INDIA'S POWER OUTLOOK

VOLUME 4

DECARBONISING

THE POWER SECTOR

OVERVIEW OF THE

TAILWINDS & HEADWINDS

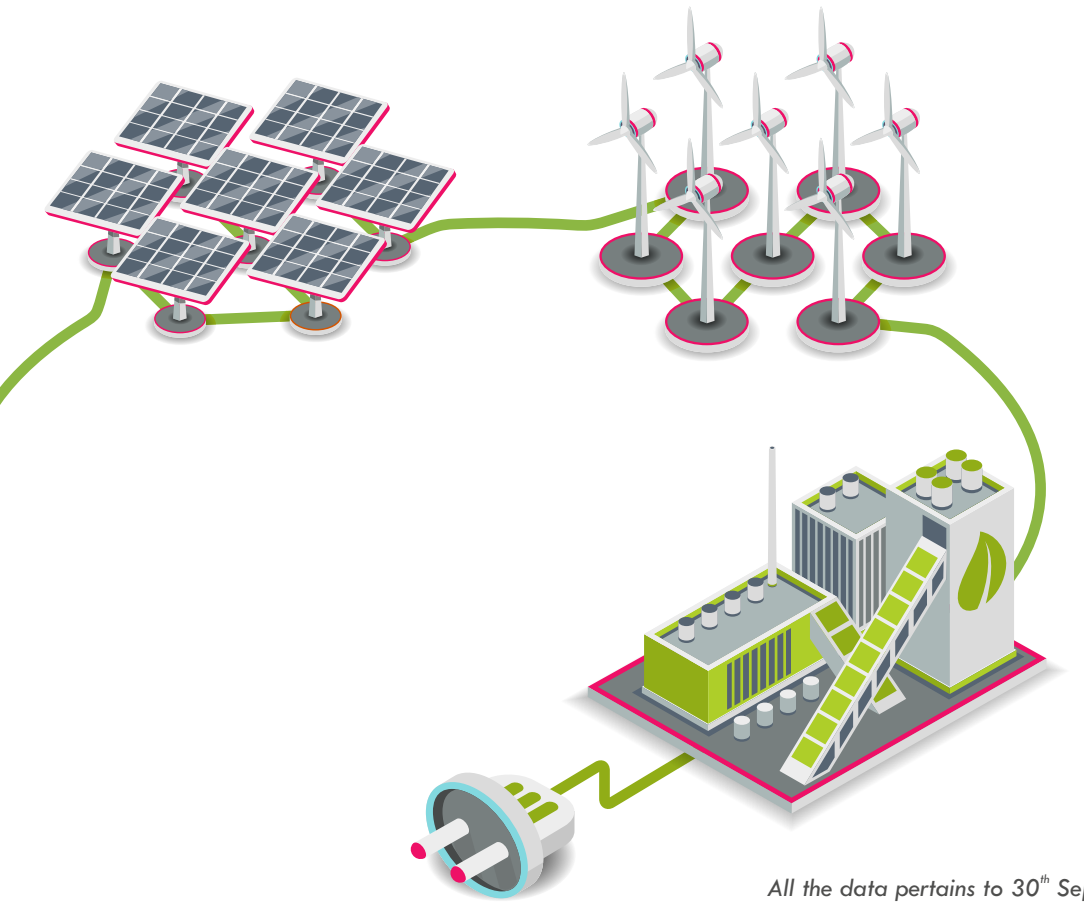
The Role of States and Energy Users

VASUDHA FOUNDATION
Green ways for a good earth!

CIFF CHILDREN'S INVESTMENT FUND FOUNDATION

The Power Outlook Series developed by **Vasudha Foundation** with support from **Children's Investment Fund Foundation (CIFF)** provides an overview of the current status of India's power sector with a focus on significant and emerging developments. The outlook series aims to develop a more informed understanding of the power sector and act as a tracking tool for stakeholders. *'Assessing the role of states and energy users in India's decarbonization journey* is fourth in the series of India Power Outlook Reports.

The Volume 4 looks at the **role of states and its consumers in its race to decarbonize the power sector.** It further discusses the journey of the power sector in the last few years and the existing status of various states.



All the data pertains to 30th September 2021, unless otherwise mentioned.

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Introduction

The Paris Agreement aims to keep the increase in global average temperature to well below 2°C above pre-industrial levels and with the new IEA's scenario to phase out fossil fuels in the quest to achieve the 1.5°C, temperature goal target by 2040, coupled with the fact that many countries globally have announced net zero target year, there would be growing pressures on countries like India to develop long term deep decarbonisation plans.

India is currently the third largest emitter of greenhouse gases, with a total emissions of 2378 Mt CO_2e, as on 2015. The total greenhouse gas emissions from India's electricity generation alone stood at 958 Mt Co_2e, constituting 51 percent of the total greenhouse gas emissions from the energy sector and approximately 40 percent of India's total greenhouse gas emissions for 2015.

India has ambitious targets for renewable energy deployment of 175GW by 2022 and 450 GW by 2030. Along with a 30% e-mobility penetration, if achieved, these measures would certainly bring down the rate of growth of GHG emissions from the energy sector as a whole and give a substantial boost to renewable energy.

However, achieving these targets is contingent upon a number of factors, that include, ensuring policy synchronization with states and UTs. Thus, it might be prudent to follow a more bottom-up approach of creating suitable eco-system of policies, regulations, incentives etc that hang together at all levels and geographies while at the same time respecting differential economic and social realities on the ground.

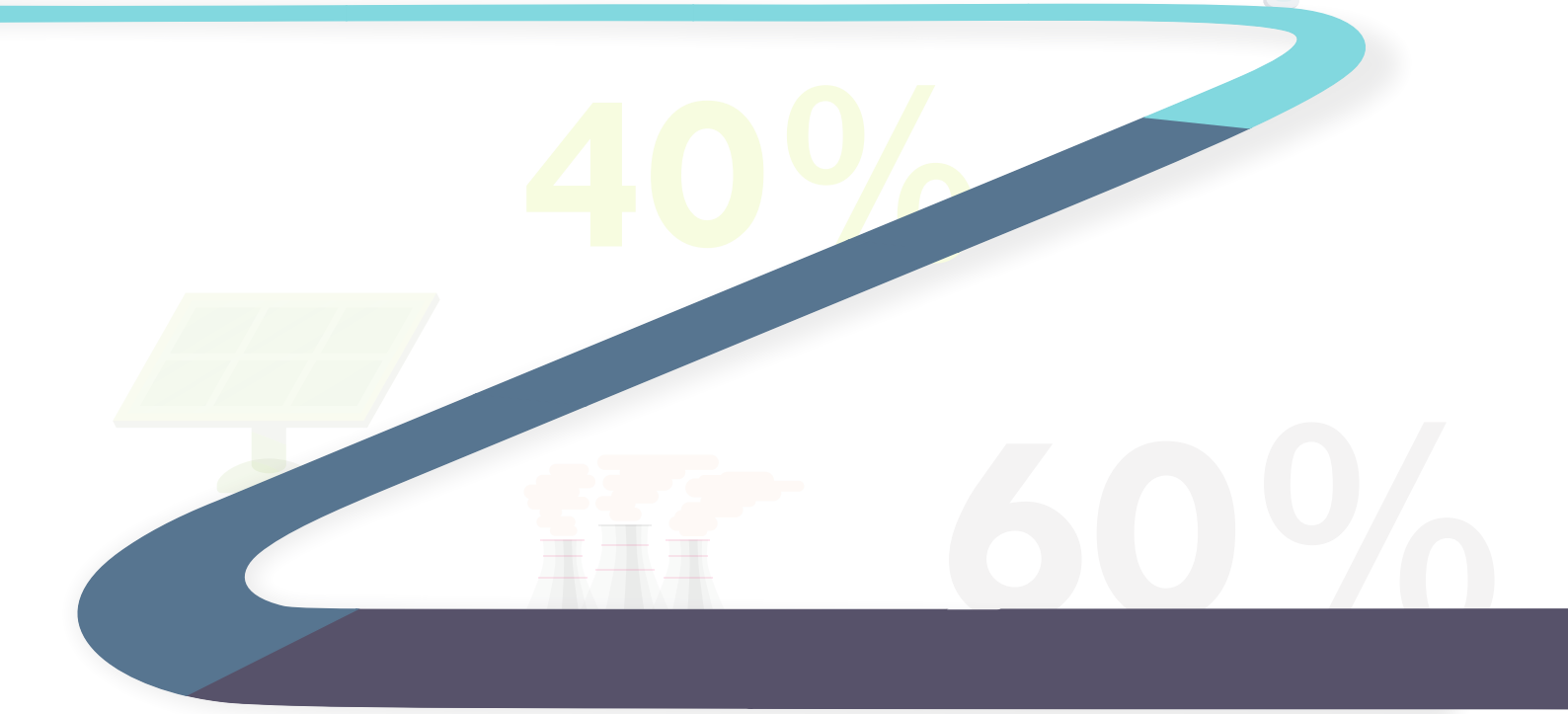
In addition, another crucial element to be factored in is the role of consumers and demand for electricity. We have already seen that the substantial reduction in electricity demand during the lockdown period in April to June 2020 had a major impact on the power sector value chain. This includes amongst others, a further squeeze in the already poor financial bottom lines of many of our electricity utilities (DISCOMs).

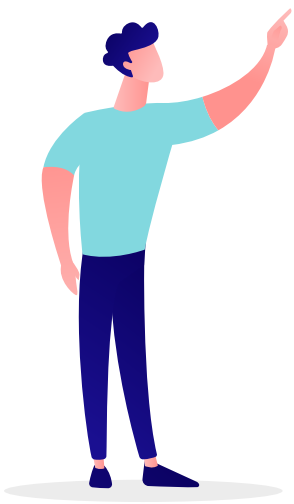
With India already witnessing a huge second wave of COVID-19 that led to disruptions in economic activity due to lockdown announced over a period of 1-2 months across most states in India, the economic revival expected in 2021, after the 2020 slowdown may not unfold as anticipated.

In the backdrop of the above, this volume of the Power Outlook Series, lays out the current state of play of decarbonization of the Power sector and also looks at the road ahead, both in terms of the possible tailwinds as well as headwinds that it could encounter, and the role of states and consumers in its race to decarbonize its power sector.

