 MW/year from 2009-2012, but has fallen in last three years to below 200 MW/year. The national target for 2016-17 is a modest 250 MW, though with 4.3 GW already installed in the country, it is safe to assume that the 5 GW target for 2022 would be surely met rather easily.

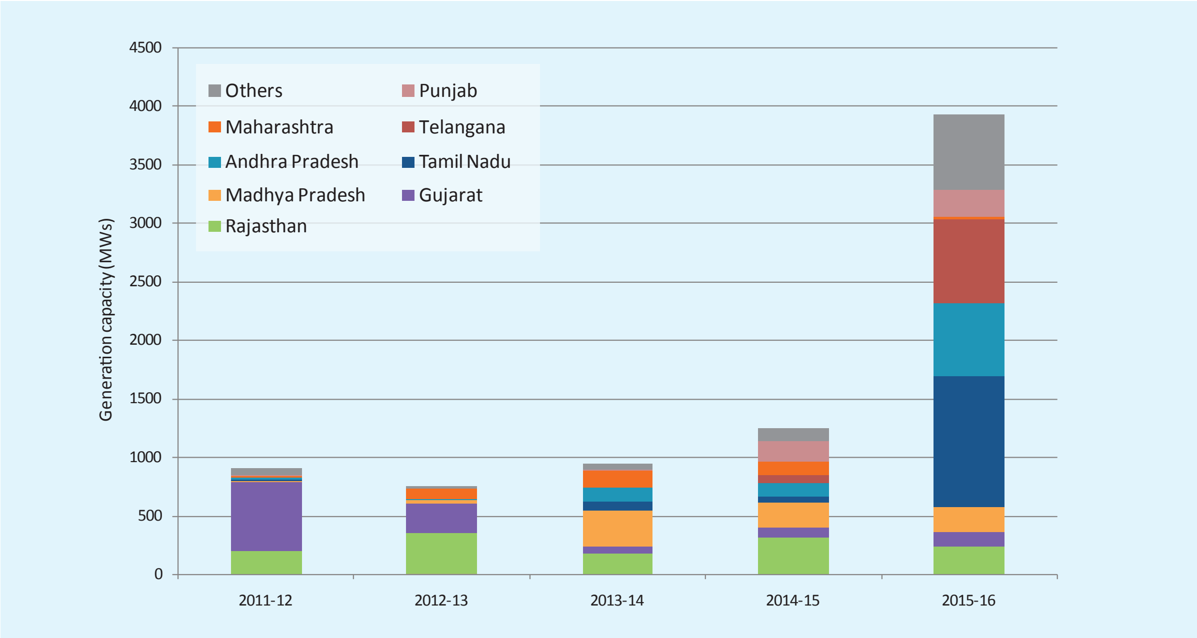
Figure 30: Year-wise state-wise SHP capacity addition



Source: MOSPI.

There has been an exponential growth in solar PV installations in 2015-16 after four years of adding just below 1 GW/year. The leading contributors to this growth were Tamil Nadu, Andhra Pradesh and Telangana. Installations have sharply reduced in the two erstwhile solar leader states, namely Gujarat and Rajasthan.

