NITI Aayog
(National Institution for Transforming India)
Government of India

State Renewable Energy Capacity Addition Roadmap

Action Plan 2022 and Vision 2030: Summary of findings

Knowledge Partner

Confederation of Indian Industry

Deloitte.

Assam

Gujarat

Maharashtra

Rajasthan

pwc

Andhra Pradesh

Karnataka

Madhya Pradesh

Punjab

Telangana

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Foreword

In November 2013, NITI Aayog (then the Planning Commission of India) undertook a stakeholder-driven study, titled 'India's Renewable Electricity Roadmap 2030', to analyse the opportunities and barriers to rapid deployment of renewable power in India. The report, released at RE-Invest 2015, proposed strategic interventions to accelerate India's renewables programme.

RE-Invest 2015 also saw the Government of India announce its target of 175GW installed renewable energy capacity by 2022. To translate the roadmap into state-level implementation, NITI Aayog embarked on the second phase of the project, working with State Governments to facilitate the process of generating and integrating renewables into their energy mixes. Our aim, in this phase, is to create a platform to promote coordination among various Central and state-level actors, identify and address policy, regulatory, financial and practical challenges.

This has led to the development of the State Action Plans (SAPs) for ten states, covering 8 rich in renewable resources, and two, with limited RE potential, in consultation with the state government who have guided the findings and helped build the roadmap to achieve the targets.

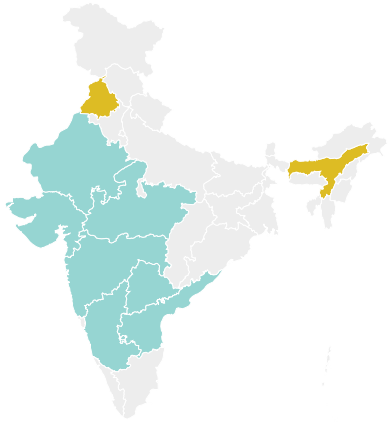
The Confederation of Indian Industry (CII) was commissioned to execute this project as knowledge partner and in the preparation of the SAPs by coordinating the activities of various stakeholders. Consulting firms PwC and Deloitte have worked on the state-level studies, while funding was provided by Shakti Sustainable Energy Foundation (SSEF), Department for International Development (DfID), UK, and Industry members.

The Executive Summary encapsulates the major learnings from the SAPs, and draws out the key recommendations for each of these states.

(Anil Kumar Jain)

स्वच्छ भारत

Contents



State summaries

Background

In November 2013, NITI Aayog (at the time, known as the Planning Commission of India) initiated a stakeholder-driven analysis of the opportunities and barriers to rapid deployment of renewable electricity in India, titled 'India's Renewable Electricity Roadmap 2030'. This activity was in conjunction with its role of co-leading the 21st Century Power Partnership (21CPP), a multilateral effort of the Clean Energy Ministerial (CEM) that serves as a platform to advance the large-scale deployment of renewable energy.

The Initiative was guided by a Steering Committee, which was led by Member (Energy), Planning Commission. Further, it included as members:

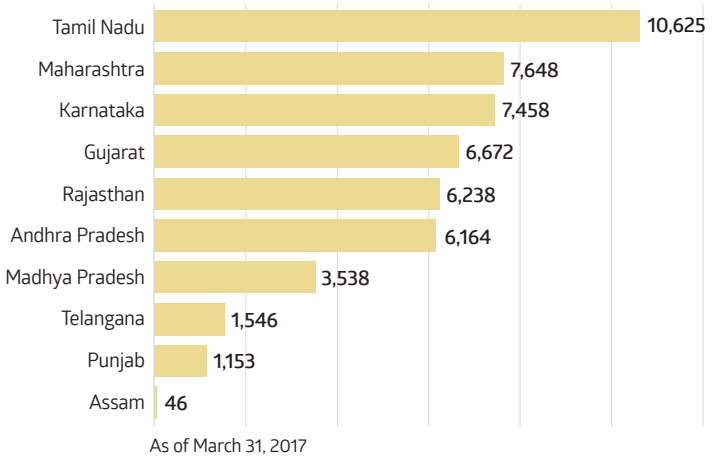
- Secretaries from key ministries (Power, New and Renewable Energy, Finance, and Environment and Forests)
- Chairpersons from key central level agencies (Central Electricity Authority, Power Grid Corporation of India Limited)
- Principal Secretaries (Energy) from two representative states (Tamil Nadu and Rajasthan)

Thereafter, NITI Aayog's operating agent for the 21CPP, the Confederation of Indian Industry (CII), and the Roadmap Initiative's knowledge partners, the Shakti Sustainable Energy Foundation (SSEF) and the Regulatory Assistance Program (RAP), constituted the RE Roadmap Initiative team. The team implemented a comprehensive stakeholder-driven "roadmap" exercise to answer the question: "How must the Indian power system evolve if India chooses to put renewable energy (RE) at the core of the future system, rather than at the periphery?"

The Initiative team conducted extensive, open-ended conversations with close to 250 stakeholders. This included the Steering Committee members, Chairpersons and senior staff of central and state electricity regulatory commissions, Energy Secretaries of states, managing directors of generation, transmission and distribution companies, grid operators and managers, power planning agencies, civil society, industry, finance, developers, and bilateral and multilateral institutions in 12 states and in Delhi.

Published in February 2015, the Roadmap Document proposed strategic interventions to achieve India's ambitious RE targets of 175 GW by 2022. It concluded that India needed new policies, programs and operational rules

RE installed capacity (MW)



As of March 31, 2017

to enable power flows from point of generation to load centers; ensure fair compensation to generators; and offer reliability of supply to consumers at affordable prices.

NITI Aayog decided to assist the states in their efforts by taking up the implementation of the Roadmap given in the above-mentioned report.

While several recommendations proposed in the Roadmap Document were already being considered by the government—for example, a draft RE law—the need to have greater integration between the efforts of various states in moving towards India's 175 GW target and the importance of looking at the renewable energy sector in a holistic manner for sustainable transformation was critical.

This formed the background for the current phase of the RE Integration Roadmap activity. The objective of this phase was, therefore, to create a platform to promote coordination among various state and central level actors to achieve national renewable energy and climate change targets. The outcomes included development of State Action Plans (SAPs) for 9 states in India, and bringing together different actors involved to realize India's RE ambitions on a common platform.

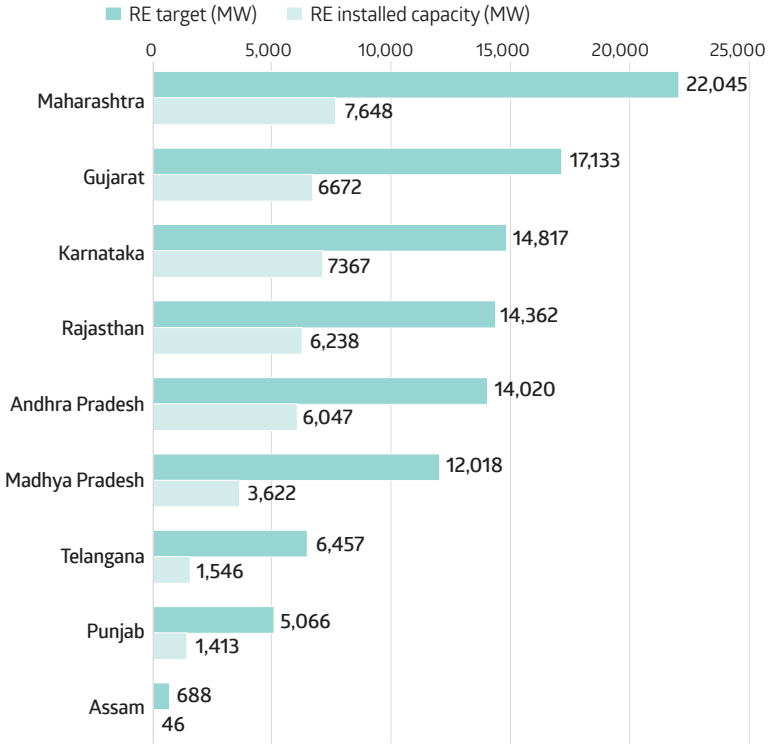
These 9 states were broadly categorized into two sets:

Resource-rich states (7): Andhra Pradesh, Gujarat, Karnataka, Madhya Pradesh, Maharashtra, Rajasthan and Telangana

Resource-deficit states (2): Assam and Punjab

As on March 31, 2017, these 9 states had a total RE installed capacity of 51,087 MW, which is about 89% of the 57,260 MW RE capacity of India. Further, 73% of the 175 GW target to be achieved by 2022 has been allotted to these 9 states. These targets are in line with the RPO targets of the states. However, they have achieved just 40% of the target so far. The major bottlenecks preventing the scaling of RE in these states are the integration of the naturally variable RE capacities into the grid, balancing, regulatory issues, lack of an effective marketplace and economic challenges.

RE target versus RE installed capacity



As of March 31, 2017, except for Andhra Pradesh and Punjab (May 2017), Karnataka (June)

Also, while RE is picking up, a majority of the states are dependent on thermal-based (coal and gas) power generation. Therefore, for India to achieve the 175 GW target by 2022, these 9 states have to give a push to their deployment of RE.

Methodology

In order to bring various Indian states under the fold of discussions and to provide a platform for dialogue between different central government institutions and agencies, NITI Aayog constituted a two-tier implementation structure: an Advisory Group and a Steering Committee.

The Advisory Group, chaired by the Vice-Chairman of NITI Aayog, had as its members state energy ministers from 9 states, along with the Union Minister of State for Power. The objective of this forum was to deliberate issues that required political consensus and resolution. The Advisory Group is not only mandated to review the progress of RE development based on status reports provided by the Steering Committee, but is also suggesting interventions required to promote India as an RE investment destination/ hub to achieve national RE targets.

The Steering Committee, chaired by the CEO of NITI Aayog, had as its members state energy secretaries, and heads of institutions such as CEA, POSOCO, PGCIL and CERC. An operational group, the Steering Committee coordinated the development of State Action Plans (SAPs) and identified action items of different states.

It also provided a platform for different stakeholders at the central and state levels to discuss market and infrastructural issues related to the management of electricity generated from renewable sources. In addition, the Steering Committee proved to be a platform for sharing knowledge and

Implementation structure set up by Niti Aayog

Oversight

Advisory Group

Chaired by Vice Chairman, Niti Aayog

- Review progress of RE development in the country based on status reports provided by the Steering Committee
- Suggest interventions required to promote India as an RE investment destination/hub to achieve national renewable energy targets
- Provide strategic guidance and directions to the Steering Committee as and when required

Monitoring

Steering Committee

Chaired by CEO, Niti Aayog

- Develop a coordination mechanism among the different stakeholders at the central and state levels to implement the aforementioned strategies
- Report the progress of the implementation assembly to the Advisory Group and the different stakeholders

Implementation

State Working Groups

Chaired by Energy Secretary of respective state

To support preparation of the State Action Plan for Renewable Energy and implementing the suggested action plan to achieve the states' RE target by 2022 and beyond

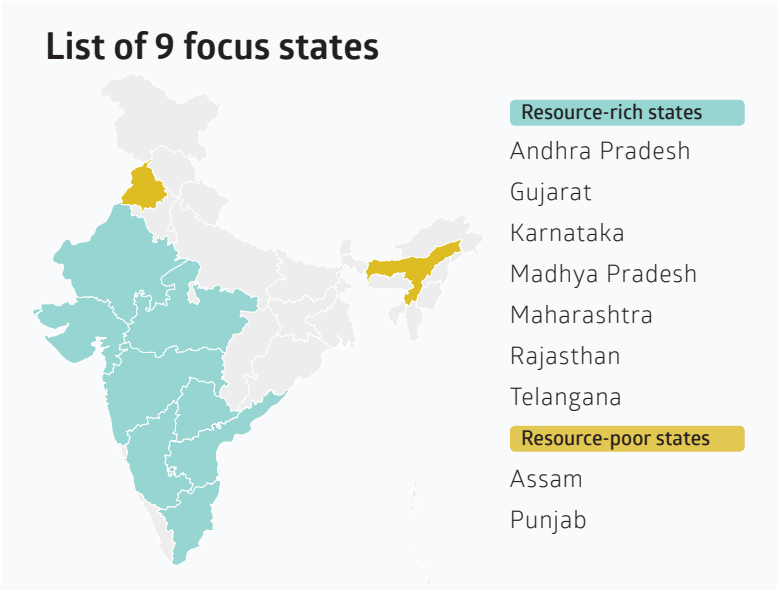
experience of several initiatives that are underway to create the support system for RE both at the central and state levels.

These two groups have been constituted to coordinate activities of RE integration across different states of India. As part of this initiative, the initial focus was on 9 states across India (See graphic: 'List of 9 focus states'). Seven of these were RE resource rich, in solar and wind, while two others were identified as having lower RE resource potential. An understanding of the concerns of the latter set was considered essential to develop a pan-India market for renewable electricity.

In addition to the two-tier machinery put in place to aid the transformation of the energy sector and to enable India to achieve its target capacity addition in 2022 and 2030, this initiative involved the creation of State Working Groups (SWGs), constituted under each representative state working towards achieving this target. The SWGs comprised representatives from the three segments of the power business—generation, transmission and distribution—and was chaired by the Principal Secretary of the Renewable Energy Department in the State. The decision to institute such groups was taken during the first meeting of the Steering Committee held on June 20, 2016, at NITI Aayog, New Delhi.

The SWG in each state focused on supporting the preparation of the State Renewable Electricity Capacity Addition Roadmaps—captured in SAP documents to achieve their 2022 RE target and to develop a Mission Document highlighting the states' contribution towards Nationally Determined Contribution (NDC) target for 2030. They were also given the objective of implementating the suggested action plan to achieve the states' RE target by 2022 and beyond.

In order to support the development and preparation of the State Level Roadmaps by coordinating activities with various state-level stakeholders, NITI Aayog's operating agent and knowledge partner, the Confederation of Indian Industry (CII), assisted in assigning dedicated consultants to these identified states, with financial support from the Department for International Development (DfID), UK, and other industry members.



Consulting firms PwC and Deloitte supported the development of SAPs for the states. The consultants worked under the direction of the SWG and submitted their recommendations to achieve the targets for RE 2030. The reports of the SWG are expected to present the agenda of the state government towards development of RE in an integrated manner until 2030.

This document summarizes outcomes from SAP documents, as developed by the states. The following section outlines the key challenges being faced by states to meet their RE targets for 2022. The subsequent section draws out key recommendations emerging from SAP documents. The various state summaries are provided thereafter.

Key challenges

The State Action Plans (SAPs) revealed that states are facing issues not only with installing the necessary RE capacities as targeted, but also with integration of the naturally variable RE capacities into the grid. The following are some of the key challenges being faced by states that developed the SAPs:

Balancing

Given the natural variability of RE sources, states are finding it increasingly difficult to accommodate such power into their grids. The challenge is perhaps greater for RE resource-rich states, given the volume of generation which already forms a higher share of their total power consumption.