1

India's NDC Tracker



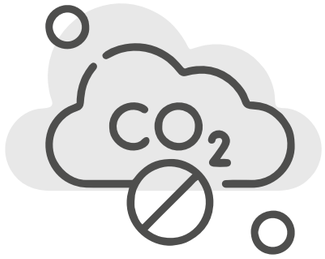


India Power Sector

Overview

Emission Intensity of GDP

2005 ↓ 24% 2016



GENERATION

Total installed capacity
388.85 GW
(As on Sep'21)
↑ 27% in last 5 years

Overall generation
1,373 BUs
(FY'21)
CAGR ↑ 3.3% in last 5 years

758 BUs
(Apr'21-Sep'21)

Average thermal PLFs
(Excluding gas-based plants)
53.5%
(FY'21)
↓ 24% in last 10 years

57.8%
(Apr'21-Sep'21)

GW-Gigawatts, BU-Billion units

Installed RE capacity
(excluding large hydro)
101.53 GW
(As on Sep'21)

FY'16 Sep'21 ↑ 2.2 times

Total Installed RE capacity + Hydro
148 GW
(As on Sep'21)

Total RE Pipeline Capacity
95 GW
(As on Sep'21)

Non-Fossil Share
39.8% (As on Sep'21)

40% NDC Target by 2030

TRANSMISSION

Number of transmission lines
4,48,407 ckm
(As on Sep'21)
↑ 29% in last 5 years

ckm -Circuit kilometers

Substation transformation capacity
10,59,391 MVA
(As on Sep'21)
↑ 55% in last 5 years

MVA-Mega Volt-Ampere

DISTRIBUTION

Total energy requirement
1,276 BUs
(FY'21)
CAGR ↑ 2.8% in last 5 years

709 BUs
(Apr'21-Sep'21)

Total energy available
1,271 BUs
(FY'21)
CAGR ↑ 3.1% in last 5 years

706 BUs
(Apr'21-Sep'21)

Total peak demand
190 GW
(FY'21)
↑ 24% in last 5 years

203 GW
(Apr'21-Sep'21)

Total peak met
189 GW
(FY'21)

201 GW
(Apr'21-Sep'21)

Average AT&C loss
22.32%*
↓ 1.6% since FY'16

ACS - ARR gap
0.2 Rs/unit*
↓ 0.45 Rs/unit since FY'16

**As per UDAY Dashboard, on 13th October, 2021*

CONSUMPTION

Number of households electrified
~21.44 Crores

Per capita electricity consumption
1,208 kWh
(As on Mar'20)
3152 kWh World Average as of 2017

% electricity share by Industry
(Highest demand sector)
43%
(As on Mar'20)
↓ 4% in last 10 years

All the percentages were calculated based on financial year (except average AT&C loss and ACS-ARR gap).

Source - CEA, Saubhagya Dashboard, MNRE and UDAY dashboard. Information collated by Vasudha Foundation for India's Power Sector Outlook Series

Power Sector Decarbonisation Tracker

ELECTRIC VEHICLE (EV)

30% EV sales by 2030

EV Policies

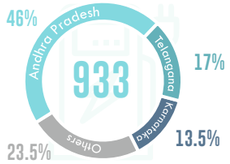
17 STATES

Targets based on battery manufacturing, number of EVs sold and total grid capacity

Registered EV Sales

Monthly Maximum
As on October 2021

EV Charging Stations



As of June 2020

LT Energy Charge

7.7/kWh
Uttar Pradesh

4/kWh
Gujarat

HT Energy Charge

7.3/kVAh
Uttar Pradesh

4/kVAh
Delhi

FDI in EV Sector

100%

Karnataka and Tamil Nadu.
Enables the entry of leading players like Tesla India Motors and Energy Pvt Ltd, OLA Electric Mobility Pvt, Ather Energy, and Mahindra Electric in the states.

Exemptions for EVs

EVs exempt from paying registration fees and renewal of registration certificate.

Ministry of Road Transport and Highways
On 27th May 2021

Bihar, Delhi, Karnataka, Maharashtra are already providing exemption of road tax and registration fee.

Electricity Demand Charges

Few states have announced no demand charges to boost EV adoption.

State EV Fund

Creation of an umbrella, non-lapsable 'State EV Fund'
To be funded through the air ambience fund, levy of additional taxes, cess, fee etc. on inefficient or polluting vehicles.

Production Linked Incentive (PLI)

Rs. **18,100** crore

For manufacturing batteries domestically .
To reduce the cost of batteries and EV production.

Hotspot for EV businesses

Karnataka
With its comprehensive EV policy, has become a hotspot for EV businesses in India, both in EV and EV ancillary manufacturing as well as R&D segments.

ENERGY EFFICIENCY

Reducing emission intensity of GDP by **33–35%** by 2030 from 2005 levels

India's Emission Intensity of GDP[1]

24%

Between **2005** and **2016.**

State Energy Efficiency Index 2019

97 Indicators

Haryana, Karnataka and **Kerala** top the 'Achiever' category.
Indicators cover all demand sectors, buildings, industry, municipalities, transport, agriculture and DISCOMs.

India Cooling Action Plan

India is the first country to develop an action Plan
Aimed at reducing its cooling and refrigerant demand requirements.

ECBC Compliance

54 buildings were declared as ECBC compliant
264 existing buildings have adopted BEE star ratings
15 States and **2** UTs have already notified ECBC.

As of March 2020

Industrial Efficiency

956 designated consumers from **13** sectors

Under the PAT schemes are adopting EE measures
This is expected to result in a reduction of **20 Mtoe** of energy and **70 MtCO$_2$** by **2022.**

RENEWABLE ENERGY

450 GW by 2030

Solar Tariffs

Rs. **6.17**/kWh
Rs. **1.99**/kWh
2014-15
FY 2020-21

Wind Tariffs

Rs. **5.92**/kWh
Rs **3.0**/kWh.

Solar and RE Policy 2021

New policies by **Gujarat and Maharashtra.**
Draft policies by **Haryana and Karnataka.**

No New Coal?

Gujarat, Chhattisgarh, Karnataka & Rajasthan State Power Authorities hint at no new coal
India's largest power companies such as **NTPC, Tata Power, JSW Energy** have committed to not building new coal projects.

InSTS charges and losses

For inter-state sale of power from solar and wind power projects.

Have been waived for all projects to be commissioned up to 30.06.2025.

Power Grid Support

MNRE has announced guidelines for procuring round-the-clock power from grid connected renewable energy projects supported by conventional thermal power projects.

'One Nation, One Grid, One Price'

Discussion paper by MOP on market-based economic dispatch (MBED) of power to bring down the cost of power for DISCOMs and consumers.
A key step towards this transition.

[1] MoEFCC. (2021). India: Third Biennial Update Report to the United Nations Framework Convention on Climate Change. Ministry of Environment, Forest and Climate Change, Government of India.

Investment Tracker

Since 2020, India has committed

At least $44.31 billion

Towards Fossil Fuel Energy

At least $37.02 billion

Towards Clean Energy

Source - Energy Policy Tracker. (13th October, 2021). India. Retrieved from https://bit.ly/3i53yPF

Electricity (Amendment) Bill 2021

The salient features of the Electricity (Amendment) Bill 2021 are -

1. The bill seeks to de-license power distribution to reduce entry barriers for private players for creating competition in the segment, which would ultimately enable greater consumer choice. Existing distribution companies "may" continue, but multiple distribution companies shall be allowed in the same area of supply.

2. New distribution companies meeting the eligibility criteria prescribed by the central government can register themselves with an appropriate regulatory commission to begin operations. The commission shall be required to register the applicant within a period of 60 days. Further, the commission can reject the registration only if the applicant does not meet the eligibility criteria.

3. The amendment will also give effect to a Supreme Court judgement wherein it has been held that Electricity Regulatory Commissions must have a member with experience and qualifications in law.

4. In the field of renewable energy, the proposed amendments provide for state commissions to fix the Renewable Purchase Obligation (RPO) as per the trajectory prescribed by the Central Government.

5. The Bill also introduces a specific provision for penalties for not meeting the RPO. This will give additional fillip for increasing the share of renewable energy in the overall energy mix.

6. Besides, the Bill seeks unification of the regional grids. This will necessitate greater supervision over the national grid. As a result, certain additional responsibilities and powers are proposed to be conferred on the National Load Despatch Centre (NLDC).

7. To address the issues of delays in payments to power generation companies by power distribution companies, the bill proposes that no electricity shall be scheduled or despatched under a contract unless adequate security of payment has been provided.

8. Some of the other proposals in the Electricity Amendment Bill 2021 are higher penalties for offences under the Act and for non-compliance of orders of the regulatory commissions, as well as put in place a mechanism for monitoring the compliance of the provisions of the Act and its rules and regulations

2

Deep Dive at State Level

2.1 Generation

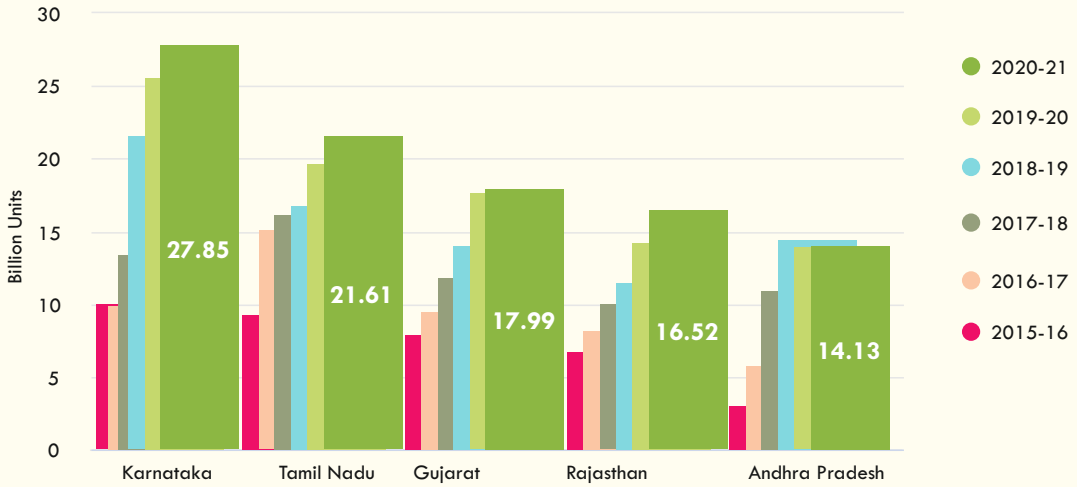
India's current electricity installed capacity stands at 388.85 GW (As of September 2021), with a 26% share of RE. With 450 GW, the share is set to increase to 53% in the overall capacity mix. While India is making consistent strides towards decarbonising its generation sector, the share of renewable energy in the generation mix remains low at 12%. This leaves a huge scope for increasing RE penetration. In order to meet its climate targets, India not only needs to do more renewables, but also needs to decrease its reliance on fossil fuels. On the other hand, coal still remains a mainstay for powering India's economy. A three-pronged approach should be adopted to augment the pace of this energy transition- Increasing Green Capacity, decreasing brown capacity and lastly, retiring/repurposing of stressed and old brown capacity.