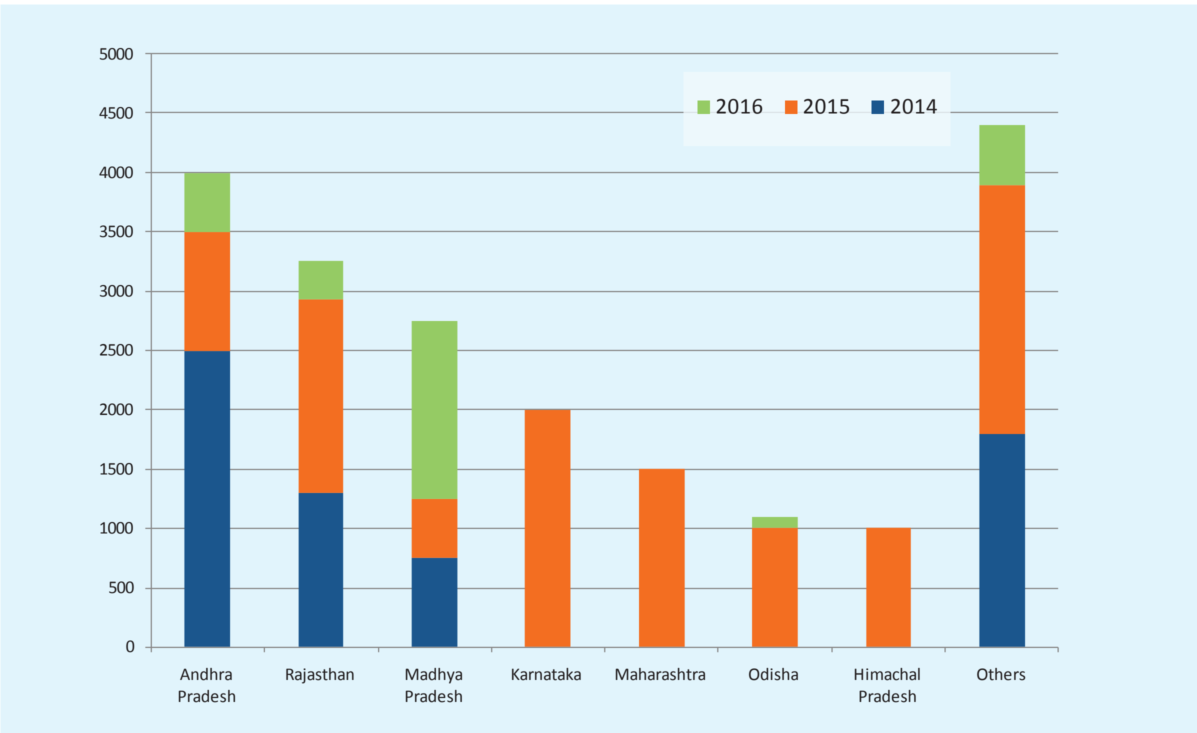
Figure 31: Year-wise state-wise solar capacity addition



Source: MOSPI, MNRE.

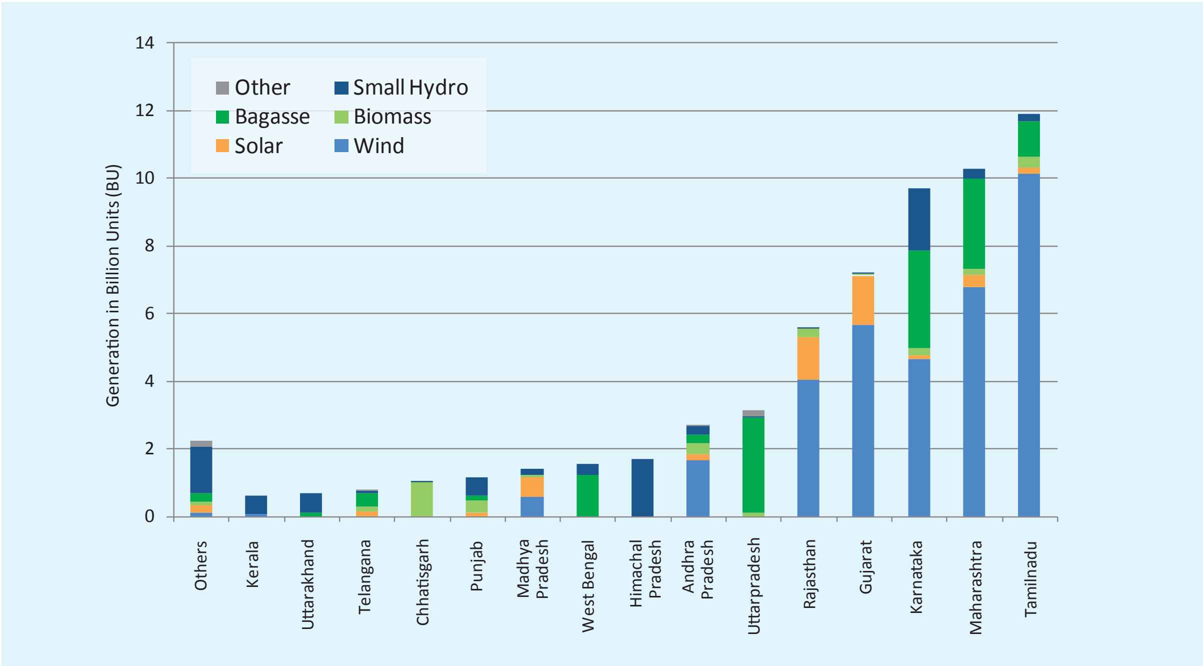
Note: 2014-15 addition is from April 2014 - May 2015, 2015-16 addition is from June 2015 - May 2016.