In this regard, they are facing challenges as a result of the following:

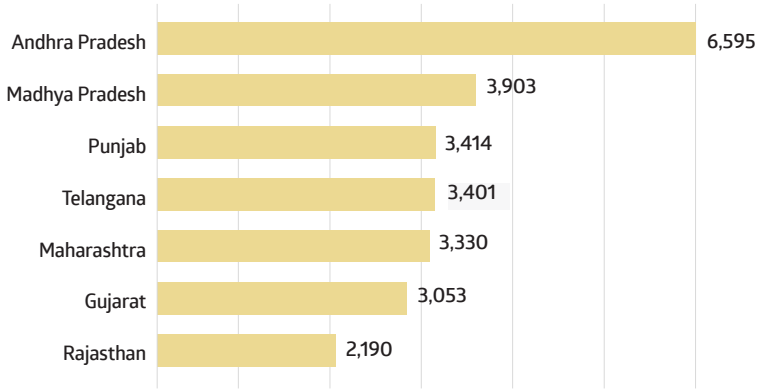
a) Availability of balancing reserves varies greatly from state to state. This makes it challenging to manage the variability of RE power across different states. For instance, while Gujarat has access to hydro and gas plants, which can be used as balancing reserves, Rajasthan and Maharashtra have limited availability of gas or hydro plants, limiting their ability to balance. Lack of parity to use flexible sources on a national basis is leading to a loss of opportunity to balance RE at a regional level.

b) Given the current absence of regional or national balancing markets to address the intermittency issues of RE, different states continue to pay huge penalties when they exceed their stipulated Deviation Settlement Mechanism (DSM) targets set by the Central Electricity Regulatory Commission (CERC). RE-rich states—whose maximum threshold is 250 MW, beyond which they are penalized for over-drawing or under-drawing from the grid—consistently appear to limit themselves to these targets. Tamil Nadu has reportedly paid Rs 100 crore as DSM penalty in 2016, as it breached its thresholds due to large variance in wind generation.

c) For almost all states, State Load Dispatch Centers (SLDCs) have limited visibility on real-time RE generation due to lack of communication channels with RE pooling sub-stations. This is a critical limitation, and it reduces the generation planning possibilities of states.

d) The absence of a clear regulatory framework that would enable states to share their balancing reserves and enable easy commercial settlement is a critical limitation for states to effectively balance their systems with available capacities. Regulators are yet to implement guiding regulations that will enable inter-state balancing and identification of balancing capacity (large

Balancing requirement (MW)



capacity already tied under PPAs). This may also require re-writing PPAs that exist between flexible generations and DISCOMs to whom the power is committed.

e) In an environment where accurate forecasting by RE generators is not available, the limiting DSM targets that states have to adhere to remains a major challenge for most states. RE generators that use the previous day's output of solar and wind generation as a reference for day-ahead scheduling are limited by the absence of accurate real-time data for forecasting. Tamil Nadu has paid large penalties. Elsewhere, Rajasthan, which is witnessing 30% variation in RE generation over scheduled levels, has undergone unplanned back-downs of cheaper conventional power at high costs.

   Therefore, developing draft forecasting and scheduling regulations become particularly critical for most RE resource-rich states with significant conventional energy capacities. This lack of an institutional framework and the absence of adequate technical expertise has slowed down the development of Renewable Energy Management Centers (REMC) in different states. Such issues have been highlighted by several states, including Andhra Pradesh, Karnataka, Madhya Pradesh, Rajasthan and Tamil Nadu, which continue to face significant challenges in integrating huge RE capacities into the grid along with huge availability of conventional sources.

f) The challenges that states face to balance their variable RE power appear to be aggravated by the slow pace of development of intra-state transmission infrastructure. Even though the challenge appears limited currently, states have highlighted this as a concern as RE capacities increase. The delay in implementation of Phase 1 of the Green Energy Corridor (GEC), and the slow progress in the planning and work of Phase 2, has been cited as a challenge by several states.

Regulatory issues

Several regulatory limitations are holding back the quick deployment and adoption of RE across different states. Ranging from issues related to inter-state sharing of RE balancing reserves to smart and net-metering, some of the key regulatory challenges raised are as follows:

a) Low demand in the Renewable Energy Certificate (REC) market and the lack of an effective mechanism to share Renewable Power Obligations (RPOs) of different states is creating a disincentive for RE resource-rich states to develop RE capacities beyond their internal obligations. Given the lack of clear regulations for enforcement of RPOs into the future, most states have not notified revised RPO targets that are aligned with 2022 capacity obligations. Consequently, several states are still to adopt and notify revised RPO targets set before them.

b) There is a delay in implementation of model regulations, as recommended by CERC, due to a lack of technical abilities and financial commitments involved. Consequently, although regulations are in place, states such as Andhra Pradesh, Maharashtra and Telangana have not yet implemented forecasting and scheduling, and have been unable to develop availability-based tariff regulations.

Given the natural variability of RE sources, states are finding it increasingly difficult to accommodate such power into their grids.

There is a delay in implementation of model regulations, as recommended by CERC, due to a lack of technical abilities and financial commitments involved.

c) The lack of model regulations for inter-state banking of RE power limits the generation of RE in RE resource-rich states and potential banking in RE-deficit regions. Noting this, states such as Madhya Pradesh have raised a petition to develop a regulatory framework around inter-state banking of RE power.

d) States have highlighted the lack of long-term regulations to support RE as a challenge to increasing investments. For instance, the lack of clarity on exemption of inter-state transmission charges for solar projects beyond June 30, 2017, poses a risk to engage on long-term PPAs, and adds uncertainty to existing or upcoming inter-state sale arrangements.

e) Given the tapering nature of growth of power demand across different states, the lack of a regulatory framework and financial mechanisms to support and incentivize DISCOMs to prioritize uptake of RE is a deterrent to RE capacity addition. In the absence of appropriate regulatory and financial incentives, DISCOMs are challenged in accommodating RE into the system beyond the designated RPO obligations.

Economic Challenges

Integrating the relatively more expensive RE into the grid, over conventional sources of energy, has been a challenge for most distribution companies. Some such key economic challenges being faced by states are as follows:

a) States are facing a unique situation where, on the one hand, there is a decline in growth rates of power consumption in the states. On the other hand, there is incremental growth in both conventional and renewable power capacities. In this environment, DISCOMs have to back down cheaper conventional sources of power, adding to their losses. In particular, states like Andhra Pradesh, Punjab, and Rajasthan have had to undertake unplanned shut downs or lower the PLF of thermal plants while bearing their fixed costs.

b) The limited availability of central government financial assistance, in the form of access to national funds such as the National Clean Energy Fund (NCEF), to strengthen RE integration activities in states has been identified as a challenge by several states. Such funds could be used to develop REMCs and to promote RE by funding the costs borne by DISCOMs to back down conventional power generation to promote RE.

c) Several states have long-standing PPAs with conventional power developers. In addition to state-level agreements, several states are also in the process of being allocated conventional power from central power generation companies. Given the tapering of demand growth, future allocation of power through long-term PPAs to Andhra Pradesh, Punjab, Madhya Pradesh and Telangana can add significant capacities to these states with no significant demand growth forecasted in future. On the contrary, PPAs of states that are being backed down ought to be transferred to these states that need to contract suppliers from conventional base-load sources.

d) The Central Government has also assigned several large-scale consumers of power (including Obligated Entities) to develop RE capacities. This has

resulted in such consumers moving away from states by setting up their own captive solar plants to ensure compliance with their RPOs. This has limited states in appropriate utilization of their RE assets.

e) As fresh capacities get created, the need to contract balancing power rises concomitantly. This is exposing RE-rich states to future increases in prices of balancing power. In order to ensure long-term well-being of DISCOMs using large volumes of RE, there is a need to lead the cost of balancing power to the variable RE as its true cost.

Lack of effective marketplace for RE in India

Although a platform for power trading exists in India, there is a lack of a vibrant and effective RE market, where generators and distribution companies can buy and sell RE across the Indian grid. Some key issues being faced by states in this regard are as follows:

a) When states generate surplus RE power, there is currently no pricing framework or platform to trade the same, thereby resulting in wastage of RE generation. An effective marketplace to trade this power is the need of the hour to reduce wastage.

b) RECs, the mechanism that could have been effective to trade RE generation and consumption capabilities, have seen a drastic fall in prices for both solar and non-solar certificates, and removal of vintage multiplier for old, untraded REC stock. This results in a situation that does not allow RECs to be used for trading power between different stakeholders.

c) RE sources that are not variable (hydro, biomass) are not receiving impetus due to a lack of true value being ascribed to them. As they are more expensive to generate with no higher value, these sources are not growing. There is a critical need to differentiate them at the RE marketplace. ■

Key recommendations

The state action plans, developed by different states, also captured information on various strategies that states felt would help them achieve their RE objectives. Some key recommendations, emerging from the different strategies suggested by states, are as follows:

Creation of ancillary markets to pool surplus RE power and development of a platform that would enable RE resource surplus and deficit states to trade and balance their RE targets.

Setting up RE LDCs at the regional and central levels to assist in power balancing across a greater geographical area and support banking of excess RE power generated by RE rich states and real-time tracking of excess RE power generation.

Development and definition of regulatory norms for an independent RE power trading platform, which will allow trading of RECs, as well as trade between different generators and consumers seamlessly.

A mechanism whereby obligated entities required to meet RPO targets are required to be enforced to buy untraded RECs to fulfil the total outstanding RPO targets. The same is also required to be enforced through appropriate regulations.

Inter-state transmission charges for RE need to be kept low to encourage regional balancing and for RE resource-abundant states to find potential consumers of RE resource-deficit states.

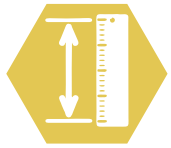
Handholding states, both technically and with necessary financial assistance, to develop world-class forecasting tools for solar- and wind-based sources of energy.

Ensure compliance of RPO targets for different states, including using appropriate penalties and enforcement mechanisms.

Providing appropriate level of feed-in-tariff support to flexible generation—gas, biomass, hydro—to ramp up their capacities.

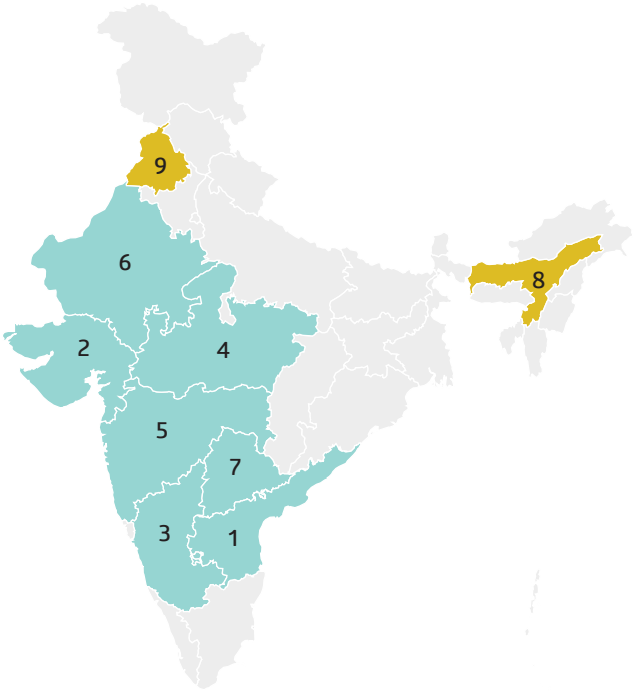
Consider creating a regional advisory mechanism to guide regulators to coordinate integration of RE.

Provide financial support to states from NCEF to strengthen intra-state transmission corridors for lines left out of the Green Corridor projects.



Many states like Madhya Pradesh, Andhra Pradesh, Gujarat and Maharashtra are surplus in power, and are adding more capacities for trade. They may not go for adding RE for inter-state sale. This calls for re-consideration of plans for conventional capacity addition.

State summaries



Resource-rich states

1	Andhra Pradesh	**14**
2	Gujarat	**18**
3	Karnataka	**23**
4	Madhya Pradesh	**27**
5	Maharashtra	**30**
6	Rajasthan	**34**
7	Telangana	**39**

Resource-poor states

8	Assam	**42**
9	Punjab	**46**

States arranged in alphabetical order in each set.

1 Andhra Pradesh

6,047 MW
RE capacity

14,000 MW
Share of 2022 national RE target

Overview

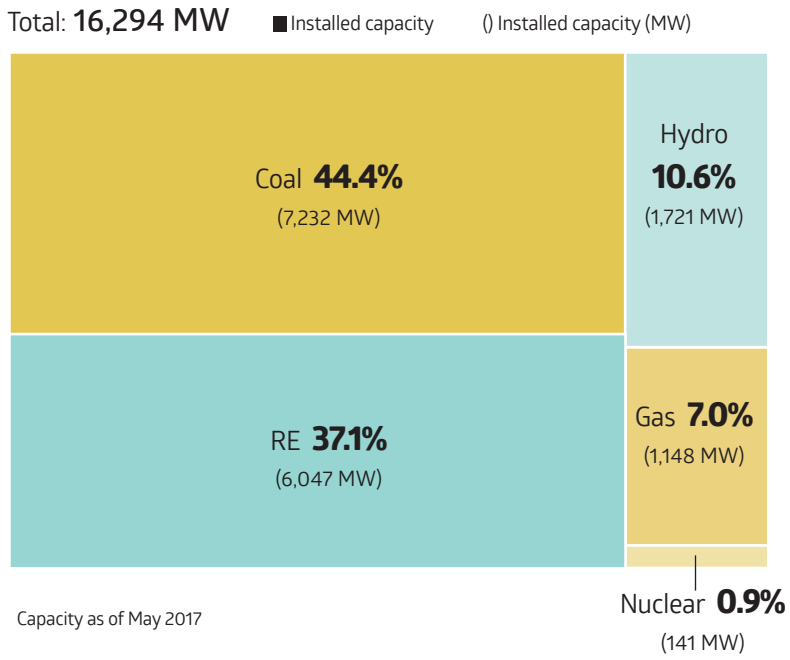
Andhra Pradesh was one of the pioneers among states to initiate power sector reforms in India, as early as in 1998. The state government is now also encouraging RE in a big way, and has released policies for solar and wind, envisioning a capacity addition of 5,000 MW by FY19 and 10,000 MW by FY 22 from solar.

Andhra Pradesh, after its bifurcation, has made significant progress in addressing its peak energy deficits, and has now turned into a power-surplus state. The state has already added 3,604 MW of solar capacity and 1,875 MW of wind capacity. As a result, RE accounts for a 37% share in the total capacity mix of 16,294 MW in the state. The New and Renewable Energy Development Corporation of Andhra Pradesh (NREDCAP) is the nodal agency for RE in the state, which became fully electrified in June 2016.

State targets for renewable energy

Andhra Pradesh has been apportioned ~8% (14,000 MW) of the 2022 national RE target. Of this, the allocation for wind is ~57% (8,100 MW) and for solar is ~38% (5,357 MW). The state, however, has set its own, greater targets for RE by FY 2022: 10,000 MW for solar (state already plans to revise the planned solar capacity) and 8,000 MW for wind.

Figure 1.1: Current installed capacity



In the RE domain, Andhra Pradesh has realized potential of ~4% so far. Solar and wind both have extremely high potential: MNRE has estimated ~44 GW for wind and ~38.5 GW for solar, or a total of ~82.5 GW.

Capacity and RPO achievements

As of May 2017, Andhra Pradesh had an installed RE capacity of 6,047 MW, of which 1.87 GW was solar and 3.6 GW was wind (See Figure 1.1). In terms of energy use, RE constitutes ~10% of the state's energy demands, which is already in line with its RPO targets. The state can easily top the national target of 8% solar RPO in FY 2022, by realizing 15% of its energy demand through solar till FY22 (Figure 1.2).