Moreover, to ensure meaningful action, there is a need to monitor the progress and track results at state level. But to ensure a robust power grid, every state needs to enable a conducive policy environment for RE growth and dispel the political hurdles towards the closure of stressed thermal assets.

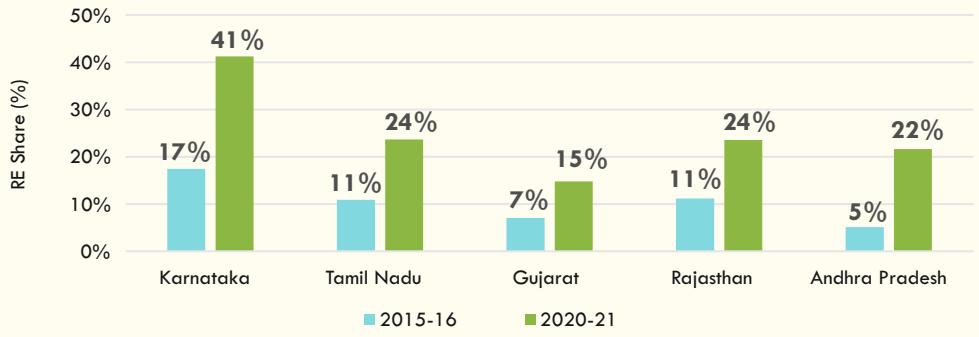
Rising Green Capacity
2.1.1 State wise trajectory of RE generation

Only 5 states, namely Karnataka (15.7 GW), Tamil Nadu (15.6 GW), Gujarat (15.1 GW), Rajasthan (12.6 GW) and Maharashtra (10.5 GW) makeup for ~68% of the total RE installed capacity (as of September 2021) in the country. Backed by India's large RE potential, each state has a huge appetite to ramp up it's RE production.

Top 5 States by RE Generation



- With its large variations in geography, local conditions, socio-political landscape, resource availability etc, the states have a huge window to cross-learn and collaborate in order to meet their clean energy targets.
- For example, Karnataka's energy transition journey sets enough evidence of how a conducive policy environment can enable better offtake of renewable energy. The state has increased its installed capacity from 4.5 GW in 2015-16 to 15.7 GW in 2021-22 (As of September 2021); which translates to a share of 17.4% to 41.2% in the overall state electricity generation mix. Positive RE related policies such as solar energy park development[2], welcoming hybrid wind-solar developments, reducing coal-based generation, simplifying land procurement process for solar plants, increasing awareness amongst consumers for higher uptake of RE etc has all led to betting big on RE particularly solar.



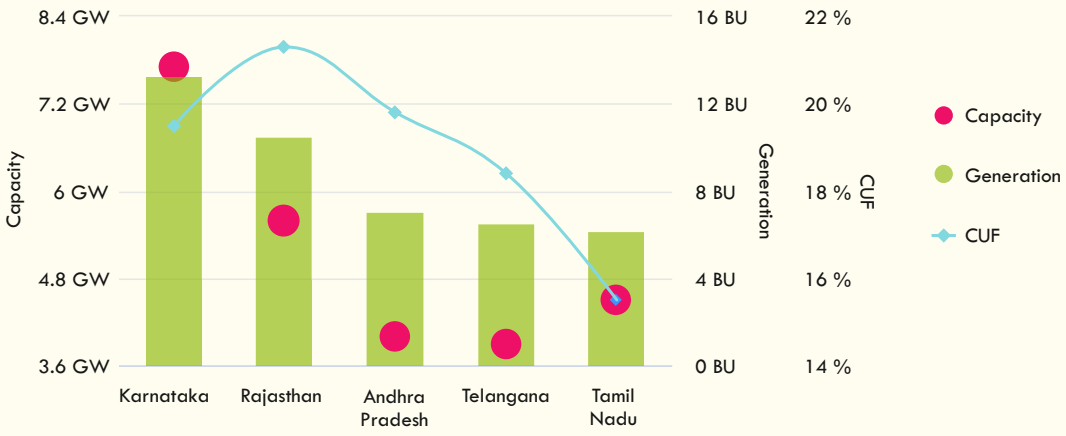
Change in RE Share in Overall State's Generation Mix

- There are also other states with increased RE share like Tamil Nadu, Rajasthan, Andhra Pradesh and Gujarat that have also shown incredible RE growth trajectory (See graph above).
- Another policy integration example is offered by Tamil Nadu where its recent policies on Solar (2019), EV (2019) and industrial development (2021) are together looking at a sustainable energy transition for the state by boosting RE manufacturing, solar-powered EV stations etc; thus, building both the demand and supply of RE in the state.
- On the other side on RE deficit states such as Uttar Pradesh and Bihar focussed on decentralised solar to a large extent to drive RE capacity expansion in their states.
- States that have under-performed on renewable energy power installations and generation are mainly Uttar Pradesh, Punjab, West Bengal, Bihar, Chhattisgarh, Jharkhand and Haryana amongst others. Further, most of the above-mentioned states are also coal rich and have substantial coal power installed capacity. However, in recent times, states such as Chhattisgarh have announced "no new coal" and therefore likely to scale up renewable energy installations. Further, a number of coal fired power plant units in the above mentioned states are also under-performing due to vintage and other reasons. It would be prudent for the respective state Governments to explore the option of converting some of the under-performing coal units in to renewable energy power units.

[2]Vikram Solar. (2019, May 16). Blog. Retrieved from https://bit.ly/3AV8WNF

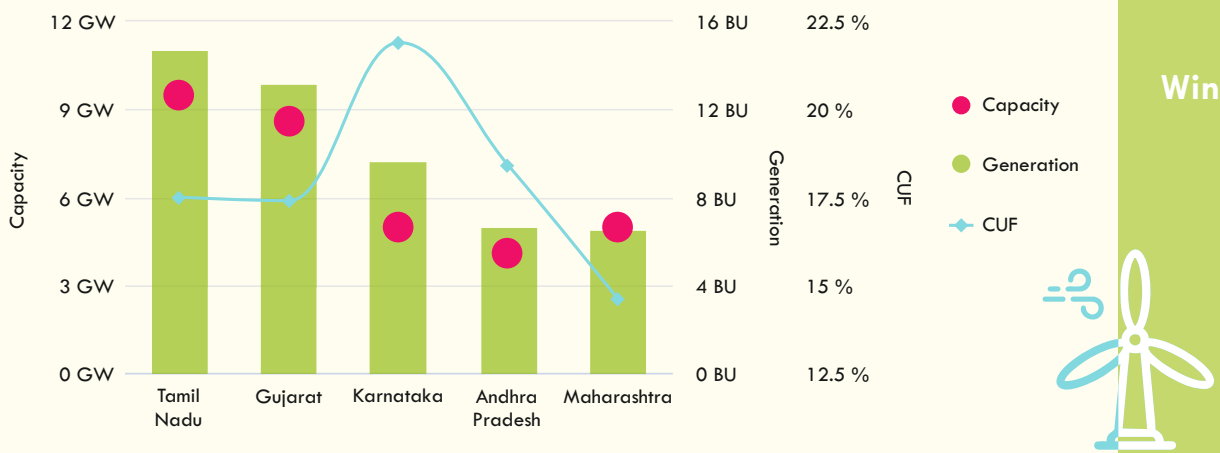
- Further, states need to re-look at the long-term power purchase agreements with high-cost coal and opt for the cheaper renewable energy power, as states such as Karnataka, Maharashtra, Tamil Nadu etc have adopted.
- Nonetheless, there are huge challenges that both RE rich (southern and western states) or RE deficit (northern states) states needs to address for the future growth of RE.
- These include issues such as RE curtailments, reneging on existing RE PPA's, delayed payments to generators, poor transmission planning, unsatisfactory RPO compliance amongst others.
- Further solutions such as stricter adoption of must run status with penalty mechanisms for failure in implementation, changes in laws to promote contract enforcement to avoid reneging of Renewable Energy Power Purchase Agreements would further help to incentivise renewable energy installations and disincentivise pursuing costly coal options.

Top 5 States by Solar Generation FY 2021



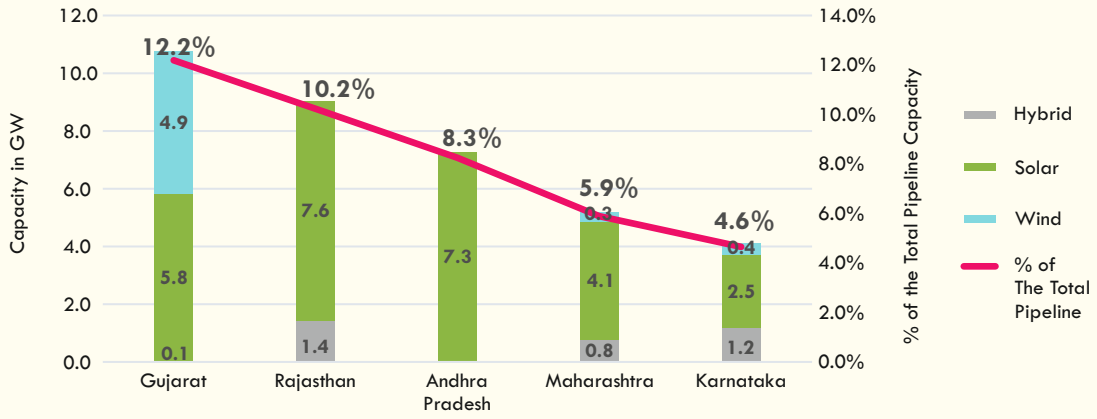
- Karnataka leads the list of solar generation in the country with 13.24 BU and a 22% share of the total solar based generation in India.
- Tamil Nadu tops the list in Wind generation with 14.56 BU followed by Gujarat (13.06 BU) and Karnataka (9.61 BU). It makes 24% of the total wind-based share of the country followed by Gujarat (22%).
- While technology advancements have led to improving solar capacity utilisation factors, but wind continues to experience lower CUFs ranging between 14-22% for key wind producing states against an optimum CUF of 30-35% for wind.