Figure 32: Year-wise state-wise solar park administrative approvals



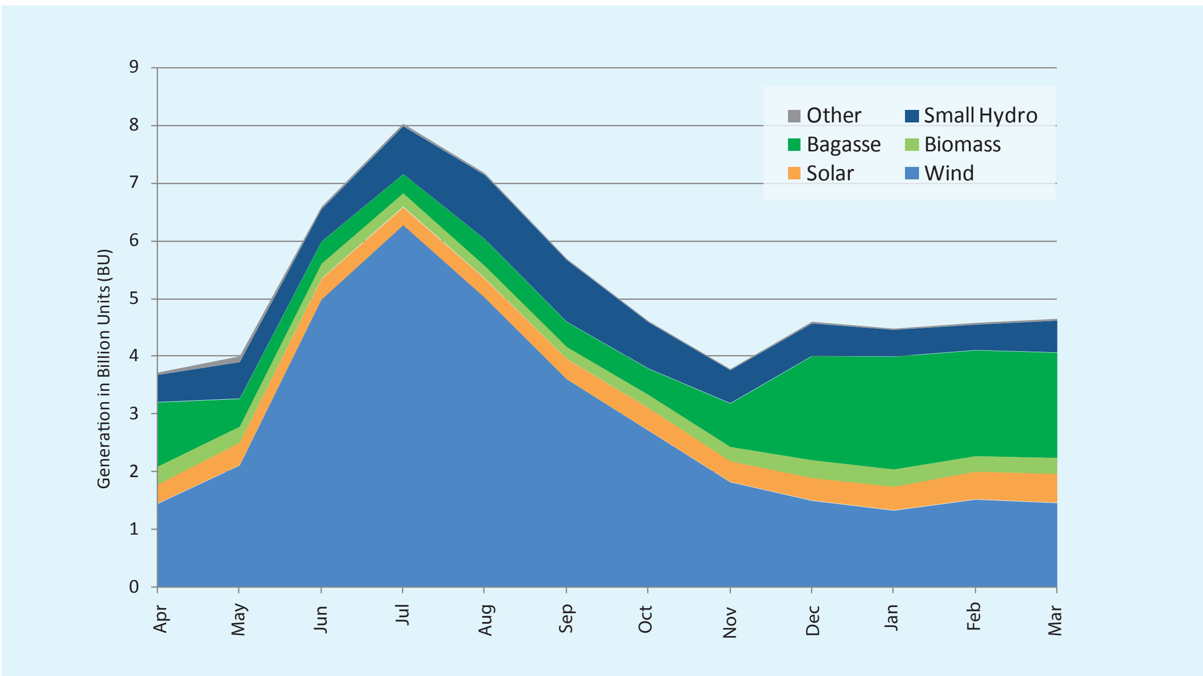
Source: SECI.

Figure 33: State-wise RE generation in 2014-15



Source: CEA; CEA disclaimer for RE data: 1) All figures are tentative 2) Data as received from SLDC of the respective states or from the electricity department.

Figure 34: Monthly RE generation in 2014-15



Source: CEA; CEA disclaimer for RE data: 1) All figures are tentative 2) Data as received from SLDC of the respective states or from the electricity department.

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India's ambitious renewable energy target of 175 GW by 2022 has firmly placed renewables as a mainstream electricity supply option. This has attracted a great deal of attention from diverse stakeholders in India as well as the international community. While the social and environmental benefits of renewables are well known, they also have other benefits, in terms of enhancing energy security, price certainty and low gestation periods. However, in spite of these benefits, the 175 GW target has profound implications and can throw up myriad challenges for the Indian power sector, especially in the medium term. Some of these are potential higher direct procurement costs for DISCOMs, greater complexity in grid operations, higher capital requirements etc.

Given these benefits and challenges, it is vital for the electricity sector actors to critically look at the growth of renewables. This report is an endeavour in this direction. It attempts to understand the growth of renewables in the past few years and looks at the country's progress towards reaching the goal of 175 GW by 2022. This is captured through various graphs and tables, relying less on a narrative.