Challenges faced by state

While Andhra Pradesh is on track to meet its 2022 RE obligations, the state faces several challenges:

- In the backdrop of limited demand growth, significant capacity addition plans of conventional power in the next five years will lead to a huge surplus in the state
- Balancing hourly demand through ancillary services
- Limited balancing reserves in the state: no pumped storage hydro or gas reserves owned by the state for balancing
- Significant solar and wind additions in the state is causing huge grid integration challenges
- The inability to shift full agricultural load to daytime, due to limitations on water availability, results in huge unused capacity during daytime

State efforts to encourage RE

The state has adopted a multi-pronged strategy to embrace RE. These are some of its key strategies:

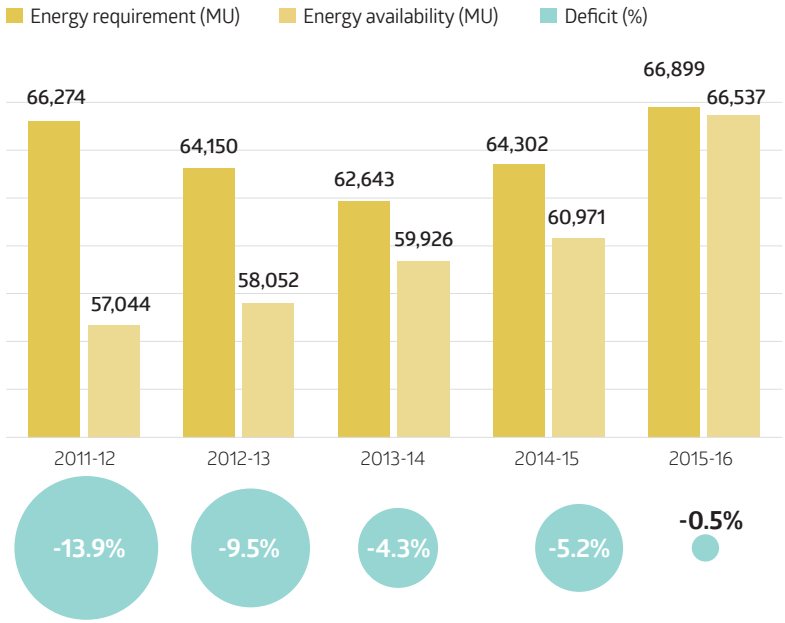
Andhra Pradesh, Solar Policy 2015

In order to increase the deployment of solar energy projects and create a favorable environment in the state, the Andhra Pradesh government announced a Solar Power Policy in 2015. The state has recorded substantial achievements in the solar segment, including:

Solar parks: The state was a pioneer in considering solar parks under the SECI scheme, and has successfully bid ~1,000 MW capacities under the Solar Park Scheme. The state further plans to allocate 500 MW, with an initiative to allocate 100 MW for the storage scheme. These projects were bid under e-auction and were the first to push solar tariffs below Rs. 4/kWh.

Decentralized projects: The state is considering adding mini-grid projects

Figure 1.2: Energy demand-supply position



in solar, shifting interest from large solar park projects. The state is also planning to revise its solar policy to bring out new capacity addition plans.

Some of the key incentives leading to high solar capacity additions in the state include exemption from electricity duty, wheeling and transmission charges (for captive use) within the state, CSS, 100% banking facility, CDM benefits and PCB clearances.

Andhra Pradesh, Wind Policy 2015

The current wind power policy 2015 is an extension of the old policy released by the state in 2012. Wind power projects commissioned during the operative period (within 5 years from 2015) shall be eligible for incentives declared under this policy for 10 years from their date of commissioning (unless the period is specifically mentioned for any incentive). All registered companies, joint venture companies, central and state power generation/ distribution companies and public/private wind power developers will be eligible to set up wind power projects, either for captive use and/or to sell to utilities or third parties, in accordance with the Electricity Act 2003. Further:

- Wind power projects shall be allowed in areas notified by MNRE or where wind monitoring studies have been undertaken by MNRE/ NIWE/NREDCAP/GoAP
- NREDCAP is responsible for capacity allotment up to 40 MW. Beyond that, the state government
- In order to enable better utilization of common infrastructure and related facilities, solar and wind hybrid power projects shall be encouraged. The tariff for such solar projects shall be as determined by APERC
- Wind power developers will be encouraged to install Wind Electric Generators (WEGs) of higher capacity and improved technology by repowering projects that have completed 15 years

Incentives offered in the policy include exemption from paying supervision charges to AP Transco/DISCOM, exemption of transmission and distribution charges for wheeling, 100% banking, exemption of electricity duty, deemed non-agricultural status being awarded to land for wind power projects, injection from wind power projects to be considered as deemed scheduled subject to prevailing regulations/grid code of appropriate commission.

Andhra Pradesh Solar-Wind Hybrid Policy-Draft

The main objectives of the policy are:

- Promotion of large grid connected wind-solar PV systems for optimal and efficient utilization of transmission infrastructure/land.
- Reducing variability of renewable power generation and achieving better grid stability
- Targeting 3,000 MW hybrid (solar-wind) by 2019-20; to be part of the 18,000 MW vision

The state was a pioneer in considering solar parks under SECI scheme, and has successfully bid ~1,000 MW capacities under the Solar Park Scheme.

It is categorized into 3 parts:

- Combined generation of power at existing or new solar/wind power projects
- Co-located: addition of wind or solar at inter-connection points of RE pooling station point of existing solar or wind installations
- Co-injection: addition of wind or solar after inter-connection point of RE pooling station point of existing solar or wind installations

Incentives offered include exemption of distribution losses for injection of power at 33kV voltage or below, exemption of T&D charges for wheeling power from hybrid power plants, 100% banking of energy for all 12 months, exemption of CSS for third-party sale within the state for five years and electricity duty in case of power sale to AP DISCOM from the hybrid plant.

State roadmap for 2022

By adopting the policy initiatives listed above, Andhra Pradesh has charted a future trajectory. After successfully commissioning large-scale solar parks, its focus shall now be towards decentralized generation of solar projects. The state also plans to consider inter-state balancing facilities and inter-state power supply to support RE-deficit states.

Figure 1.3: State meetings held

Date	Location	Participants
November 11, 2016 (1st Steering Committee Meeting)	Hyderabad, Telangana	PwC Team, State Representative, Niti Aayog
December 14, 2016	Hyderabad, Telangana	PwC Team, State Representatives
May 23, 2017 (2nd Steering Committee Meeting)	Amaravati, AP	PwC Team, Principal Secretary

List of state recommendations

Realizing the state's roadmap will require concerted efforts cutting across policy, regulation, finance, infrastructure and market-related interventions. Key recommendations have been highlighted below:

1. Large focus on energy storage will require subsidy support from the central government to address the challenge of high cost of batteries in the initial stages.
2. To promote RE, the central government should offer incentives to states for meeting RPO targets.
3. Pumped storage scheme to be encouraged to provide natural storage for green intermittent power; provision for Power System Development Fund.
4. Given the reduced demand growth, and to incorporate green power and prevent surplus capacity addition, states to reconsider further addition of conventional power sources.
5. Central agencies like NVVN, NTPC and SECI to buy excess RE power and distribute to RE-deficit states. ■

2 Gujarat

6,634 MW
RE capacity

17,133 MW
Share of 2022 national RE target

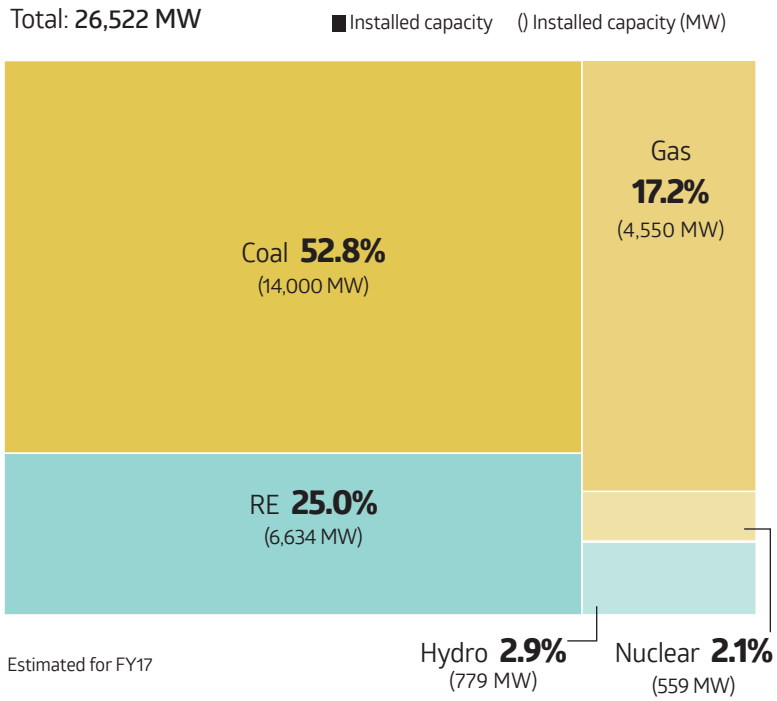
Overview

Gujarat, sometimes referred to as the Jewel of Western India, is located in the western part of India. It has a geographical area of 196,024 sq km with a coastline of 1,600 km (990 mi), most of which lies on the Kathiawar Peninsula. The population of Gujarat is around 60 million. The state is bordered by Madhya Pradesh on the east, the Arabian Sea and the Pakistan province of Sindh on the west, Rajasthan on the north, and Maharashtra and the union territories of Daman, Diu, and Dadra and Nagar Haveli on the south. The capital of Gujarat is Gandhinagar, while Ahmedabad is its largest city and is also considered to be its financial capital.

Gujarat is endowed with huge RE potential. This is particularly true of solar, where the state is blessed with 300 days of sunshine and abundant land reserves. The state's 1,600 km shoreline can be used to harness wind energy. There's also scope for energy plantation in its vast wastelands, and waste-to-energy options that harness bio, agro and industrial waste.

However, Gujarat has limited hydropower potential. And the coal-based plants located in the state source coal from the eastern part of India, about 1,500 km away. Therefore, it is in the economic self-interest of the state to deploy more RE technology, reducing the carbon footprint of the state and the country.

Figure 2.1: Current installed capacity



RE capacity, state targets and RPO

The share of renewables in Gujarat has increased from 13% in 2011 to around 25% in 2017, expanding at an annualized rate of ~7.1%. By 2022, it is expected that overall renewable capacity in this state will increase to 17,133 MW, as per the targets suggested by MNRE.

However, if Renewable Purchase Obligation (RPO) of 19% (9% solar and 10% non-solar) is considered a driving force for renewable capacity addition in the state, the RE capacity required to meet the RPO target by 2022 will be ~16 GW. Figures 2.2 and 2.3 outline the renewable capacity required in the state to meet the 19% RPO under projected electricity demand scenario.

Challenges faced by state

While the RE sector in Gujarat has been growing at an annualized rate of 22% since 2011, there are challenges that need to be addressed to ensure sustainability of investments in the sector and achievement of RE targets set by the government for 2022. Some of these are:

- Policy and regulatory environment in Gujarat needs to be strengthened in three areas: ease of doing business; overall incentives offered by the state to the RE sector; notification of the revised RPO trajectory till 2019, as per NAPCC and National Tariff Policy.
- Slippages in RPO compliance by DISCOMs, which has increased the offtake risk for RE developers.
- Increasing variability in the system due to a rising share of RE in the state's electricity mix. Figure 2.4 details the expected demand profile, RE generation and period of high ramp-up/ramp-down scenario in case RE targets of 17,133 MW for the year 2022 is achieved. Following are some key observations:
  - Most of the ramping down requirement occurs during morning time, while ramping up requirement occurs during afternoon/ evening time.

Figure 2.2: RPO trajectory till 2022

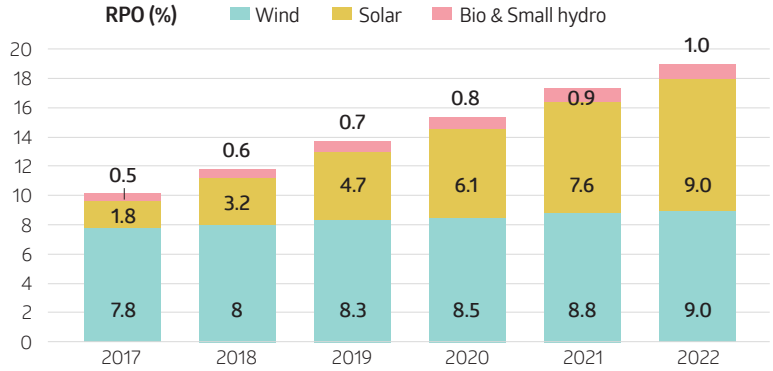
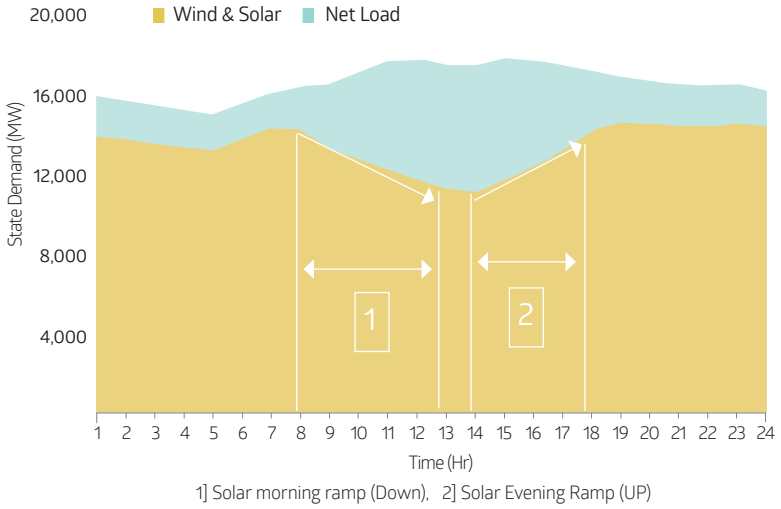


Figure 2.3: RE capacity required to meet RPO target

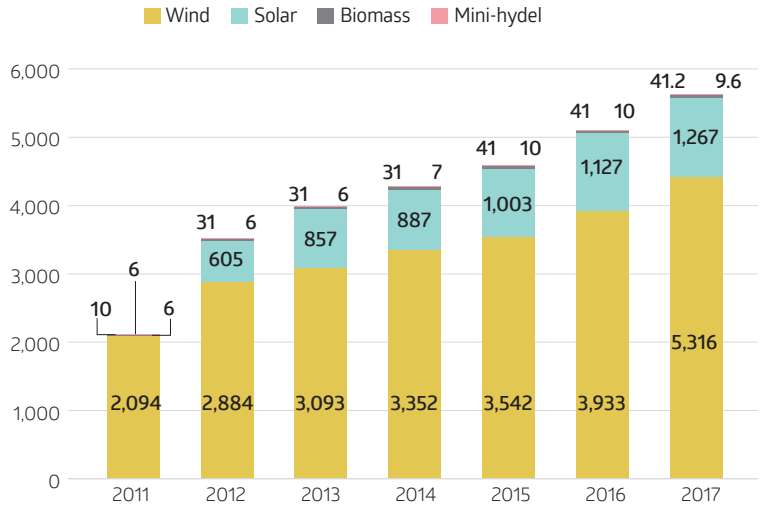
	Solar	Wind	Bio & Small
2017	1,318	4,514	119
2018	2,559	4,949	152
2019	3,952	5,423	189
2020	5,363	5,780	223
2021	7,023	6,295	266
2022	8,837	6,835	311

Figure 2.4: Variability in the system



1] Solar morning ramp (Down), 2] Solar Evening Ramp (UP)

Figure 2.5: Renewable energy growth trajectory



Key drivers of RE growth in the state

Solar

- First Solar Policy was introduced in FY09, followed by a revision in FY16
- Feed-in tariff allowed during FY09-14
- Government provided facilitation in approvals and clearances, and creation of evacuation and connecting infrastructure
- Exemption from electricity duty

Small Hydro

High possibility for setting up SHP near river streams and large canal network

Biomass

- Huge MSW potential of 100 MW
- Initiatives undertaken to reduce the cost of electricity generated using bio waste

Wind

- First wind policy was launched in 1991, followed by revisions in FY07, FY12 and FY16
- Feed-in tariff of 3.5 per unit was offered
- Exemption from electricity duty in case of sale to GUVNL
- Generation-based incentives from the Centre
- Offtake supported by RPO issued by the state

- The minimum continuous ramping down requirement will be ~3.077 GW from 0800 to 1300 hours

- The maximum continuous ramping up requirement will be ~3.053 GW from 1400 to 1800 hours

State efforts to encourage RE

Policy and regulatory support, along with financial incentives, have been some key drivers of RE in the state. In order to accelerate investments in the RE sector, Gujarat has introduced and amended its solar and wind energy policy from time to time to give direction to the nascent RE market; it has also offered financial incentives to jumpstart utility-scale solar and wind energy projects (Figure 2.5).

In order to promote solar and non-solar power generation, GERC has issued procurement of RE regulation, which sets separate RPO targets for obligated entities in each category. The state has also introduced solar rooftop net metering regulation and solar pump schemes, wherein power generated can be used for captive consumption and excess power can be sold to third parties or state distribution companies.