Top 5 States by Wind Generation FY2021



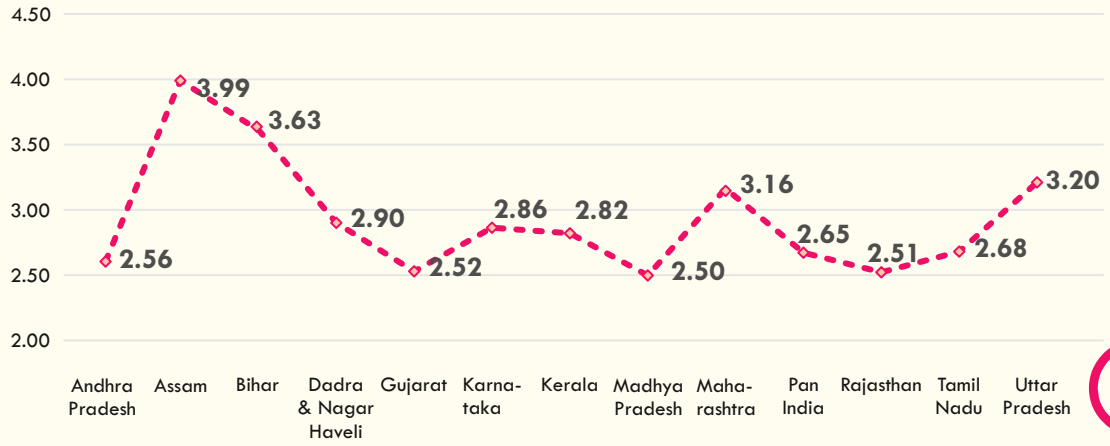
2.1.2 State wise break up of pipeline RE capacities

Top 5 State with Highest RE pipeline Capacity



- A total RE capacity of ~88 GW (as on September 2021) is under pipeline with 24.6 GW under construction tendered capacity, 36.2 GW under bid awarded capacity and the remaining 27.4 GW under various stages of bidding.
- Apart from the 46.8 GW of pipeline capacity at state level, another huge portion of 41.5 GW of the total pipeline is expected to come across India or more than one state.
- Gujarat has the highest share of 12.2% (10.75 GW) of pipeline capacity of the total RE pipeline projects followed by Rajasthan (10.2%) and Andhra Pradesh (8.3%).
- Going forward, for a successful realization of this capacity, there is a need to focus on creating positive RE policy environment, reducing projects cancellation rate, PPA fulfillment, strengthening transmission infrastructure, and further enhancing RE uptake by both DISCOMs and consumers.

2.1.3 Recent RE Auction prices



State-wise Average Auction Tariff Rs./kWh As of September 2021

- The per-unit cost for both solar and wind have decreased substantially, thus incentivizing their deployment.
- The relatively higher tariff for states like Bihar (3.63 Rs/kWh) and Uttar Pradesh (3.20 Rs/kWh) is because this tariff was for floating solar.
- Recently in late 2020, a new low tariff of 2 Rs/kWh and 1.99 Rs/unit for solar was discovered for Gujarat and Rajasthan respectively. Amongst other factors of declining panel & equipment prices and lower interest rates, assured buyer for power was a key driver to the discovery of such record low tariff amid fiercely competitive bidding.

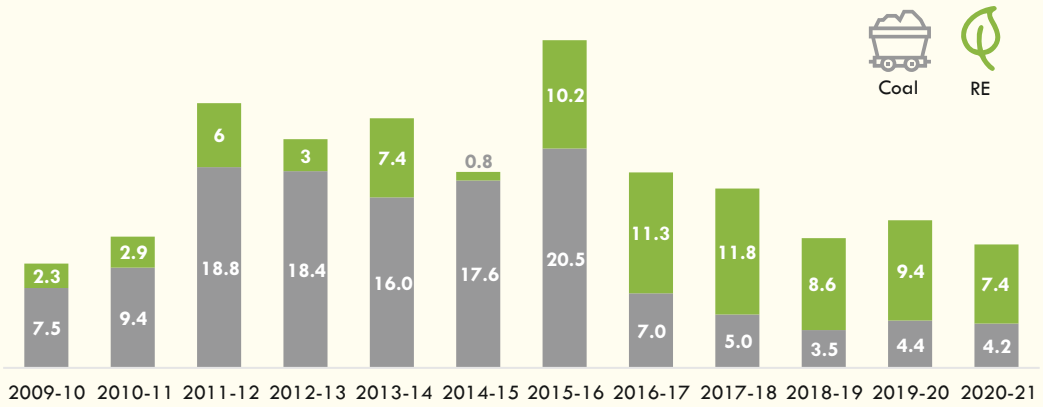
As per few studies[3], the variation in tariffs is due to many factors. CUF varies from state to state and has an impact on project return accordingly. Payment risk is another major factor, which has an impact on the tariff e.g., project tenders floated by central agencies have lower tariff than states because of the payment security from the central agencies. While delays in payments from state has resulted in no participations from the bidders. Many state level tenders are cancelled due to no bidders showing up for the bid. Recently, the easy access to foreign capital and the increased interest of foreign based firms to capture the solar markets in India is also believed to play an important role in bringing down the prices.

[3]IEEFA. (2020, May). Report. Retrieved from https://bit.ly/3wG3Ula

Declining Brown Capacity

2.1.4 Trends of coal-based capacity addition in India

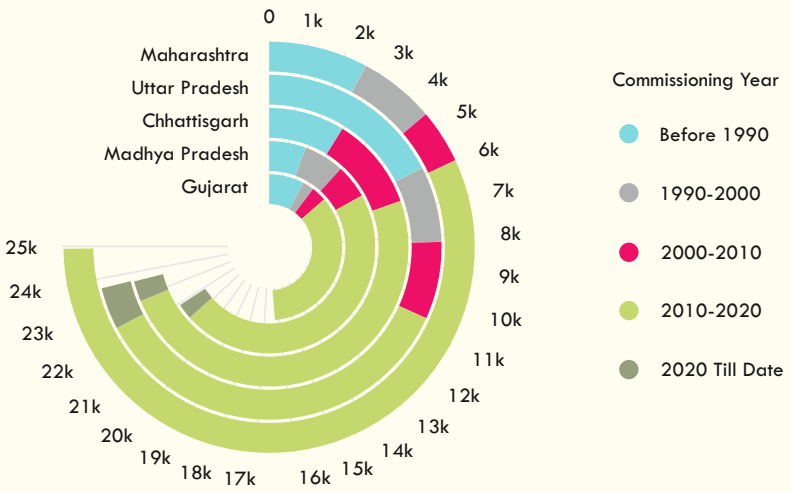
Coal vs RE capacity addition in India GW



- Owing to large energy and peak deficits, the Indian Power sector saw a spree of new power plants between 2011-2016. During these six years, India added more than 100 GW of coal capacity to the grid with the coal capacity addition last peaking in 2015-16. However, it is yet to be ascertained whether this is a permanent shift or a temporary one.
- However, post 2016 and the announcement of 175 GW RE Target by 2022 led to higher cost-competitiveness and conducive policy environment for RE which further enabled a higher share of RE capacity addition vis a vis coal in the recent years.

2.1.5 States with majority coal-based capacity in India

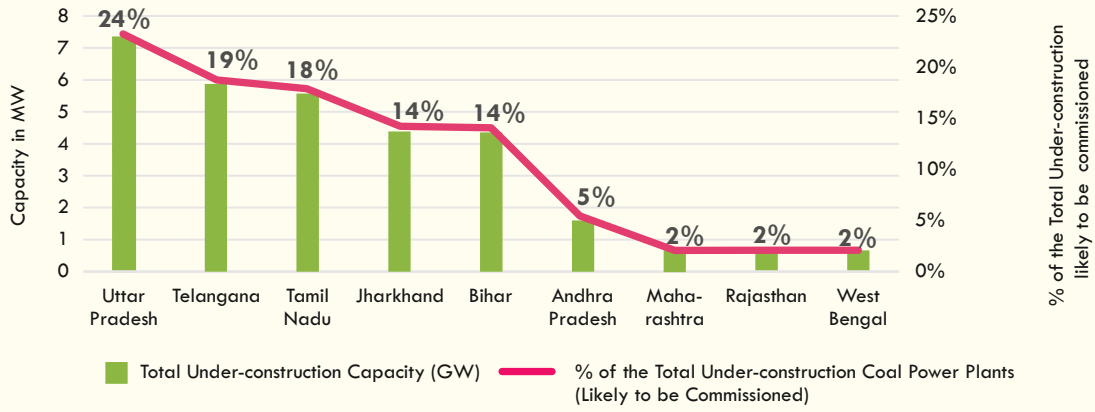
Top 5 States Coal States by Installed Capacity (Vintage-Wise)



- Total No. of Coal Power Plant Units are 597 which corresponds to 208.61 GW (as on September 2021). Uttar Pradesh has maximum 77 units (23.72 GW) followed by Maharashtra with 74 units (24.75 GW).
- A whopping 309 number of units were commissioned during 2010-2020 which contributes to more than 50% of the total operational units with a capacity of 133.8 GW. Out of 133.8 GW, 80.92 GW of capacity was added during 2010-2015 period (CAGR of 15.8%), while 52.87 GW was added during 2015-2020 (CAGR of 4.1%).
- 33% of power plant units for the top 10 states (by number of units) were commissioned before 2000.
- For the top 5 states (by installed capacity), Uttar Pradesh has 34% of its capacity commissioned before 2000 followed by Gujarat (20%), Madhya Pradesh (18%) and Maharashtra (18%). This capacity has attained/will attain the age of 25 years in a few years.

2.1.6 State-wise break up of pipeline coal capacities

Under-construction Coal Power Plants Likely to be Commissioned by 2024-25 ~31 GW



- The total Coal fired plant pipeline Capacity under-construction and likely to be commissioned is 30.86 GW. Many of the projects under construction have been continuously delayed due to infrastructure, technical, manpower related issues, deferred coal linkages etc. The situation intensified further due to Covid related lockdowns and slowdowns.
- Additionally, a large amount of pre-construction capacity of ~24 GW has been delayed for many years now. Most of these plants are owned by private enterprises who have been reluctant to fund these new coal power plants and the risk of them turning into "stranded assets" due to the rising cost-competitiveness of RE.
- Uttar Pradesh has the highest under construction projects (7.26 GW) which are likely to be commissioned and further corresponds to 24% of the total under construction capacity. It is followed by Telangana and Tamil Nadu with 5.8 GW and 5.5 GW respectively.