State roadmap for 2022

Of the 175 GW renewable energy target the Government of India has set to achieve by 2022, 17,133 MW of renewable energy target has been allocated to Gujarat. This includes 8,800 MW of wind, 8,020 MW of solar, 288 MW of bio-power and 25 MW SHP capacity. The RE capacity in the state has been assumed to grow linearly till 2022 to achieve the 17 GW target

Based on the discussion with the State Working Group, it is assumed that apart from meeting its own state RPO target, Gujarat will focus on exporting RE power to other states to meet the MNRE RE targets for 2022.

Figure 2.6: Projected renewable energy capacity addition till 2022

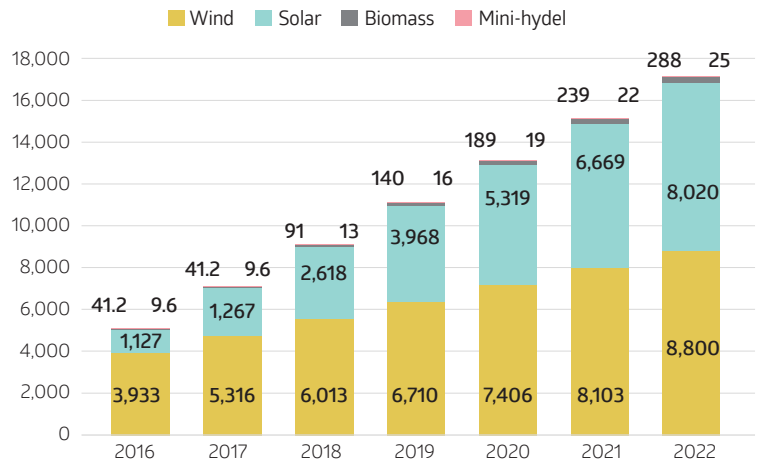


Figure 2.7 details the expected break-up of the same. And the RE capacity to be absorbed within the state for meeting the RPO is indicated in Figure 2.8.

List of state recommendations

Realizing the state's roadmap will require concerted efforts cutting across policy, regulatory, finance, etc. The state has listed out a suggestive set of recommendations to enable this transformation:

1. Make policy and regulatory environment in the state investor-friendly by:
   - **a.** Notifying RPO trajectory in the state as per NAPCC and National Tariff Policy till 2019
   - **b.** Strengthening the incentive framework
   - **c.** Addressing operational challenges that may arise while implementing RE projects
2. Improve flexibility in the system to absorb 17 GW of RE in the grid

Figure 2.7: RE capacity and RPO

	MNRE target	Capacity required to meet RPO trajectory	Capacity for sale to other states (MW)
Solar	8,020	8,837	-817
Wind	8,800	6,835	1,965
Bio energy & small hydro	313	311	2
Total	**17,133**	**15,984**	**1,150**

Negative means that the state will import solar power to meet solar RPO obligation

Figure 2.8: RE (million units) to be absorbed within the state to meet RPO trajectory

	Solar	Non-solar	Total
2017	2,187	9,749	11,936
2018	4,248	10,940	15,188
2019	6,560	12,246	18,806
2020	8,903	13,311	22,214
2021	11,658	14,761	26,419
2022	14,670	16,300	30,970

by FY22, by undertaking demand- and supply-side measures and by strengthening system operations.

3. Real-time monitoring of RE generation for grid management—mandating the setting up of communication channels between RE pooling station and SLDC.
4. Mandatory implementation of RE generation forecasting tools to reduce errors in schedule and actual generation.

Figure 2.9: State meetings held

Date	Location	Participants
February 7, 2017	Gandhinagar, Gujarat	GERC, GUVNL, GETCO, CII, among others
April 27, 2017	Gandhinagar, Gujarat	SLDC, GETCO, GEDA, Torrent Power, among others
June 27, 2017	Gandhinagar, Gujarat	SLDC, GETCO, GEDA, Torrent Power, among others
July 24, 2017	Gandhinagar, Gujarat	Working Group Participants

5. Focus on developing CTU-connected RE projects to enable inter-state sale of RE.
6. Development/capacity augmentation of intra-state and inter-state transmission network for RE evacuation.
7. Launching dedicated programs to promote solar irrigation through adoption of innovative business models i.e. moving away from subsidy-based models.
8. Focus on development of distributed solar projects through innovation business models.
9. Developing a framework for regional balancing of renewable energy; CERC and SERCs need to agree and develop regulation for balancing at the regional level.
10. Faster implementation of renewable generation obligation (RGO). ■

3 Karnataka

7,367 MW
RE capacity

14,817 MW
Share of 2022 national RE target

Overview

Karnataka was the first state to have separate entities for generation and distribution. In 1999, the state passed the Karnataka Electricity Reforms Act, leading to major reforms in the power sector.

The state has been striving hard to bridge peak demand and energy deficits. It has reduced the deficit from 13.5% in FY13 to 0.2% in FY17 on the back of strong DSM initiatives taken by DISCOMs and by sourcing power on a short-term basis.

Karnataka has ample hydro and renewable sources of energy, which become vulnerable to deficits in rainfall or lower availability of solar and wind sources. The state also has a significant RE share, with 52% contribution from wind power and ~16-18% from solar and co-gen plants.

In line with MNRE targets, Karnataka has achieved an RE capacity of 7,367 MW (Figure 3.1). The state government has also taken steps to promote renewable energy in the state by announcing a Solar and Renewable Energy Policy. Moreover, the state plans to add 2,000 MW solar capacity through a mega solar park in FY18 and FY19, besides other planned capacity additions.

State targets for renewable energy

Karnataka has been apportioned ~8.5% (14,817 MW) of the 2022 national RE target. Of this, the share of solar is targeted at ~38% (5,697 MW), wind at ~42% (6,200 MW), and the rest is from biomass and small hydro. The state is, by itself, aligned to these targets, and its policies in each of these areas outline its vision for FY22. The state has realized a potential of ~8.5% up to

Figure 3.1: Current installed capacity

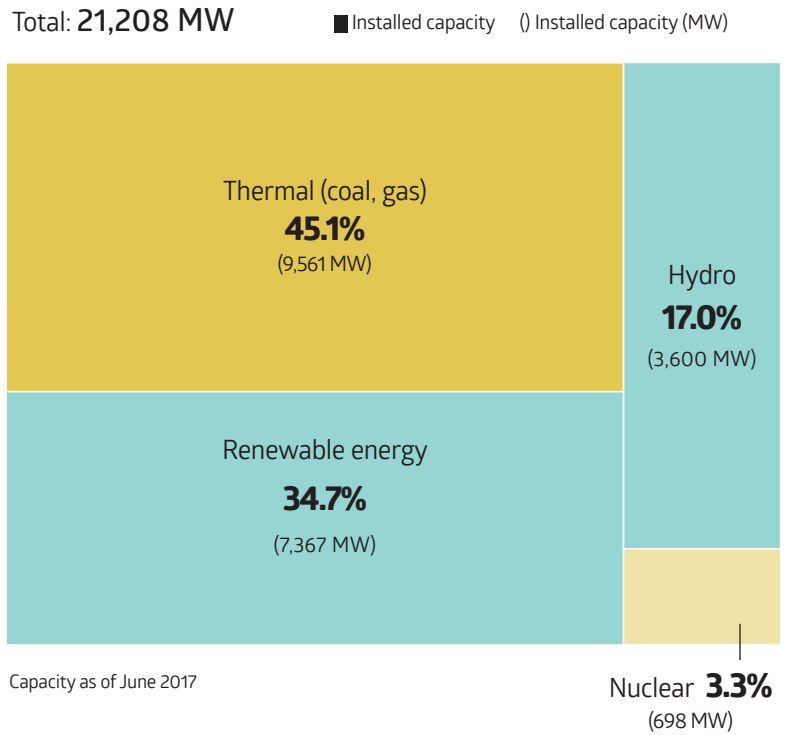
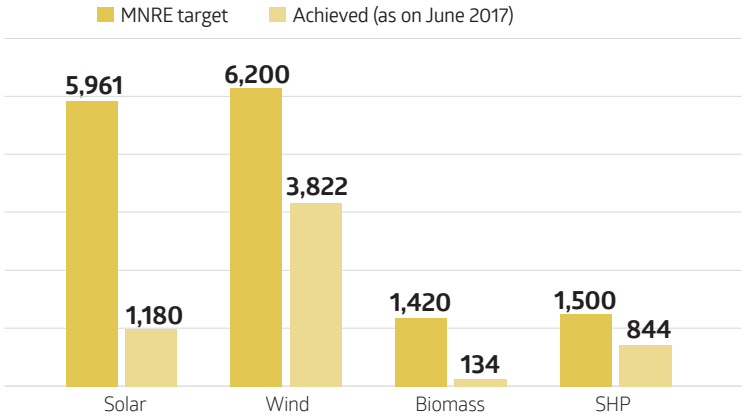
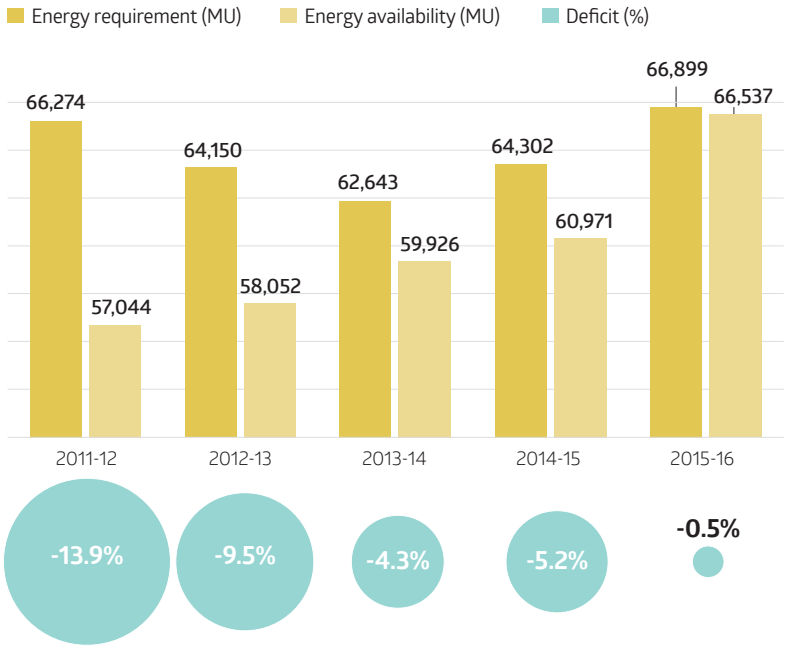


Figure 3.2: Current installed capacity



Note: Cogeneration capacity of Karnataka is 1,386 MW

Figure 3.3: Energy demand-supply position



Data for 2016-17 up to January 2017

now. Solar and wind have an extremely high potential of 80.6 GW (~55.8 GW for wind and ~24.7 GW for solar), as estimated by MNRE.

Capacity and RPO achievements

As of June 2017, Karnataka had an installed capacity of 7,367 MW of RE, contributed by 1.18 GW of solar and 3.8 GW of wind capacity. In terms of energy use, RE constitutes ~8% of the state's energy demands, which is already in line with its RPO targets (Figure 3.2). However, solar RPO is only ~2-3% in the state, which needs to be increased for it to meet the 8% target for FY22. The state, however, has the potential to top the national target of 8% solar RPO in FY22 (Figure 3.3).

The current RPO compliance figures reveal that state DISCOMs are doing exceptionally well in keeping pace with mandated targets, and most are even surpassing their obligations. A clear picture to showcase the compliance rate for various DISCOMs for FY16 is presented in Figure 3.4.

If the state is able to achieve its share of MNRE-allocated RE targets, especially for solar, it can easily overachieve the national RPO%.

Challenges faced by state

Although Karnataka is on track to meet its 2022 RE obligations, it faces several challenges:

- There is significant capacity addition planned in conventional power in the next two to three years, which could introduce a huge surplus

in the state, with limited demand growth. The state is planning to increase its thermal capacity by ~2 GW from FY 2017-19

- Balancing hourly demand through ancillary services
- Limited balancing reserves in the state. The state owns no gas reserves and only limited pumped storage hydro (only one in planning phase) for balancing
- Huge grid integration challenges due to significant solar and wind additions
- In spite of huge RE potential, the state is limiting further addition due to a lack of demand projections and insufficient corridor for inter-state sale

State efforts to encourage RE

The state has adopted a multi-pronged strategy to embrace RE in the state. Here are some key strategies:

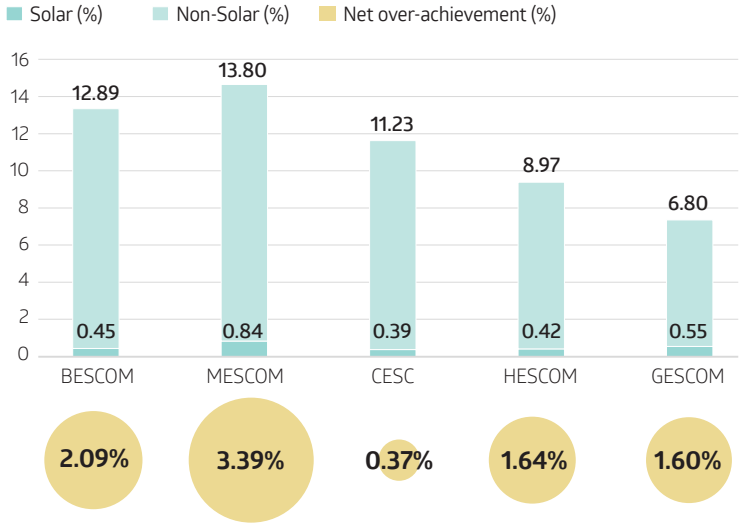
Karnataka Solar Policy 2014-21

Although Karnataka currently does not have substantial solar capacity, the rate at which it is augmenting its share in the past few years has been commendable. In FY16, capacity addition was a mere 59 MW, but it increased nearly 15-fold in the next year to 869 MW.

The state has made substantial achievements in the solar segment, including:

Solar Parks: The state plans to commission an ultra-mega private solar park of 2,000 MW capacity, with capacity addition of 1,000 MW in successive years.

Figure 3.4: RPO compliance



Grid-connected solar rooftop projects and net-metering: The state is currently promoting solar rooftop projects on public buildings, domestic, commercial and industrial establishments through net- and gross-metering methods based on tariff orders issued by KERC. Under rooftop generation, the state also plans to focus on solar-wind hybrid projects.

Some key incentives leading to high capacity additions include exemption from pollution control board clearance, deemed conversion of land for solar projects, reduction of supervision charges by ESCOMs to 5%, etc.

Karnataka Renewable Energy Policy 2016-22 (draft)

Over the years, Karnataka has been developing a composite policy encompassing all non-solar technologies. This is comprehensive in detail, including well-defined growth targets, guidelines, approvals, incentives, etc.

Given the high-wind density regions in the state, wind is the mainstay. Some noteworthy pointers in the policy include:

- Minimum capacity addition of 4,000 MW by 2022 in a phased manner
- Development of both inter-state and intra-state based business models
- Repowering of old wind plants. Wind projects installed at wind-rich sites prior to 2002-03 shall be taken up in the first phase (2016-18) of the repowering program. In the second phase (beyond 2018), projects developed after 2002-03 shall be considered
- Setting up "Biomass Parks" in rural areas to supply, on a dedicated basis, biomass fuel to designated biomass power projects

The policy includes all fiscal and financial incentives provided by MNRE, including concessions such as Central Financial Assistance, concessional customs duty on specified items, excise and sales duty exemption, etc.

State roadmap for 2022

By adopting the policy initiatives stated above, Karnataka has charted a future trajectory for itself. Its main focus will now be solar projects, including commissioning of large-scale solar parks. The state also plans to consider inter-state balancing facilities and also inter-state power supply. Thus, it can support RE-deficit states while utilizing the significant state potential for RE.

Figure 3.5: State meetings held

Date	Location	Participants
June 29, 2017 (Steering Committee Meeting)	Bengaluru, Karnataka	PwC Team, Additional Chief Secretary, KREDL, KPTCL

List of state recommendations

Realizing the state's roadmap would require concerted efforts cutting across policy, regulation, finance, infrastructure and market-related interventions. Here are the key recommendations.

1. Large focus on energy storage would require subsidy support from the central government to address the challenge of high cost of batteries in the initial stages.
2. In order to promote RE, the central government should offer incentives to states to meet RPO targets and provide a corridor for better inter-state power transfer.
3. Given the lower rate of demand growth, states should reconsider further addition of conventional power, and they should incorporate green power and prevent surplus capacity addition.
4. Central agencies like NVVN, NTPC and SECI to buy excess RE power and distribute to RE-deficit states. ■

4 Madhya Pradesh

3,622 MW
RE capacity

12,018 MW
Share of 2022 national RE target

Overview

Madhya Pradesh has emerged as one of the fastest progressing states, and RE has become a key component in meeting its daily power consumption demand. The state has an overall RE potential of 74.33 GW, as estimated by MNRE. It is already one of the leaders in RE installed capacities, with about 17% of its 19 GW installed power generation capacity comprising of renewables. The New and Renewable Energy Department, Government of Madhya Pradesh (MPNRED), is the nodal agency for establishing RE in the state. As per NFHS Survey (FY 2016), 90% of households in the state have been electrified, with 100% electrification possible by FY 2018.

State targets for renewable energy

Madhya Pradesh has been apportioned 6.8% (11,979 MW) of the 2022 national RE target. Of this, the share of solar is 47% (5,636 MW). Of the non-solar share of 53%, wind has been allocated 6,200 MW, small hydro 25 MW and biomass 118 MW. Yet, this is only a fraction of RE resources available in Madhya Pradesh. The state has realized a potential of 4.4% so far, with maximum achievement in the wind sector.

Capacity and RPO achievements

Madhya Pradesh has a total installed capacity of 19 GW (conventional and non-conventional), (Figure 4.1). Till FY 2022, about 9.4 GW capacity—of which, 5.78 GW is RE and 3.62 GW is thermal—is in the pipeline. In terms of energy use, RE constitutes about 8.5% of the state's energy demands, in line with its RPO targets. The state is on track to achieving the national RPO target of 17%, but it may face challenges in fulfilling solar targets of MNRE as demand is not keeping pace with supply additions (Figure 4.2).

Figure 4.1: Current installed capacity

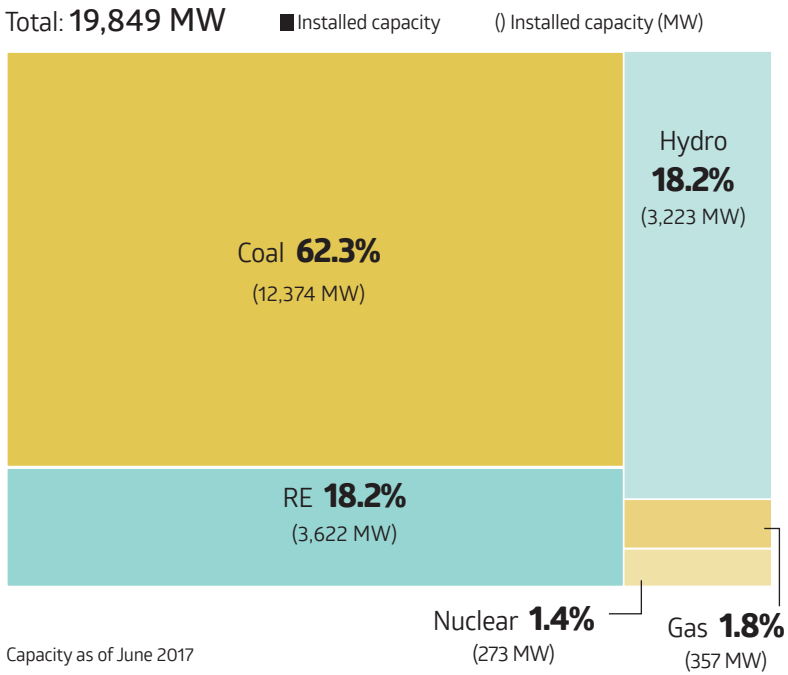


Figure 4.2: RE installed capacity

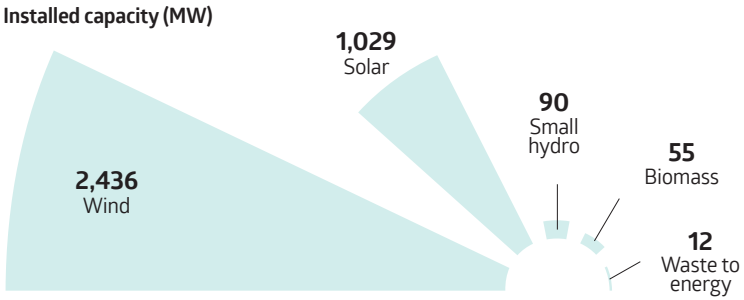


Figure 4.3: RE targets (as per MNRE)

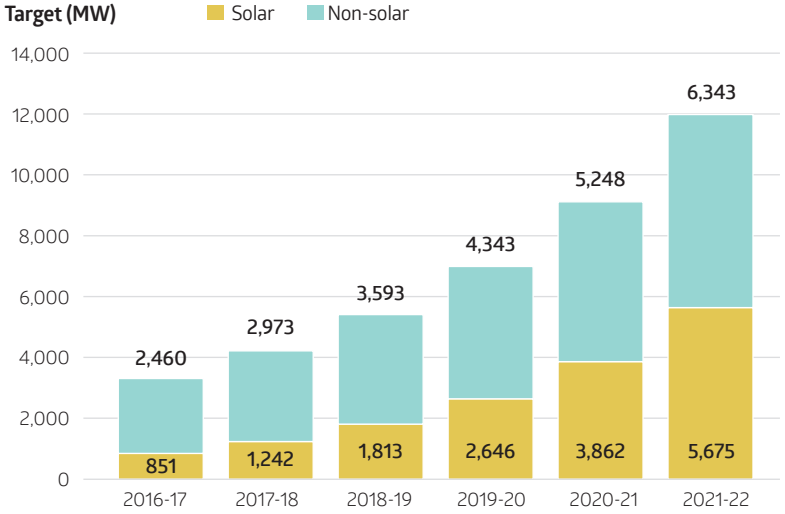


Figure 4.4: Energy demand-supply position

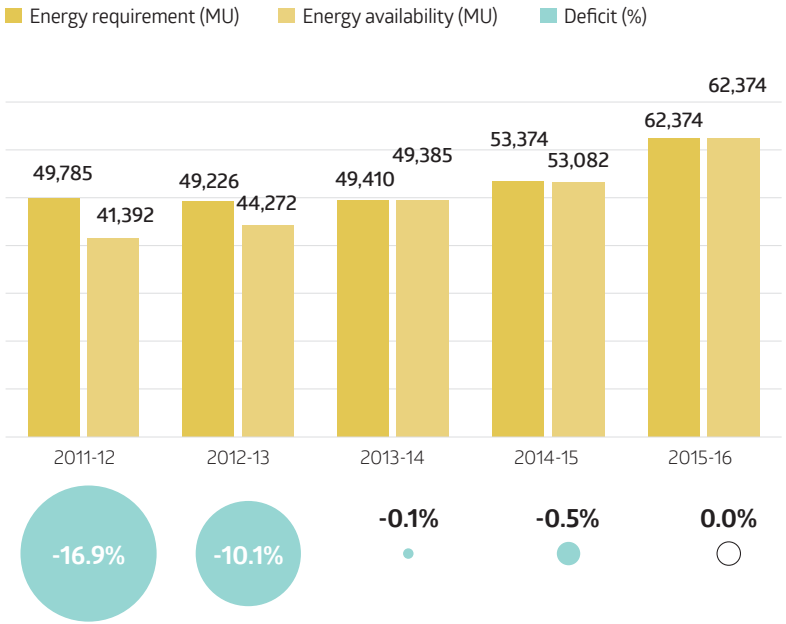
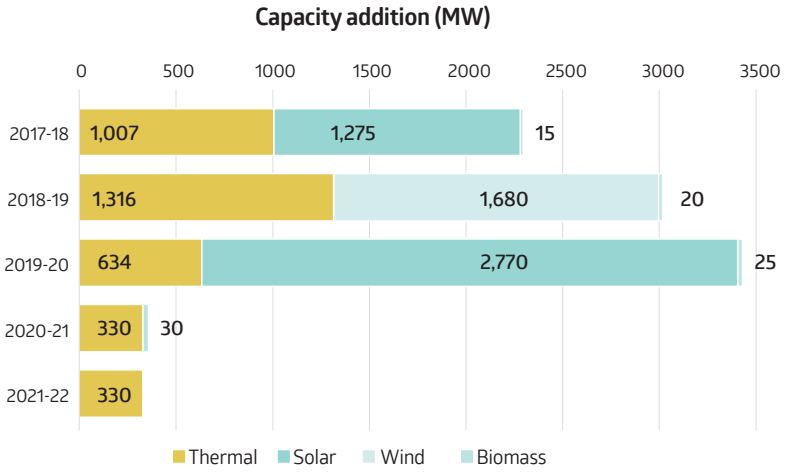


Figure 4.5: Year-wise generation plans (MW)



Challenges faced by state

While the state is envisioning meeting its 2022 RE obligations, it faces several challenges. These include:

- Significant capacity addition plans of conventional power (about 3,000 MW) in the next five years. With limited demand growth, this will introduce a huge surplus in the state
- Slow progress of Green Energy Corridor (including REMC establishment)
- Central banking regulation framework strengthening (inter-state)
- Excessively high solar rooftop target allocated to state
- Huge balancing requirements for future, considering significant RE additions

State roadmap for 2022

Backed by the host of policies mentioned above, Madhya Pradesh has charted a trajectory till 2022. It already has 4 GW of solar, 1.6 GW of wind and 0.095 GW of biomass projects in the pipeline (See Figure 4.3). Moreover, the state has been extremely proactive in updating its generation plans till FY 2025 as well.

List of state recommendations

Realizing the state's RE roadmap would require concerted efforts cutting across policy, regulation, finance, infrastructure and market-related interventions. Key recommendations have been highlighted below:

1. To match demand and supply, the state needs to increase demand, promote power consumption through tariff-based incentives and devise inter-state power supply arrangements. Improved quality of supply to rural areas may also increase demand.
2. Greater number of PSUs (such as DMRC in case of Rewa) to be engaged for procuring RE power. For such situations, states should get the benefit of PMC work, especially for obligated PSUs.
3. GEC work has been slow, failing to keep pace with tenders. In order to speed up overall procedure, states should be given direct access to funds for building dedicated transmission infrastructure, including REMC establishment.
4. Standard banking regulation (inter-state) to be devised; sender state to be incentivized for providing power during peak demand. Concept of night banking to be more focused.
5. The centre should revisit solar rooftop targets allocated to few states. States should be given leverage to fulfil their 2022 solar target, depending on solar potential, whether rooftop or large scale. States like Madhya Pradesh having an abundance of wastelands should be allowed to realize their target through the development of large-scale utility projects.
6. Creation of ancillary markets to bank/park thermal capacities to avoid shut down situation.
7. A dedicated pumped hydro storage department to be formed to address balancing-related issues ■

Figure 4.6: State meetings held

Date	Location	Participants
29th November, 2016 (1st Steering Committee Meeting)	Bhopal, Madhya Pradesh	PwC Team, State Representative, Niti Aayog
5th December, 2016	Bhopal, Madhya Pradesh	PwC Team, State Representatives
3rd April, 2017 (2nd Steering Committee Meeting)	Bhopal, Madhya Pradesh	PwC Team, Manu Srivastava and MPNRED Team

5 Maharashtra

7,400 MW
RE capacity

22,000 MW
Share of 2022 national RE target

Overview

Maharashtra has the largest base of electricity consumers among all states. The power sector in the state has witnessed substantial improvement over the past decade due to an increase in generation capacity and a strengthening of network infrastructure, leading to an improvement in power supply position in the state.

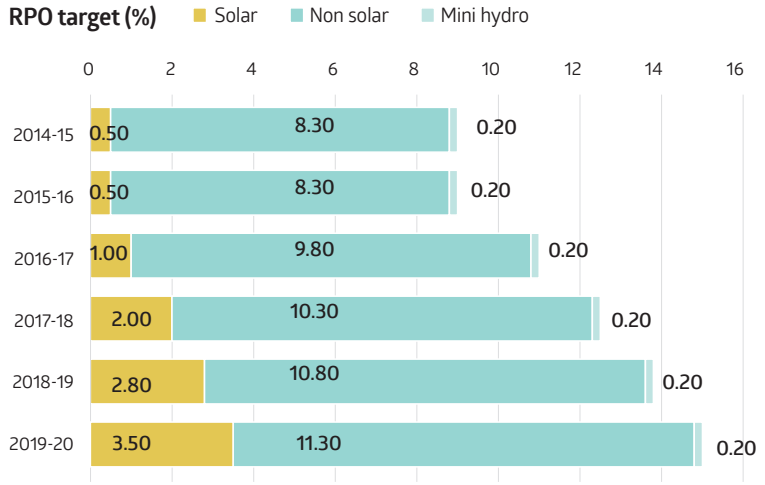
With per capital energy consumption of 1,239 kWh, Maharashtra is among the top 10 states in terms of energy consumption. In terms of electrification, as of March 2014, the state had about 18.73 lakh rural households and 0.63 lakh urban households that were yet to be electrified (as per Power for All).

Maharashtra has a total installed capacity of 41 GW, with coal having a share of about 60% and RE 18%. Maharashtra is a surplus state in demand and energy availability. It also faces the problem of large payouts as fixed charges against PPAs due to a lack of demand growth and rising RE capacities. In the current power-surplus scenario, Maharashtra is able to meet its energy requirements without any constraint.

State targets for renewable energy

Maharashtra has an overall RE potential of ~114 GW. The state also has the highest potential for small and distributed solar projects, of 6.9 GW (as per NISE). During the last five years, RE capacity in the state has recorded a compounded annual growth rate of above 15%. The installed RE capacity in the state is about 7.4 GW (November 2016), including 4.66 GW of wind and 1.99 GW of bio power capacity.

Figure 5.1: RPO target (%)



Maharashtra has a RE target of 14.4 GW by 2020 under the State RE policy. Considering high potential of RE in the State, MNRE has allocated a target of 22 GW of RE by 2022. To promote RE consumption in Maharashtra, MERC has also imposed RPO target on obligated entities.

Figure 5.2: RPO target (MW)

RPO target (MW)

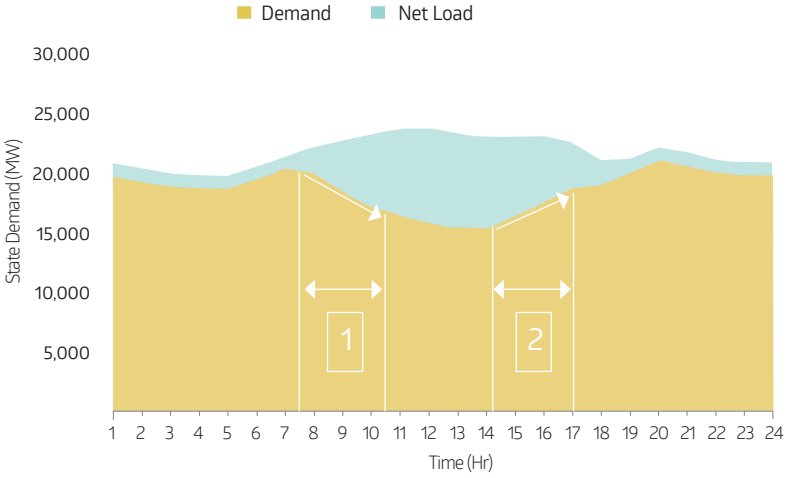
	Solar	Non solar	Mini hydro
2014-15	404	3,775	102
2015-16	404	3,775	102
2016-17	808	4,457	102
2017-18	1,617	4,685	102
2018-19	2,223	4,912	102
2019-20	2,829	5,140	102

In view of the high RE generation, state DISCOMs are facing issues of absorption of high-priced RE and backing down of cheaper conventional power to manage the mismatch between state demand profile and supply by RE projects. However, based on discussions with the State Working Group, RE generators are not facing any back down issues in Maharashtra.