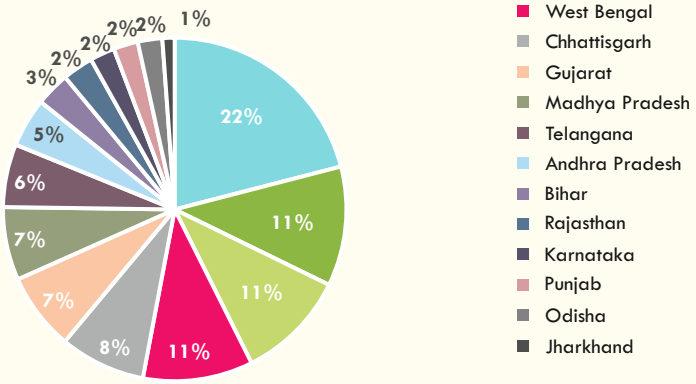
2.1.7 Retiring/Refurbishing of old and expensive brown capacity

A study[4] estimates that about 100 GW of existing coal capacity has a variable cost higher than 2.44 Rs/kWh average cost of energy from solar. This implies that a large number of existing coal power plants is already unviable since the average cost of solar is less than the variable cost of coal power generation. Therefore, there is little amount of risk appetite left in the sector to invest in new coal power plants.

Going forward, it makes economic sense for the DISCOMs to buy power from solar as compared to existing coal-based plants. However, there are a large number of combination of factors to be assessed before retiring/refurbishing any of the coal-based units. These include age, low PLFs, technology efficiency, generation outages, emission control, costs, employment opportunities etc. It is important to carefully assess the benefits of retiring coal capacity against the benefits of effectively utilising them.

2.1.8 State wise list of coal-based power plants exceeding 25 years

State-wise Break up of 35.54 GW Operational Capacity (Age>25 years) As of September 2021

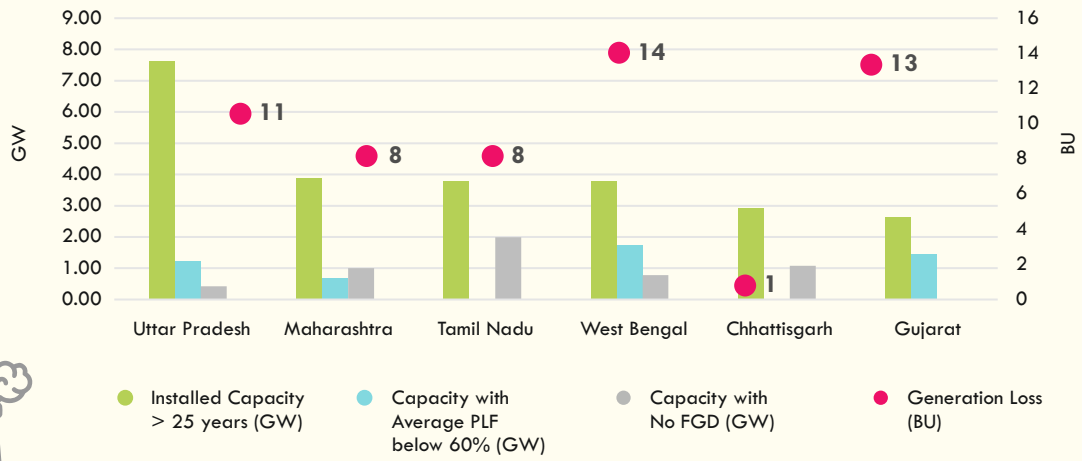


- Considering the age of the coal power plant,35.54 GW of operational power plant units have age>25 years (as on September 2021) with Uttar Pradesh, Maharashtra, Tamil Nadu and West Bengal making up more than 55% of this capacity aged more than 25 years.
- As per the CEA's plan to retire the coal power plants during 2017-22 period and 2022-27 period- the operational capacity with age > 25 years as of March 2022 and March 2027 will be 37.09 GW and 45.02 GW respectively.

[4]Sustainable Finance Initiative. (2021, April 23). Seminar. Retrieved from https://bit.ly/3hyLU7Z

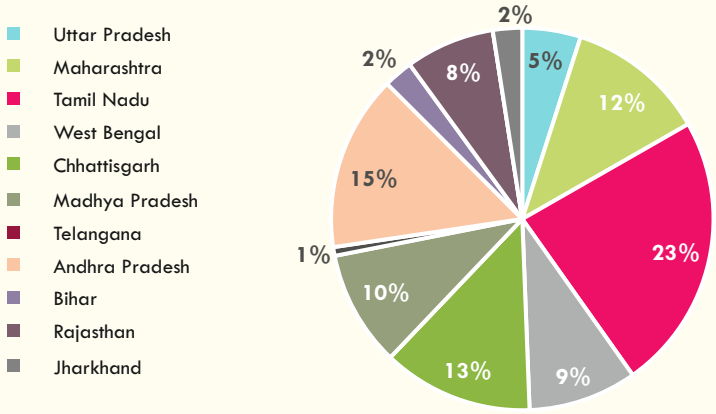
2.1.9 States who should consider phasing out thermal power plants in the short term

State-wise Breakup of highest capacity > 25 years along with PLFs < 60% No FGD and respective Generation Loss As of September 2021

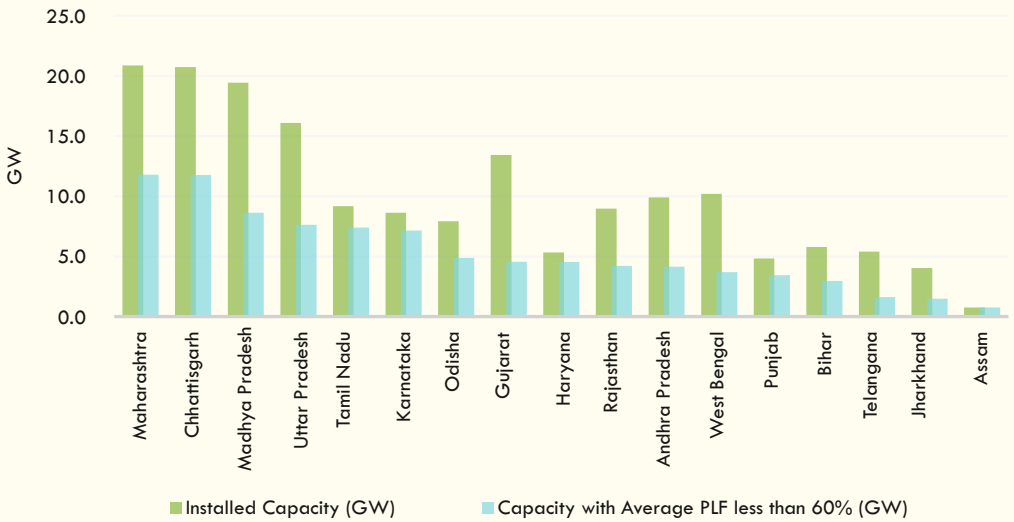


- States having operational coal power plants (Age > 25 years as on September 2021) and average PLF less than 60% (Between FY 09 to FY 22) make up the capacity of 8.01 GW. Major states in this range are West Bengal, Gujarat, Madhya Pradesh, Maharashtra, Punjab and UP which make up 7.16 GW.
- States having operational coal power plants (Age > 25 years as on September 2021) and no FGD makes up for 8.48 GW of the capacity in the graph on the right.
- Combined generation loss for the coal capacity during FY 21 stands at 82.78 BUs.

State Wise Breakup of 8.48 GW with No FGD Installed for Plant units (Age > 25 years As on September 2021



2.1.10 State/National level Performance of Coal TPPs age less than 25 years



Capacity (Age < 25 years) Vs Capacity (with PLF below 60%) As on September 2021

- India has a current coal fired installed capacity of 173 GW with age less than 25 years as on September 2021. However, 53% of this capacity (~92 GW) is running on an average PLF below 60%.
- This indicates underutilization of new coal power plants and further adding to the rising number of non-performing assets in the sector.
- With ~31 GW of under-construction capacity likely to be commissioned and 53% of the capacity age < 25 years running below 60% PLF indicates the need to utilise existing capacity efficiently and plan no further setting up of coal power plants. These plants need to evaluated to meet non-base load and peaking capacity and hence provide more flexibility to the system.

2.1.11 Policy Incentive Mechanism to decommission coal power plants

In the light of the above sections, it is very clear that coal power plants by and large have been under-performing in recent times, with the average PLF of coal power plants being in the region of under 60% in the last 5 years. Further, close to 87.41 GW of coal fired power plant units have a PLF of under 50% due to a wide range of reasons.

Despite this fact, these plants continue to operate due to lack of appropriate policy framework to incentivise decommissioning of such underperforming units. Such a policy framework would also help in reducing the portfolio of "non-performing assets" of Banks, which have given project funding to coal plants and reduce the number of stranded assets.

Such a policy framework, would help in leveraging existing transmission infrastructure for RE deployment. This would also avoid complications arising out of land acquisition for greenfield RE projects. Further, it would also help in cleaning up the air quality index in those regions and would be in line with the announcement made by the finance minister in her budget speech of 2020 on the issue.

Overall, the energy transition for big states like Maharashtra, Uttar Pradesh, Chhattisgarh and Madhya Pradesh with huge latent electricity demand and high percentage share of thermal power assets will play a crucial role in carving the path for India's clean energy ambition in the coming decade. Reassuringly, states like Gujarat, Maharashtra, Chhattisgarh, and Karnataka have almost no coal power plant under construction until next 3-4 years. Recently, they have also committed to no new coal capacity. Concurrently, Gujarat, Maharashtra and Karnataka are in the top 5 states with highest RE pipeline capacity.

As States have shown trends to shift to RE based generation, it will be important to cater to the rising electricity demand from RE and evaluate the need for pipeline capacity of coal that can be used to replace the old and high emitting power plants.