In order to manage variability of current RE generation, the state has flexible capacity in the form of storage hydro capacity of 250 MW (Ghatghar) and 2,000 MW of hydro capacity. As per discussions with the State Working Group, the current flexible capacity is sufficient to manage existing RE generation in the state. However, to meet MNRE targets, the state would require around 3.3 GW of flexible capacity on an annual average basis by FY 2022. As per the state generation planning, the state will have flexible generation capacity of 1.4 GW by FY 2022, and would have to rely on other states for the remaining.

To achieve MNRE targets for RE capacity addition, the state will require to enhance its capability to balance periods of high ramp-up/ramp-down through flexible generation. Figure 5.3 details the expected demand profile, RE generation and period of high ramp-up/ramp-down scenario in case MNRE RE targets are achieved (FY 2022).

Figure 5.3: MNRE RE target scenario (MW)



1] Solar morning ramp (Down), 2] Solar Evening Ramp (UP)

Capacity and RPO achievements

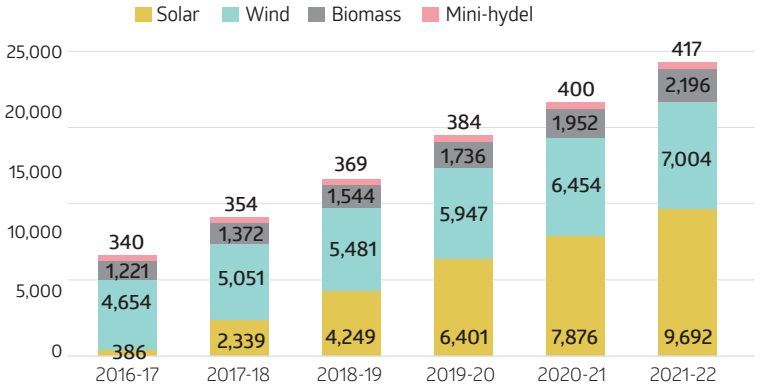
In terms of RPO compliance, Maharashtra is among the top states, with compliance of around 80% in 2015-16. Based on discussions with the State Working Group, for 2016-17, the state has achieved 100% of its RPO targets.

Further, Maharashtra has one of the strongest intra-state network. The state is also planning to add another 3.6 GW of transmission capacity in view of the state policy target of 14.4 GW of RE. The state is also focusing on developing distributed projects to reduce transmission requirement and it is planning to develop projects for sale of power outside Maharashtra, in view of MNRE targets.

Based on discussions with the State Working Group, the state can target to add more RE capacity over and above its RPO targets, subject to visibility in demand from other states.

Figure 5.4: RE target for 2022

Projected installed capacity (MW)



Challenges faced by state

While Maharashtra is on track to meet its 2022 RE target, it faces a host of challenges:

- DISCOMs are facing huge financial burden on account of promoting RE and giving away cheaper conventional power
- Regulatory framework for implementing scheduling and forecasting of RE is not available
- Lack of clarity on operationalizing balancing reserves outside Maharashtra
- SLDC does not have real-time visibility of RE generation; RE pooling sub-stations are in the process of connectivity with SLDC
- Regulatory and commercial framework for development of solar wind hybrid projects is not available
- RPO compliance of CPP and OA consumers is quite low. A majority of OEs are not reporting their compliance to SNA
- Limited capacity of state agencies in operationalizing and managing high RE generation
- The state is witnessing reduction in demand forecast, which will impact the ability of state utilities to achieve the proposed RE targets

State efforts to encourage RE

The state has adopted a multi-pronged strategy to embrace RE in the state. Some of the key strategies as follows:

Maharashtra RE Policy, 2015

Maharashtra announced an integrated Renewable Energy Policy in 2015, with a focus on developing 14.4 GW of RE capacity by 2020. The policy envisages a target of 7.5 GW solar, 5 GW wind, 1.5 GW bio power and 0.4 GW of SHP capacity. It also focuses on development of hybrid and distributed solar projects. The state also provides various incentives such as exemption of electricity duty, capital subsidy, etc. for selected technologies under this policy.

Scheme for agriculture consumers

Maharashtra is also focusing on supporting agricultural consumers through a solar irrigation pump scheme. It is targeting to install 5 lakh solar irrigation pumps. A beneficiary can obtain a solar pump by contributing 5% of the pump cost, with the remaining cost being borne by the central government (30%), loan (60%) and state government (5%). Maharashtra is also planning to install solar agriculture feeder-based projects near existing substations to reduce infrastructure costs. The state is identifying land near sub-stations to install solar projects under the scheme.

Solar rooftop

Maharashtra is also focusing on developing solar power though solar rooftops and has developed a net metering framework for implementation. To facilitate applicants in installation of solar rooftop projects, the state nodal agency is accepting subsidy applications online. DISCOMs too are

accepting applications online for connectivity and providing online approvals to applicants.

Evacuation infrastructure

Maharashtra has one of the strongest intra-state networks, and its capacity addition planning is in line with proposed RE targets. The current infrastructure of the state is adequate to absorb 14 GW of RE and the state is adding 3.6 GW of ISTS capacity under the Green Energy Corridor. The state is also planning to add RE projects for inter-state sale to reduce overall evacuation requirement.

State roadmap for 2022

Adopting the host of policies indicated above, the state has charted out a trajectory for itself till 2022. It has already installed RE capacity of 7.4 GW, including 4.66 GW of wind and 1.99 GW of bio-power. MNRE has allocated a target of 22 GW of RE capacity by 2022. However, as per discussion with the State Working Group, Maharashtra will absorb RE capacity as per the RPO target and the remaining will be developed for inter-state sale.

List of state recommendations

Realizing the state's roadmap will require concerted efforts cutting across policy, regulatory, finance, etc. The state has listed out a suggestive set of recommendations to enable this transformation:

1. Develop a Wind-Solar Hybrid Policy to encourage investment in hybrid projects.
2. Adoption of sustainable/innovative business models to enable agricultural consumers to move away from subsidy-driven model.
3. Encourage development of SS-based solar projects or solar rooftop to minimize infrastructure investments and losses.
4. Real-time monitoring of RE generation for grid management—mandating the setting up of communication channels between RE pooling station and SLDC.
5. Mandatory implementation of RE generation forecasting tools to reduce errors in schedule and actual generation.
6. Focus on developing CTU connected RE projects to enable inter-state sale of RE.
7. Restructuring of RE contracts to include provision of back down with suitable compensation to generator.
8. Explore retrofitting of existing thermal plants to arrange balancing capacity within the state.
9. Developing a framework for regional balancing of RE; CERC and SERCs need to agree and develop regulation for balancing at the regional level.
10. Re-negotiating PPAs with existing projects having balancing capacity to make balancing capacity available for other states.
11. Faster implementation of renewable generation obligation (RGO). ■

Figure 5.5: State meetings held

Date	Location	Participants
November 21, 2016	Mumbai, Maharashtra	State Working Group
May 22, 2017	Mumbai, Maharashtra	State Working Group

6 Rajasthan

6,198 MW
RE capacity

14,300 MW
Share of 2022 national RE target

Overview

Rajasthan is the largest Indian state by area, and it comprises vast arid land and deserts. Agriculture and related activities are the main economic vocation of its people. The power sector in Rajasthan has witnessed substantial improvement in the past decade due to an increase in generation capacity and a strengthening of its network infrastructure.

The state has a total power installed capacity of 18 GW, wherein the share of coal is above 50% and RE is 30%. The power deficit in the state is only 0.2% and the energy gap is continuously falling. As on February 2017, around 75.4% households in the state were electrified. The projected energy requirement of the state is expected to grow around 6.5% annually.

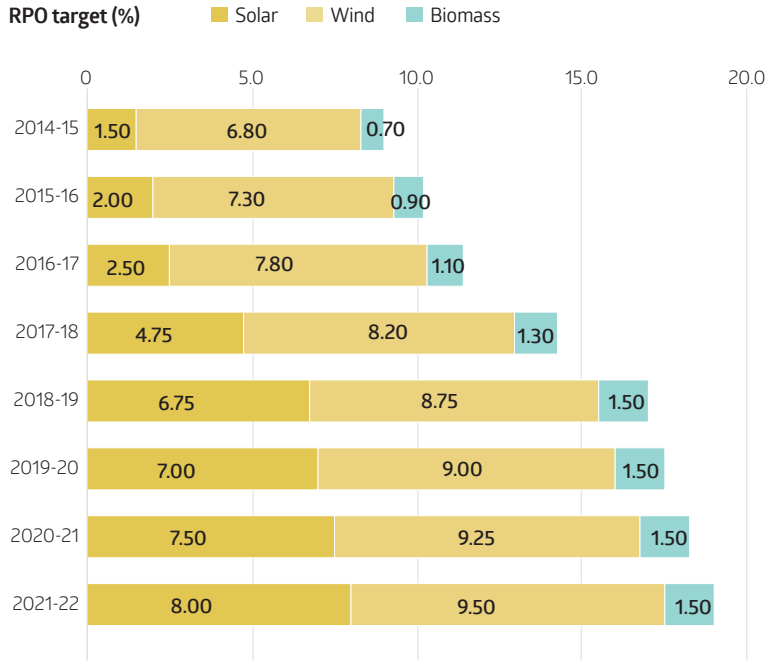
State targets for renewable energy

Rajasthan is one of the high RE potential states, estimated at 142 GW for solar and 18.7 GW for wind. In view of this high potential, MNRE has allocated a target of 14.3 GW for solar and wind capacity addition for the state by 2022. Under the Rajasthan Solar Policy, the state has a vision of 25 GW solar project development in the state.

Capacity and RPO achievements

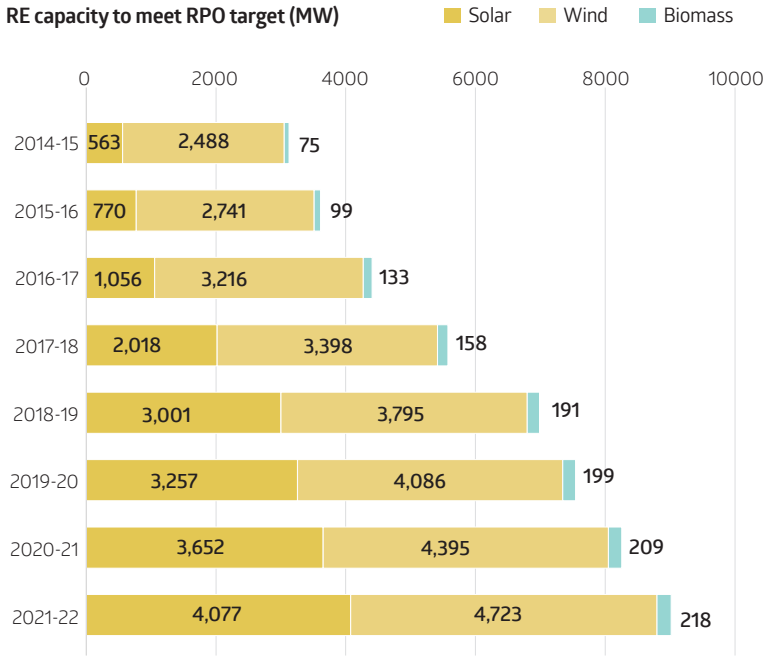
Rajasthan has an installed RE capacity of 6,198 MW, and about 681.8 MW capacity in the pipeline, as of 2017. DISCOMs met their solar and non-solar

Figure 6.1: RPO target



RPO targets from FY12 to FY14, except biomass RPO target. DISCOMs are making considerable efforts to meet their RPO targets. RPO compliance of other OEs such as CPP and OA consumers is a concern in the state.

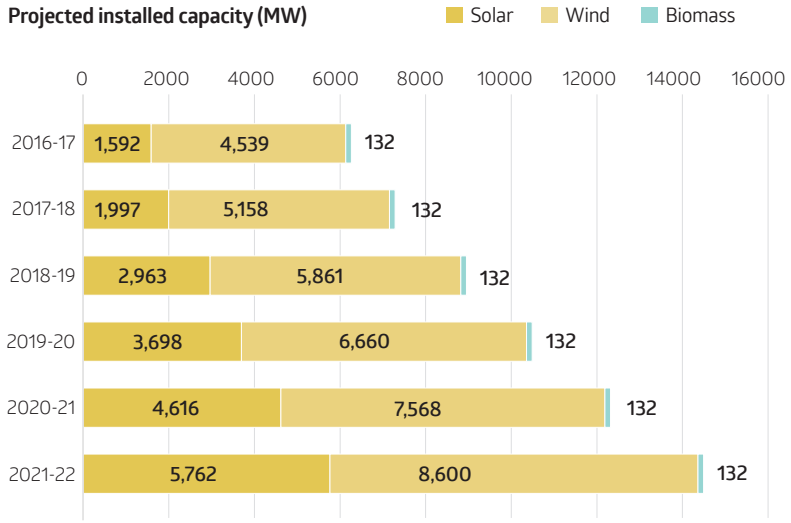
Figure 6.2: RE required to meet RPO target



Based on discussions with the State Working Group, the state is currently facing issues due to high variability in RE generation. It has been pointed out that there is huge variation in scheduled and actual RE generation, which is resulting in DISCOMs backing down conventional power generation to maintain grid stability.

MNRE has specified an RE target of 14.49 GW for Rajasthan for 2022 (Figure 6.3). Achieving this will require the state to enhance its capabilities to balance periods of high ramp-up/ramp-down through flexible generation. Figure 6.4 details the expected demand profile, RE generation and period of high ramp-up/ramp-down scenario in case RE targets of MNRE for 2022 are achieved.

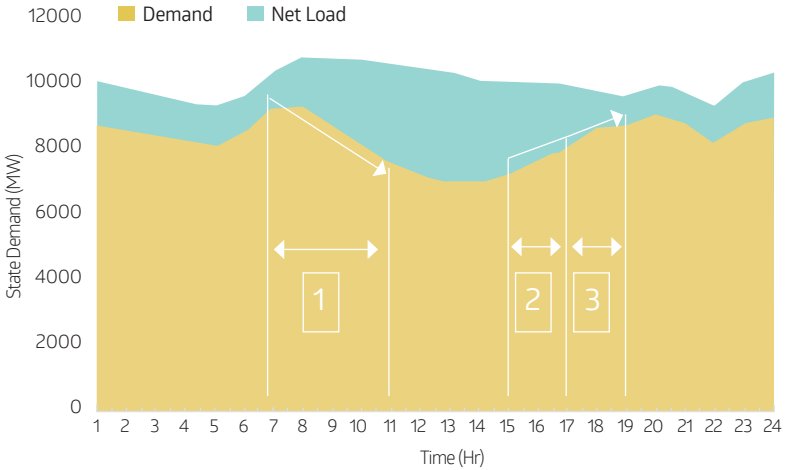
Figure 6.3: Renewable energy targets



With increasing RE generation, increasing complexity in managing the Demand-Generation, flexible generation sources is necessary. Super-critical power plants, gas plants, storage-based hydro projects can be considered as flexible generation sources. RRVUNL is expected to have 830 MW as flexible generation capacity, which can be used for grid balancing by 2019. It is estimated that Rajasthan will need around 1,475 MW of flexible energy sources by 2022. Hence, the state will need an additional 645 MW of flexible energy capacity forces to balance grid with RE capacity addition.

Absorption of high RE capacity requires adequate transmission infrastructure. The state has already taken initiatives to facilitate high RE capacity addition. Currently, RVPN and PGCIL are planning for the transmission network to evacuate 15 GW of RE power. RVPN has invested to develop transmission systems to evacuate around 9.6 GW power through its own resources.

Figure 6.4: Rajasthan 2022-MNRE target scenario



1] Solar morning ramp (Down), 2] Solar Evening Ramp (UP), 3] Demand Evening Ramp (UP)

Challenges faced by state

While the state is on track to meet its 2022 RE target, it faces a host of challenges.