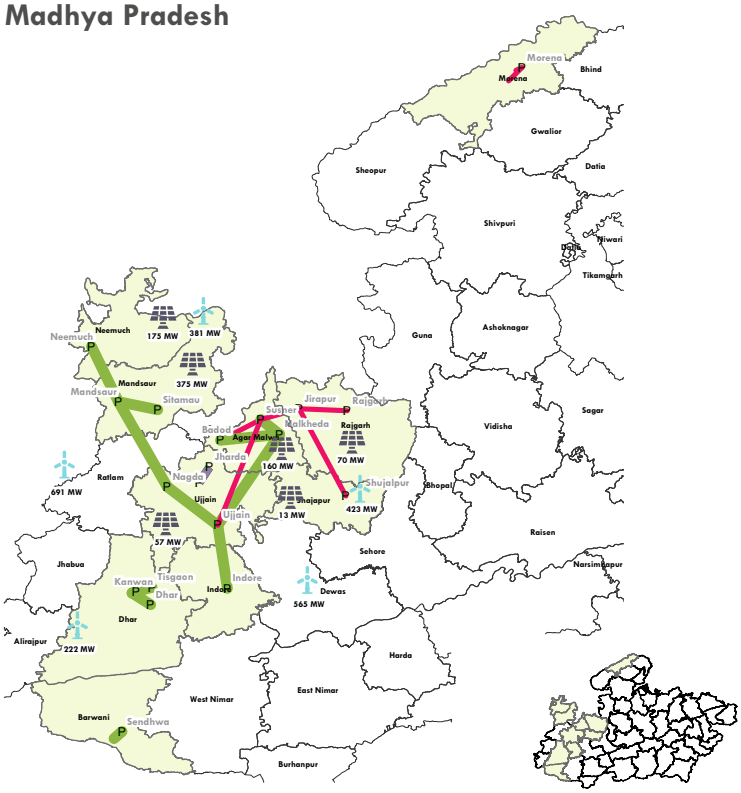
2.2 Transmission

ntra state transmission projects called 'Green Energy corridor' were sanctioned by GOI for evacuation of renewable energy in RE rich states. The transmission line progress in CKM as of March 2021 in RE rich states are depicted here.

Green Energy Corridor Transmission Systems

Transmission lines progress

Madhya Pradesh

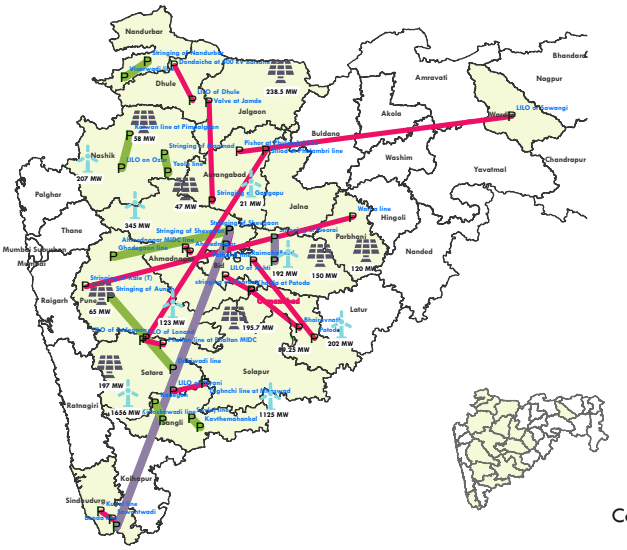


Karnataka

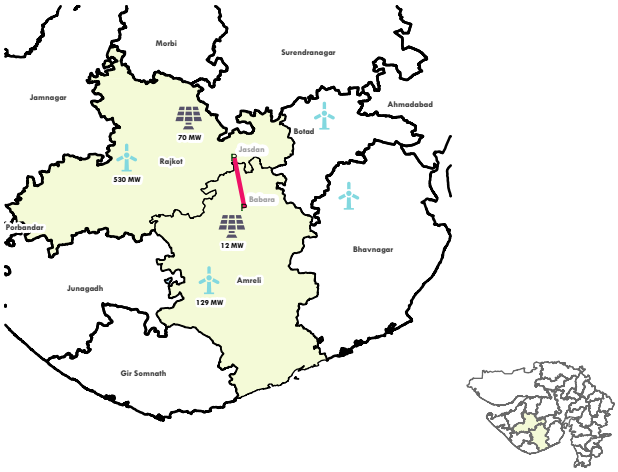
Green Energy Corridor Transmission Systems

Transmission lines progress

Maharashtra



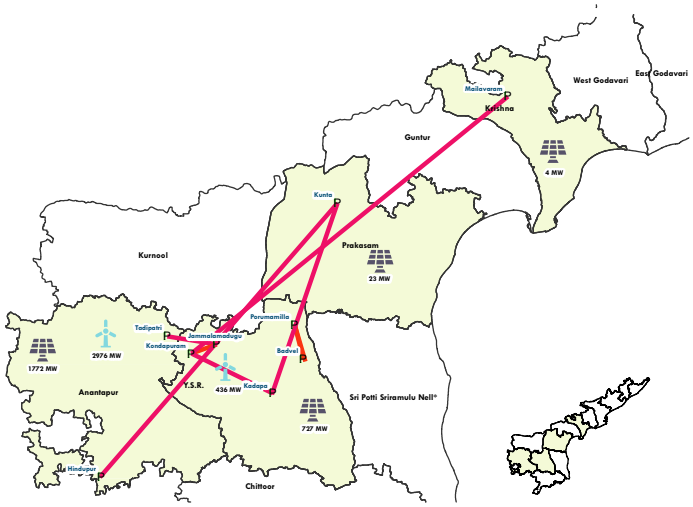
Gujarat



Completion/Progress

- 0 %
- Upto 50%
- Upto 75%
- Upto 100%
- Districts under GECTS

Andhra Pradesh



Rajasthan

On the overall transmission infrastructure, the target Vs achievements, CKM during April to September 2021 are as below-

Description	Central Sector	State Sector	JV/Private Sector	Grand Total
Programme	3259	9885	1609	14753
Achievement	2734	3366	486	6586

As can be seen from the table above, the expansion of the transmission network continues to be in line with the set target, however, the green transmission corridor seems to be lagging behind.

2.3 Distribution

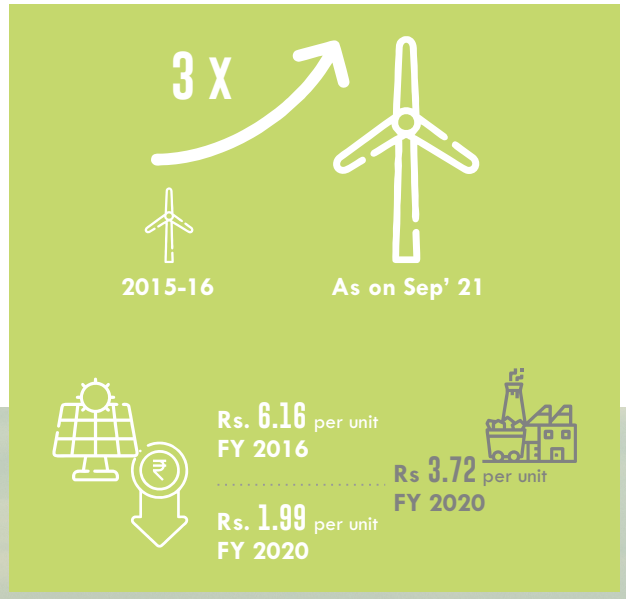
2.3.1 Power Purchase Portfolio Trends of States/DISCOMs

The renewable energy sector has seen rapid strides over the last five years. The total installed capacity of renewable energy (RES) as on September 2021 was 101.53 GW, recording close to a 3X rise in its installed capacity from 36 GW in 2015-16. Along with the increase in installed capacity, the cost of renewable energy generation has also become more competitive when compared with coal, oil and gas. From a cost of Rs. 6.16 per kWh being the weighted average of the highest bid for solar in 2015-16, its cost has come down to Rs. 1.99/kwh recently in 2020. Similarly, the price of wind generation has also reduced from Rs.6.58 (highest bid) of 2015-16 to Rs. 2.69 as on 2019-20. On the other hand, the average price of coal as on 2019-20 was Rs. 3.72 per kWh.

This development has led to DISCOMs having more options of power procurement sources and are also now in a situation where then can opt for more economical renewable energy option as opposed to the fossil fuel power options.

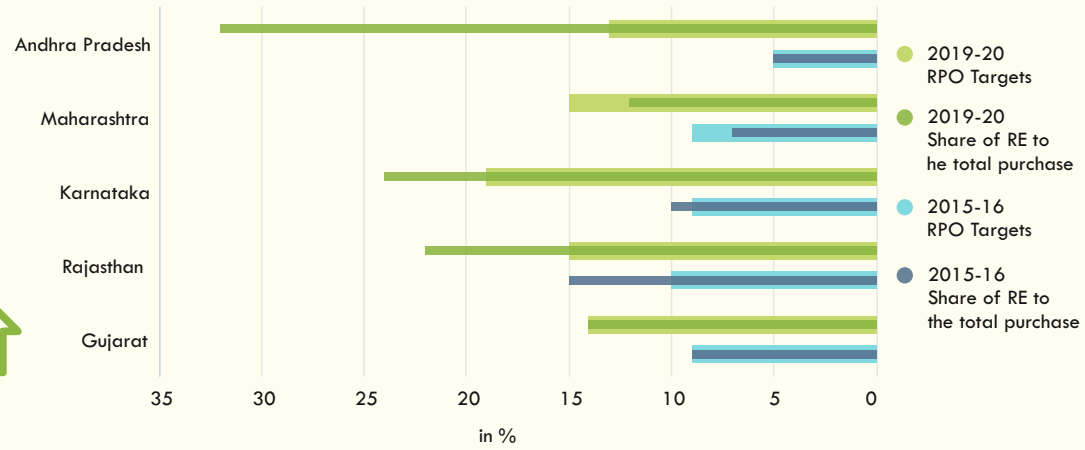
However, one factor that perhaps come in the way of DISCOMs to opt for more power purchase from renewable energy is that they are bound by long term coal-based power purchase agreements.

Notwithstanding the above, declining prices of renewable energy coupled with increased capacities, a number of distribution utilities (DISCOMs)/states have dramatically increased the share of purchase of electricity from renewable energy sources in 2019-20 as compared to 2015-16.



As can be seen from the graph below,

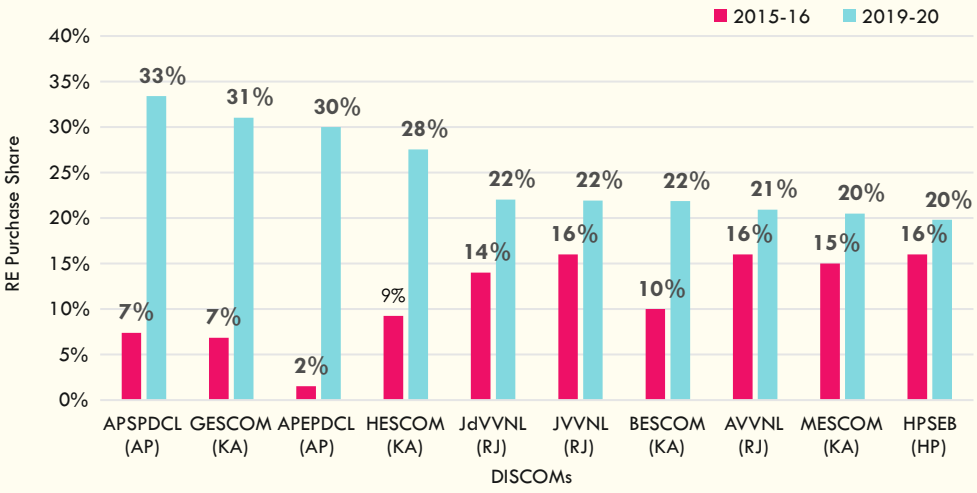
Top States Increasing Power Purchase from RE



- Andhra Pradesh showcases more than six times increase in its share of RE purchase in 2019-20.
- Karnataka increased its RE share from 10% in 2015-16 to 24% in 2019-20; Gujarat increased its share of RE from 9% in 2015-16 to 14% in 2019-20; Rajasthan from 15% to 22%; and Maharashtra from 7% to 12%.
- Further, three of the above states, namely, Karnataka, Andhra Pradesh and Rajasthan have not only complied with the National RPO target of 21% by 2022, but have even surpassed it.

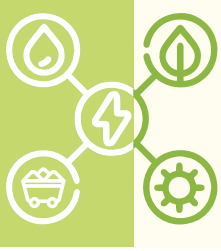
At a DISCOM level, the top performing ones with respect to increasing share of renewable energy in their electricity purchase portfolio over the last five years can be seen from the figure below.

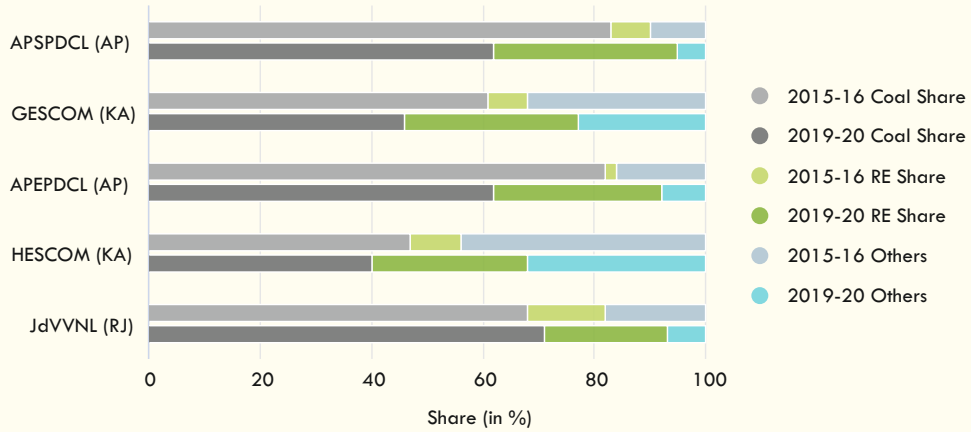
Top 10 DISCOMs with Maximum RE Power Purchase Share



The figure below gives an overview of how RE rich DISCOMs have shown a considerable decline in coal power purchase indicating the preference of RE over coal and not just for meeting the incremental demand opportunity for their consumers.

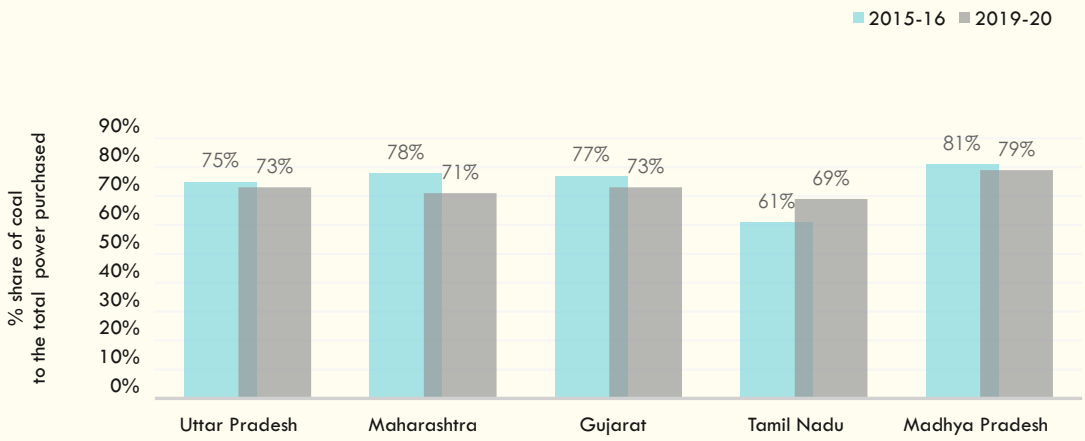
Change in Share of RE for Top 5 RE DISCOMs FY2016 vs FY2020





However, it should be noted that most states that even have a dominant share of coal power in their electricity purchase portfolio, have also shown a decline in the share of electricity from coal to total purchase in 2019-20 from 2015-16, as can be seen from the graph below-

Top States with Maximum Power Purchase from Coal

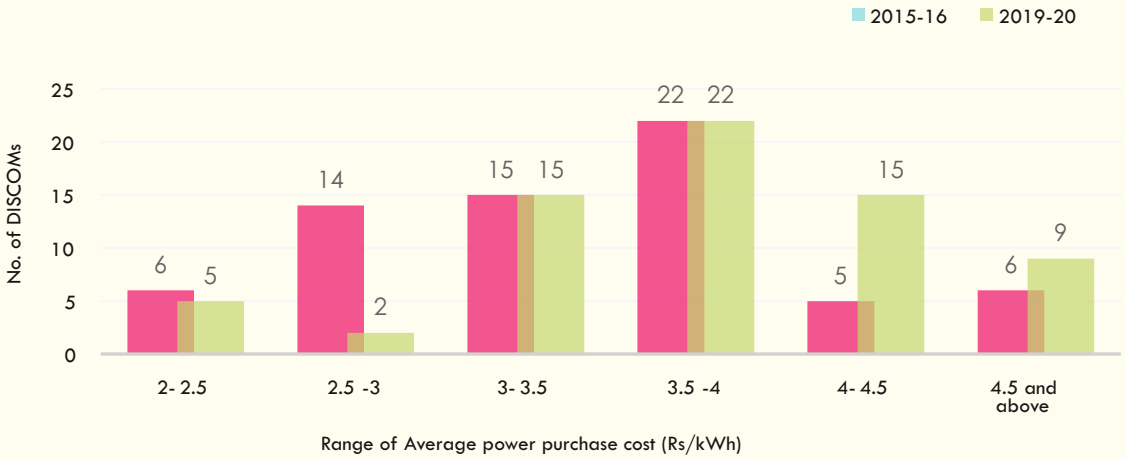


2.3.2 Power purchase cost trends at State/DISCOM level

Power purchase cost is the most important component of expenditure incurred by DISCOM. Higher the cost of purchase would impact the average cost of supply and would also have a bearing on the tariff structure of electricity sold to consumers. The high cost of supply often leads to a situation of revenue gap, since, the tariff structures may not be changed at regular intervals.

A recent paper released by the Forum of Regulators (May 2021), based on data from 12 states observed that the power purchase cost was the largest contributor to average cost of supply of DISCOMs, with coal cost being the major contributor to power cost.

APPC Range for DISCOMs



- A quick analysis of the Average Power Purchase Cost (APPC) across all the DISCOMs in India, has revealed that close to 22 DISCOMs had an average power purchase cost in the region of Rs. 3.5-Rs.4.0 per kWh.
- However, due to higher cost of supply in recent years, out of the 14 DISCOMs with an APPC between Rs. 2.5 to Rs. 3.00 per kWh in 2015-16, only two DISCOMs continued to maintain the same level of average power purchase price in 2019-20. While on the other hand, five DISCOMs which had APPC of Rs. 4.00 –Rs. 4.50 per kWh has now increased to 15 DISCOMs.
- In short, it can be seen that the APPC has been generally on the rise from 2015-16 as compared to 2019-20 in the case of most DISCOMs.
- As mentioned earlier, one of the main reasons for this, is that most DISCOMs are bound by long term coal power purchase agreements and with the rising prices of electricity from coal, DISCOMs have no option but continue to buy the costlier coal power, on account of the long-term power purchase agreements.
- While a few DISCOMs have already shown the trend of increasing share of renewable energy in their power purchase portfolio, it needs to scale up to include many more DISCOMs in order to bring down its average power purchase cost. A move towards this while reducing its cost burden, will also help in reducing consumer tariffs, while also giving a boost to investments in renewable energy systems and help India to achieve its 450 GW target by 2030.

2.3.3 Financial Health of DISCOMs - T&D Loss Trends

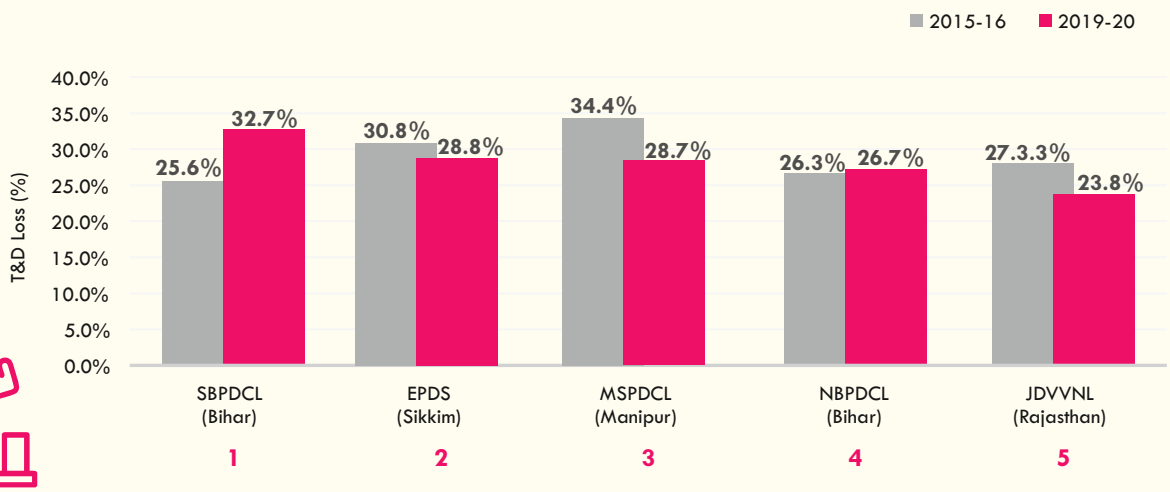
India's T&D losses is currently 20.66 % which is more than double of the world average of T&D 8.1% and over 5 times over the global best loss percentage of 4.3% (Germany).