- SLDC does not have real-time visibility of RE generation; RE pooling sub-stations are in the process of being connected with SLDC. Funding support is an issue for STU to establish connectivity of pooling sub-station to SLDC
- Regulatory framework for implementing scheduling and forecasting of RE is in the draft stage
- The state lacks balancing reserves, forcing DISCOMs to back down RE generators during low demand periods
- Financial losses to DISCOM due to backing down of conventional power to absorb RE generation
- Regulatory and commercial framework to develop solar wind hybrid projects is not available
- RPO compliance of CPP and OA consumers is quite low. Majority of OEs are not reporting their compliance to SNA
- A delay in availing MNRE subsidy is impeding the growth of solar rooftop market in the state
- Biomass supply chain has still not developed, which impacts the sustainability of biomass power projects
- Limited capacity of state agencies like SNA, DISCOM in terms of manpower, awareness, etc. is impacting the growth of solar rooftop in the state

State efforts to encourage RE

The state has adopted a multi-pronged strategy to embrace RE in the state, with some of the key strategies as follows:

Rajasthan Solar Energy Policy

Rajasthan has developed a Solar Energy Policy in 2014. The state has various schemes and incentives which have been built into the policy. The policy focuses on developing both large and small scale solar projects

Solar parks: Rajasthan Solar Park Development Company Limited (RSDCL), a subsidiary of RREC, has been appointed as the Special Purpose Vehicle (SPV) to develop and manage solar parks in Rajasthan. Six projects with a combined capacity of 4,505 MW have already been planned across three

Figure 6.5: State RE roadmap for 2022

	MNRE target (MW)	Assumed for meeting state RPO (MW)	RE power export to other states (MW)
Solar	5,762	4,077	1,685
Wind	8,600	4,723	3,877
Biomass	0	218	0
Total	**14,362**	**9,018**	**5,562**

locations (Bhadla, Phalodi and Fatehgarh) and 440 MW of solar capacity has already been commissioned.

Solar Irrigation Pumps Program: Rajasthan has a large agriculture base: about 42% of the power consumption in the state is on account of agriculture load, which is getting electricity in block hours for irrigation. To give more flexibility to farmers, the state government is planning to install 1 lakh solar-powered irrigation pumps, of which, 7,400 solar pumps had been installed by December 2016.

Wind Policy

To harness the potential of wind energy, the state government brought out a wind policy in 2012, with a focus on development of projects under sale of power to DISCOMs, captive use, third-party sale and REC mechanism. The policy envisages a target of 500 MW of wind capacity under sale of power to DISCOMs by 2015-16.

Biomass

In order to harness the potential of biomass power, the state government announced a biomass policy in 2010. The policy focuses on developing projects for captive use, sale to third party or sale to DISCOM. It also provides concession of 50% in electricity duty for a period of 7 years from COD for captive consumers. The policy is silent on the targets to be achieved.

Evacuation infrastructure

Rajasthan's planning in terms of evacuation corridor is in sync with RE targets. The state has planned intra-state transmission capacity of 9.6 GW and 4.5 GW of inter-state transmission capacity for evacuation of RE.

State roadmap for 2022

Adopting the host of policies listed above, the state has charted out a trajectory for itself till 2022. It already has RE capacity of 6.19 GW, including 1.78 GW of solar and 4.29 GW of wind.

The MNRE has provided a RE capacity addition target of 14,362 MW for 2022. Based on discussions with the State Working Group, it is assumed that besides meeting its own state RPO target, Rajasthan will focus on exporting RE power to other states to meet MNRE RE targets for 2022. Figure 6.5 and Figure 6.6 detail the expected break-up of the same.

List of state recommendations

Realizing the state's roadmap would require concerted efforts cutting across policy, regulatory, finance, etc. The state has listed out a suggestive set of recommendations to enable this transformation:

1. Develop a framework for regional balancing of RE; CERC and SERCs need to agree and develop regulations for balancing at the regional level.

2. Real-time monitoring of RE generation for grid management—

Figure 6.6: Expected RE capacity to meet RPO targets

	RE capacity (MW)			
	Solar	Wind	Biomass	Total
2017-18	2,018	3,398	158	**5,573**
2018-19	3,001	3,795	191	**6,987**
2019-20	3,257	4,086	199	**7,542**
2020-21	3,652	4,395	209	**8,256**
2021-22	4,077	4,723	218	**9,018**

mandating setting up of communication channels between RE pooling station and SLDC.

3. Mandatory implementation of RE generation forecasting tools to reduce error in schedule and actual generation.

4. Focus on developing CTU connected RE projects to enable inter-state sale of RE.

5. Restructuring of RE contracts to include provision of back down with suitable compensation to generator.

6. Explore retrofitting of existing thermal plants to arrange balancing capacity within the state.

Figure 6.7: State meetings held

Date	Location	Participants
January 9, 2017	Jaipur, Rajasthan	PSE, RRECL, DISCOM
April 20, 2017	Jaipur, Rajasthan	State Working Group

7. Launch dedicated programs to promote solar irrigation through adoption of innovative business models i.e. moving away from subsidy-based models.

8. Develop a wind-solar hybrid policy to encourage investments in hybrid projects for optimal utilization of land and transmission line.

9. Focus on development of distributed solar projects through innovative business models.

10. Re-negotiate PPA with existing projects having balancing capacity to make balancing capacity available to other states.

7 Telangana

1,230 MW
RE capacity

6,457 MW
Share of 2022 national RE target

Overview

Credit for the transformation of Telangana from power deficit to power surplus should go to the rapidly-growing power sector in the state. Over the years, the sector has ramped up supply, especially of the renewable component, gradually bridging the demand-supply gap.

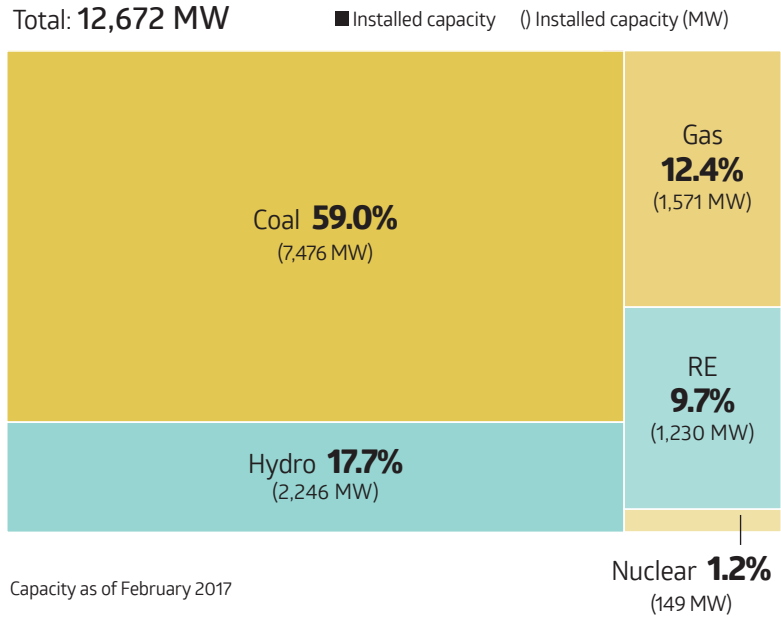
The state has an overall RE potential of 24 GW. The newly-formed state has emerged as one of the top performers in the solar sector, despite being a land-locked state. Renewables currently constitute ~13.4% of the total 11.5 GW capacity in the state. The Telangana State Renewable Energy Development Corporation Limited (TNREDCL) is the nodal agency for establishing RE in the state. As of June 2016, 100% of households were electrified.

State targets for renewable energy

Telangana has been apportioned 3.7% (6,457 MW) of the 2022 national target of RE. Of this, the share of solar is targeted at 69% (4,457 MW) and wind at 31% (2,000 MW). However, the state has established its own RE targets for 2022: 5,000 MW for solar and 1,000 MW for wind.

The state has realized a potential of 4.27% so far, with solar having an extremely high potential of 20.4 GW (as estimated by MNRE).

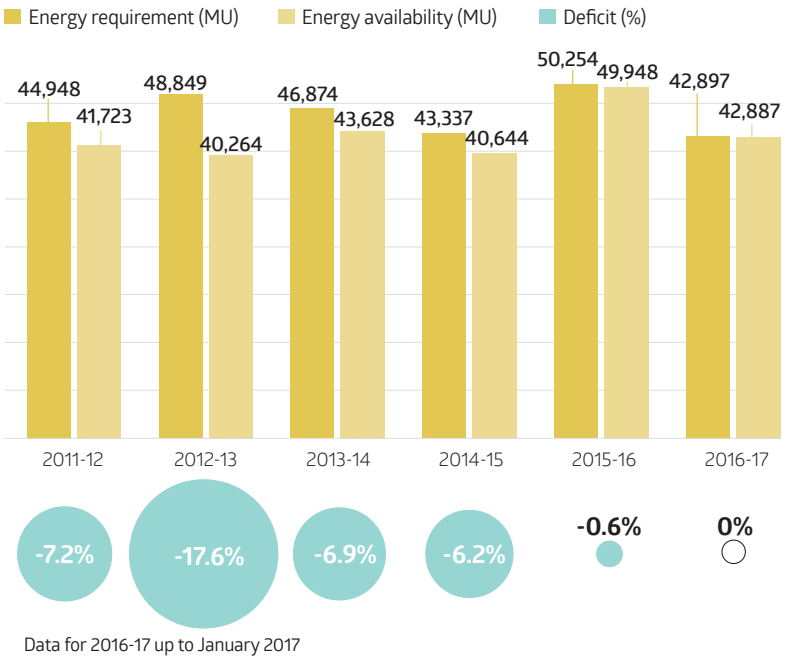
Figure 7.1: Current installed capacity



Capacity and RPO Achievements

Telangana has an installed RE capacity of 1.5 GW (See Figure 7.1). Further, about 2.5 GW of solar and 300 MW of wind capacity is already in the pipeline

Figure 7.2: Energy demand-supply position



Data for 2016-17 up to January 2017

for FY18. In terms of energy use, RE constitutes ~5% of the state's energy demands, which is already in line with its RPO targets. The state can easily top the national target of 8% solar RPO in FY 2022, by realizing 15% of its energy demand through solar till FY22.

Challenges faced by state

While Telangana is on track to meet its 2022 RE obligations, it faces several challenges:

- In the backdrop of limited demand growth, significant capacity addition plans of conventional power in the next five years will lead to a huge surplus in the state
- Balancing hourly demand through ancillary services
- Concessional land issues, as a large portion is utilized for industrial growth
- High tariffs paid by DISCOMs for solar projects commissioned earlier
- Installation of wind projects with low potential sites (C-Grade)

State efforts to encourage RE

The state has adopted a multi-pronged strategy to embrace RE in the state. Some of its key strategies are:

Telangana, Solar Policy 2015

In order to increase the deployment of solar energy projects and create a favorable environment in the state, Telangana announced a Solar Power Policy in 2015. The state has made substantial achievements in the solar segment, including:

Solar pumps: Telangana has been focusing on improving performance and making technology eco-friendly, as well as adopting measures to increase participation levels. The state has followed a unique strategy to effectively utilize solar energy. It powers its pump sets during daytime, which helps it divert excess solar power, and thus avoid significant problem of power evacuation or grid integration.

Solar rooftop: Due to low land availability, Telangana has shifted its focus

from ground mounted to decentralized generation (that is, solar rooftop). The state plans to be aggressive in the coming years to expand its rooftop capacity.

Some key incentives leading to high solar capacity additions in the state include exemptions from electricity duty, VAT, wheeling and transmission charges (for captive use) within the state, CSS, stamp duty, land ceiling, 100% banking facility, CDM benefits and PCB clearances.

State roadmap for 2022

By adopting the policy initiatives stated above, Telangana has charted a future trajectory for itself. The state has targeted an overall generation capacity of 16,000 MW by FY18 (both conventional and non-conventional), with 2,500 MW RE addition (mostly solar). Decentralized, generation-based capacity addition is its top priority in the coming years.

List of state recommendations

For Telangana to realize its roadmap, it will require concerted efforts cutting across policy, regulation, finance, infrastructure and market-related interventions. Key recommendations are:

1. To match demand and supply, the state should increase power demand by promoting the adoption and use of electric vehicles, promote power consumption through tariff-based incentives, and devise inter-state power supply arrangements.

Figure 7.3: State meetings held

Date	Location	Participants
November 11, 2016 **(1st Steering Committee Meeting)**	Hyderabad, Telangana	PwC Team, State Representative, Niti Aayog
December 14, 2016	Hyderabad, Telangana	PwC Team, State Representatives
April 5, 2017 **(2nd Steering Committee Meeting)**	Hyderabad, Telangana	PwC Team, Energy Secretary, TRENDCL officials

2. Competitive bidding for wind to be introduced to increase deployment of wind projects in the state.

3. Solar pumps: Create a pool of skilled local technicians near villages to address agri-pump issues. At the same time, incorporate solar pump sets with battery storage facility so that additional power can be stored and utilized for other purposes such as lighting (at night) in off-grid areas.

4. Incentivize state for high-cost solar PPAs. State should be compensated for high-tariff solar projects allocated to it in the initial phase of JNNSM.

5. RE storage technology to be focused in the state: that is, deployment of battery storage-based solar projects. ■

8 Assam

46 MW
RE capacity

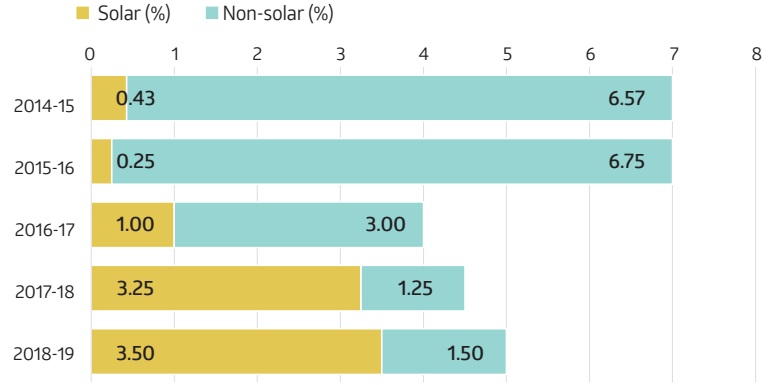
688 MW
Share of 2022 national RE target

Overview

Assam is one of the seven states in the North Eastern Region (NER) of India. It is surrounded by six sister NER states and connects NER with the rest of the country. Assam shares its international boundary with Bhutan on the northern side, and with Bangladesh on the south and south-west side.

As per the Ministry of Power, Assam has a 53% electrification rate, which is among the lowest in the country. Recurring floods, insurgency and inaccessible terrains have led to poor electrification of households and associated economic development in the state.

Figure 8.1: RPO target



Assam has a total installed power capacity of 1,446 MW. The share of conventional energy in this is about 67%, followed by hydropower with ~30%, with the remaining 3% being generated using renewable energy resources (as per CEA, January 2017).

The power supply position of the state is not adequate, but it is improving steadily. The state has a power deficit of 3.9% (276 million units) and peak demand deficit is 2.4% for the period April-December 2016 (as per CEA, January 2017).

State targets for renewable energy

Assam is one of the RE-deficit states in India. The state has an overall RE potential of 45 GW, with the maximum being in solar.

Considering its low RE potential and low state demand, MNRE has assigned to Assam an RE target of 688 MW by 2022. Given the low wind and biomass potential, the state has not been allocated any targets in these two areas. Almost 99%, or 663 MW, of the target is from solar and the remaining 25 MW from small hydro power.

Capacity and RPO achievements

Assam has an overall installed capacity of 1,445 MW, of which, 45 MW is

from RE. Since FY12, the state has added ~14 MW of renewable capacity, mostly from solar and small hydro.

Due to lack of RE capacity, Assam continuously lags renewable purchase obligations (RPOs) target set by the regulatory commission. Between FY12 and FY14, the state's RPO compliance level was 8-10%. However, RPO compliance by obligated entities in the state has improved from 25% in FY15 to 38% in FY16.

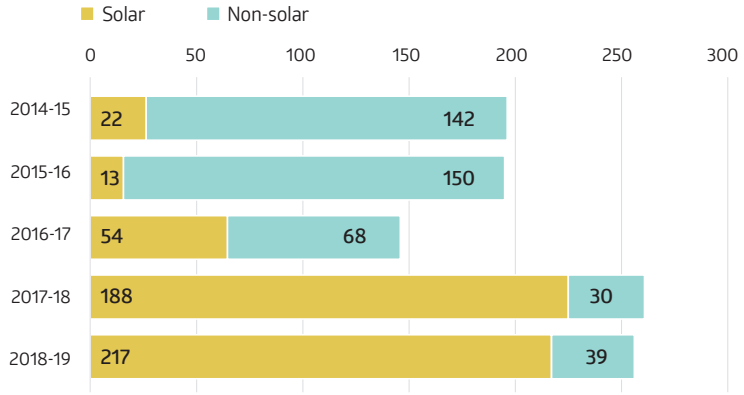
In 2015, the Assam Electricity Regulatory Commission (AERC) notified an updated RPO of 8.5% till 2020. However, in late-2015, RPO targets were reduced to 5% till 2019 (See Figure 8.1 and Figure 8.2).

Challenges faced by state

Assam is yet to firm up its strategy to achieve its RE target for 2022. The following are some of the challenges it faces:

- Limited RE potential in the state
- Limited land availability to set up large ground-mounted projects
- Low irradiation, which leads to lower yield per MW and higher unit cost per MW of solar plant
- Lack of capacity of state agency to implement and manage large RE projects
- Limited initiatives to promote distributed rooftop solar, lack of capacity building of state agencies to manage large-scale programs for distributed RE generation
- Lack of regulatory framework to encourage high RE penetration

Figure 8.2: RE capacity required to meet RPO target (MW)



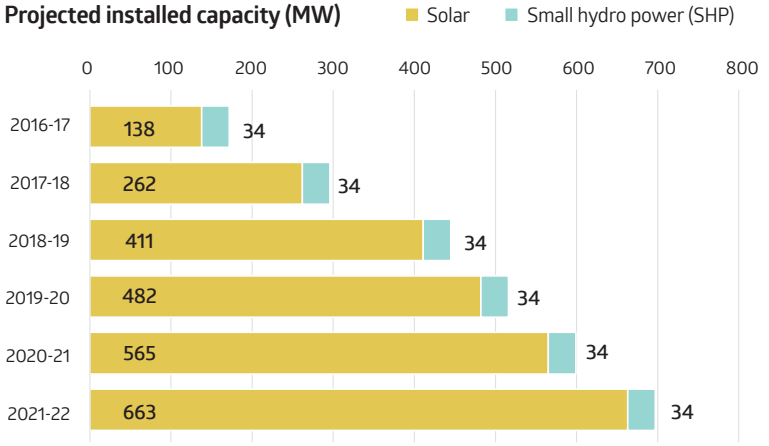
RE capacity to meet RPO is computed based on the State's energy requirement as per 18th EPS

- Low awareness of the concept, financing and PPP framework is limiting the replication of distributed RE applications
- Financial health of state DISCOMs is not good
- SHP policy needs to be revised with new incentives and promotional measures to attract private investment in the state
- Installation cost of small-scale solar projects in the region is higher than other parts of the country due to geographical constraints, lack of incentives and limited participation from private players

State efforts to encourage RE

The state has taken up select initiatives to embrace RE. The following are some of its key strategies:

Figure 8.3: Capacity expansion planned till 2022



- Procuring RE power from RE-rich states. Assam recently participated in MNRE's first-ever wind power scheme and agreed to procure 50 MW
- Promoting grid connected solar rooftop projects: the state is planning to install ~117 MW of solar rooftop in the next few years
- Assam has the potential to generate 541 MW from small hydro power development. In order to harness this potential, the state government notified its first Small Hydro Policy in March 2007. The policy identified potential to develop 117 MW of small hydropower (SHP) projects at about 88 identified locations
- Promoting utilization of solar pump-sets for agriculture/micro-irrigation in the state (under MNRE Scheme)
- Strengthened regulatory framework in the state by notifying net metering policy, renewable energy tariff regulations, renewable purchase regulations, etc
- In order to promote the capacity of distributed solar generation in states, AERC has also issued Regulations for Grid Interactive Solar PV Systems, 2015

State roadmap for 2022

The state government has so far not indicated any RE target for 2022 under the current policy framework. MNRE has provided the state a RE capacity addition target for 2022 of 697 MW.

The state has a total RE installed capacity of 34 MW. The RE capacity addition target for year 2022 is expected to be met mainly through solar (See Figure 8.3).

In order to explore the available potential of RE, APGCL, APDCL & AEDA have planned various renewable energy programs in grid connected & off-grid segment. Towards this end, ~270 MW of capacity addition has been planned in the state. In addition, the state will also be procuring RE power from other RE-rich states on a need basis.

List of state recommendations

The following are some recommendations to resolve state-level issues and to develop RE capacity in the state.

1. The state government shall develop a clear policy framework to encourage obligated entities to procure from resource-rich states and benefit from low-cost RE power available in these states.
2. Focus on development of distributed solar projects through innovative

business models and scaling up replication.

3. Capacity building of DISCOMs and SNAs for development of rooftop projects. The state government, supported by the central government, should organize knowledge exchange programs with states that are experienced in rooftop implementation. Further, best practices shall be adopted for the implementation of solar rooftops to minimize the time for approval of interconnection request and administrative burden on distribution utilities.

4. Encourage harnessing of RE potential in the tea sector.

5. Enhance local employment by tapping electrification through biomass gasifier to enhance access to energy.

6. Real-time monitoring of generation from RE for grid management in the long term.

9 Punjab

1,413 MW
RE capacity

5,066 MW
Share of 2022 national RE target

Overview

Even with limited availability of land and zero potential in wind energy, Punjab has come a long way, as illustrated by it being awarded the best-performing state in RE capacity building in 2015. Over the years, it has ramped up its energy supply, especially in renewables, gradually bridging its demand-supply gap and eventually turning into a surplus state.

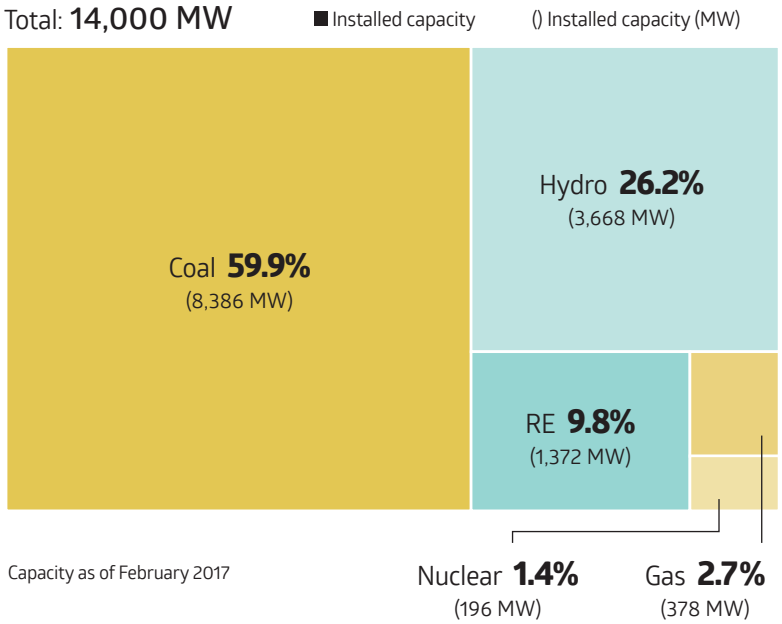
Punjab has an overall RE potential of 6.72 GW. Renewables currently constitute for ~10% share of the total installed capacity of 14.16 GW. The Punjab Energy Development Agency (PEDA) is the nodal agency for establishing RE in the state. The state achieved 100% electrification status in FY16.

State targets for renewable energy

Punjab has been apportioned 2.9% (5,066 MW) of the 2022 national RE target. Of this, the share of solar is 93% (3,917 MW) and non-solar is 7% (294 MW). However, the state has established its own RE targets till FY 2020: 1,000 MW of solar and 1,100 MW of non-solar.

This is still a fraction of the RE resources available in Punjab. The state has realized potential of 22% so far, which is commendable when compared to the performance of some other RE-rich states. Moreover, Punjab has achieved its small hydro project (SHP) target for FY 2022.

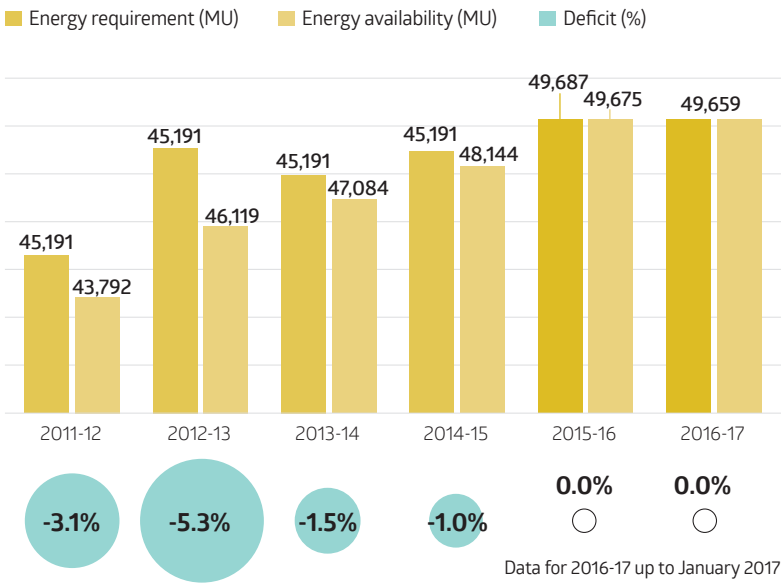
Figure 9.1: Current installed capacity



Capacity and RPO achievements

Punjab has an installed RE capacity of ~1.4 GW (See Figure 9.1), with solar comprising 795 MW (56%), SHP 145 MW (10%) and biomass-cogeneration

Figure 9.2: Energy demand-supply position



Data for 2016-17 up to January 2017

473 MW (34%). In terms of energy use, renewable energy fuels constitute ~4.4% of the state's power demands, in line with its RPO targets set by the Punjab State Electricity Regulatory Commission (PSERC). However, give the low availability of land in the state, it might be difficult to attain 8% national solar target by FY 2022.

Challenges faced by state

While Punjab is on track to meet its 2022 RE obligations, the state faces several challenges:

- Punjab turning into a surplus state, leading to shut down of thermal plants and eventually facing huge financial losses
- Grid integration: Due to substantial differential in peak and non-peak demand (50%), Punjab faces issues in integrating large capacities during non-peak demand
- Lack of balancing reserves in the state (practically zero)
- Land-related issues in development of large scale solar projects/ parks
- Non-solar RPO compliance is challenging as there is no wind potential in the state deployment. Lack of subsidies in the biomass segment has further aggravated the problem

State efforts to encourage RE

The state has adopted a multi-pronged strategy to embrace RE in the state, with these being some of the key strategies:

NRSE Policy, 2012

In order to accelerate the deployment of RE projects and create a favorable environment in the state, the Punjab government came out with its New and Renewable Sources of Energy (NRSE) Policy in 2012. Under this policy, specific targets have been set for each RE technology, along with a goal of 10% of installed capacity of RE in the state by FY 2022.

- The key focus areas of the policy has been solar, SHP, biomass, waste management, cogeneration and solar thermal, including RE initiatives for meeting energy/lighting needs in rural areas and supplementing energy needs in urban, industrial and commercial sectors.

- The Punjab government assures fiscal assistance in the form of notional lease amount on irrigation canal land. Some other incentives provided under this policy include 100% exemption of electricity duty, VAT, registration and stamp duty charges for land acquisition, single-window clearances, and exemption of NOC for solar PV projects from Pollution Control Board. Banking facility for power generated is also allowed for one year

Punjab Solar Rooftop Policy, 2014 (Net Metering)

Solar rooftop has been a thriving sector for the state government, especially with no large-scale project (solar park) in Punjab. This can be attributed to the Solar Rooftop Policy being launched in 2014. It was conducive to development, and had defined guidelines/procedures, including single-window clearances. Punjab's Dera Beas solar rooftop project is India's largest rooftop solar PV plant in one campus (19.5 MW on multiple roofs), generating 27 million units per annum.

Among major policy incentives, the solar rooftop system under net metering arrangement, whether self-owned or third-party owned and installed on eligible consumer premises, is exempt from banking and wheeling charges and losses, cross subsidy and additional surcharge. Other various benefits of NRSE policy are also applicable.

Figure 9.3: State meetings held

Date	Location	Participants
November 24, 2016 (1st Steering Committee Meeting)	Chandigarh, Punjab	PwC Team, State Representative, Niti Aayog
January 20, 2017	Chandigarh, Punjab	PwC Team, PEDA and PSPCL Officials
April 18, 2017 (2nd Steering Committee Meeting)	Chandigarh, Punjab	PwC Team, PEDA Officials

State roadmap for 2022

By adopting the policy initiatives stated above, Punjab has charted a trajectory for itself in the near future. In the upcoming years, the state is planning to add 200 MW solar, 27.5 MW SHP and 182.5 MW biomass-based projects.

List of state recommendations

Realizing the state's roadmap will require concerted efforts cutting across policy, regulation, finance, infrastructure and market-related interventions. The key recommendations are:

1. To match demand and supply, the state should increase power demand by promoting the adoption and use of electric vehicles, and devise inter-state power supply arrangements (separate RE NLDC Centers to be established).

2. Create an ancillary market for thermal. The back down of low-cost thermal plants adds a fixed cost obligation on DISCOMs, as well as creates huge idle capacities in the state. A low plant load factor (PLF) also results in high electricity costs, due to more fuel usage, and high carbon footprint. Creation of ancillary markets to bank/park thermal capacities can avoid a shut down.

3. Incentivizing state through balancing. Explore the option to convert run-of-the-river hydro projects to storage-based projects. This can result in huge balancing reserves in the state. Central funds to be allocated to state to conduct such amendments in existing plants.

4. RE storage technology to be focused in the state: that is, deployment of battery storage-based solar projects.

5. Incentivizing the biomass sector framework:

   i) The state should consider allowing open access facility for biomass

   ii) Mechanization of fuel collection system

   iii) A separate dedicated skill development center formation, focusing on agricultural residue management

   iv) Establish a farmer commission, targeting farmer needs

   v) Farmers to be provided with bailers, trolleys (for biomass collection) and other useful equipment, including tractors, at a nominal rate of interest. (Agriculture is already under priority sector lending.)

   vi) Since the biomass industry is labor-intensive, the state can revise its payment mechanism for the sale of electricity by reducing payment receivable from 60 days to 15 days (PPA clause)

Abbreviations

Abbreviation	Description
AD	Accelerated Depreciation
AEDA	Assam Electricity Development Agency
AERC	Assam Electricity Regulatory Commission
CAGR	Compounded Annual Growth Rate
CEA	Central Electricity Authority
CERC	Central Electricity Regulatory Commission
COD	Commercial Operation Date
GBI	Generation Based Incentive
GOI	Government of India
GW	Giga Watt
GDP	Gross Domestic Product
IESS	Indian Electricity Security Scenario
JNNSM	Jawaharlal Nehru National Solar Mission
kWh	Kilowatt Hour
MEDA	Maharashtra Electricity Development Agency
MERC	Maharashtra Electricity Regulatory Commission

Abbreviation	Description
MNRE	Ministry of New and Renewable Energy
MOP	Ministry of Power
MU	Million Units
MW	Mega Watt
NAPCC	National Action Plan on Climate Change
NDC	National Determined Contribution
RE	Renewable Energy
RES	Renewable Energy Source
REC	Renewable Energy Certificate
RERC	Rajasthan Electricity Regulatory Commission
RPO	Renewable Purchase Obligation
RRECL	Rajasthan Renewable Energy Corporation Ltd.
SAP - RE	State Action Plan - Renewable Energy
SHP	Small Hydro Project
SERC	State Electricity Regulatory Commission