However, the silver lining is that India's T&D Losses has shown a decline from a level of 22.27% in 2014-15 to 20.66% in 2019-20.

High T&D Losses are amongst the main contributor to poor financial health of DISCOMs, in addition to other contributors. A quick analysis of six DISCOMs have revealed that even a one percentage point increase in T&D losses could result in an increase in costs in the region of Rs. 200 to Rs. 400 Crores[5].

As can be seen from the graph below, the T&D losses of DISCOMS of Bihar (SBPDCL and NBPDCL) has increased in 2019-20 as compared to the loss level in 2015-16 and are in the region of 25% to 30% approximately.

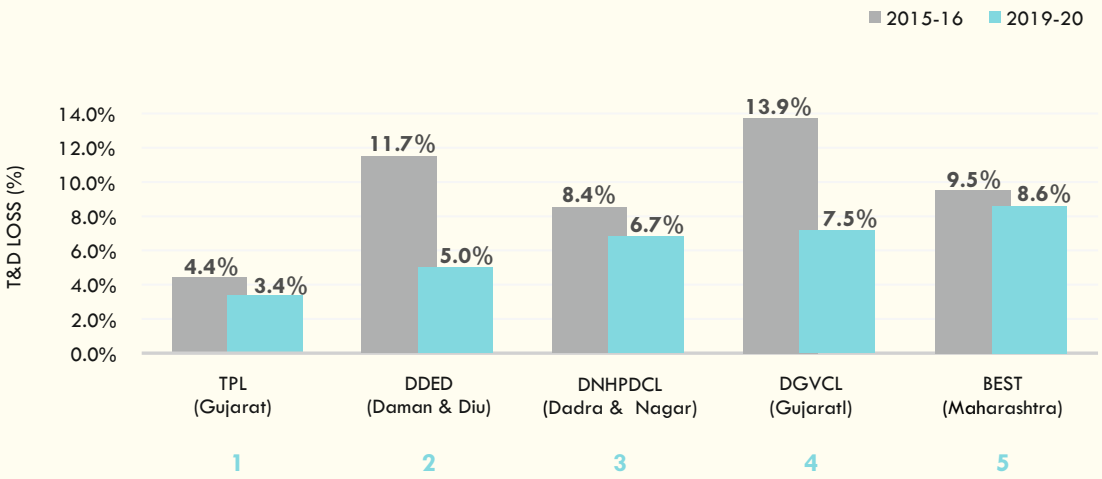
Top 5 DISCOMs with high T&D Losses in %



The T&D losses continue to be stubbornly high, largely due to the poor financial health of DISCOMs, resulting in their inability to upgrade and modernize their distribution infrastructure, such as transformers, sub-stations etc.

There are clearly lessons for such DISCOMs to learn from their counterparts in a few other states. States and particularly DISCOMs of Gujarat have clearly shown the trend of reducing T&D losses and are more or less at par with the Global loss standards and in some cases almost on par with the global best loss standards, as can be seen from the figure below-

Top 5 DISCOMs with low T&D Losses in %



Some practices followed by these DISCOMs that needs to be emulated by others include, smart metering, 100% meter coverage, efficient and electronic billing system, feeder segregation amongst others.

[5]The Hindu. (2019, February 27). Article. Retrieved from https://bit.ly/2U0Tpvk

2.4 Consumption

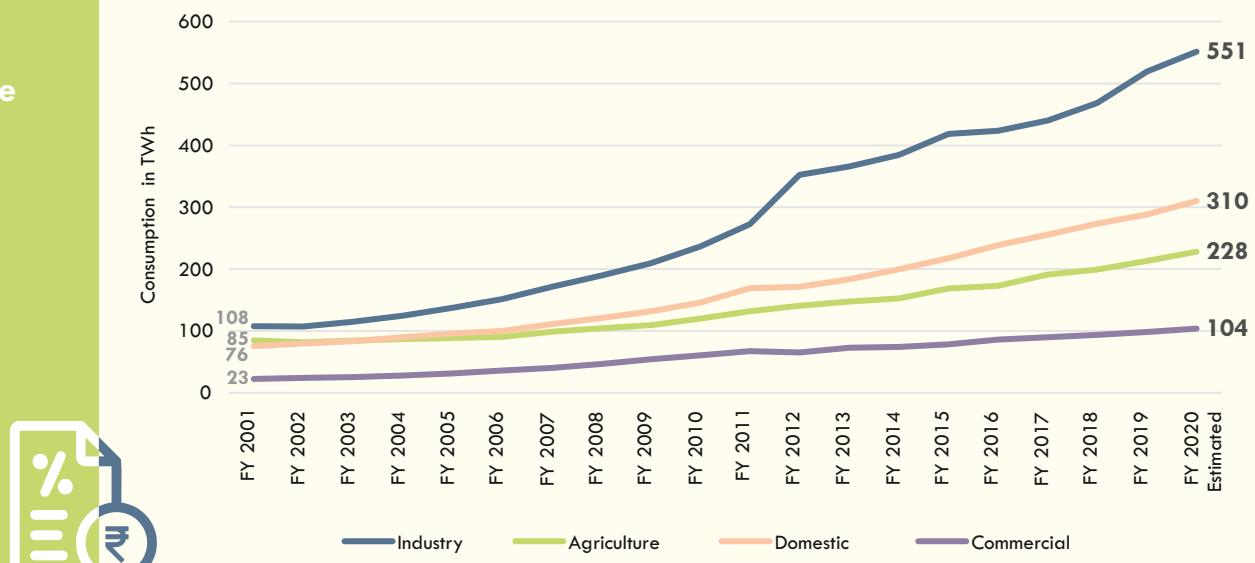
2.4.1 Electricity Consumption Trends in India

While India is the third largest consumer of electricity in the World, it ranks in the sub 100 category in terms of its per-capita electricity consumption. India's per capita electricity consumption as on 2020 is 1208 kWh, while the global average is 2500 kWh. However, India's per-capita consumption has grown at a CAGR of 4 % over last 10 years, while its gross electricity consumption growth is at a CAGR of 7.7% over the last 20 years.

As can be seen from the graph below, the consumer category that has the highest growth rate with a CAGR of 8.98 % is the industrial consumer, followed by the commercial consumer at a CAGR of 8.37%. Domestic consumers at 7.71% and the agriculture consumers at 5.35% are the other categories.

The major growth in consumption, particularly for the industrial and domestic consumer segment has been in the last 10 years. This could largely be due to factors such as rising population, increase in urbanization rate, rapid increase of village and household electrification, rapid industrialization etc.

Consumer Category wise Consumption Trend

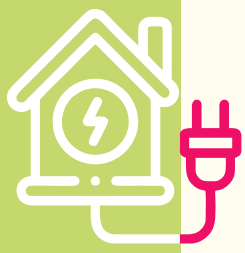


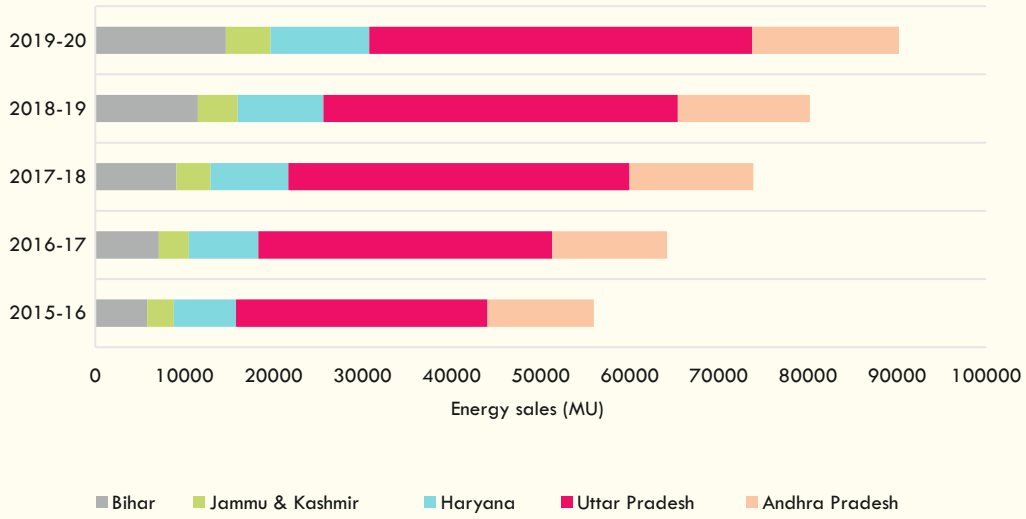
Understanding of the past and current trends of electricity consumption by various consumer categories at a state/DISCOMs level would help to assess possible future growth trends and further help India to set further targets for Renewable Energy and develop a pathway for decarbonizing its power sector. This understanding could also help in assessing the growth in consumption due to various flagship programmes of Government of India, such as "24 x 7 power for all" "Make in India"and also give trends of possible growth in electricity consumption due to newer programmes such as "Atmanirbhar India" "30% e-mobility by 2030" amongst others. Further, the growth trends, would also help in projecting future demand requirements and further assess the role for demand side management programmes and other energy efficiency measures to optimize the future demand requirements and meet it efficiently.

2.4.2 Deep Dive in the Consumption trends of various consumer categories at a State/DISCOM Level

At an all-India level, the electricity consumption by domestic consumers has increased 4 times in the last 20 years, from a total consumption of 75 TWh in the year 2001 to 310 TWh in the year 2020. Increase in access to electricity from 55% in 2001 to 99.99% in 2020 has been the major reason for this rapid increase in domestic consumers.

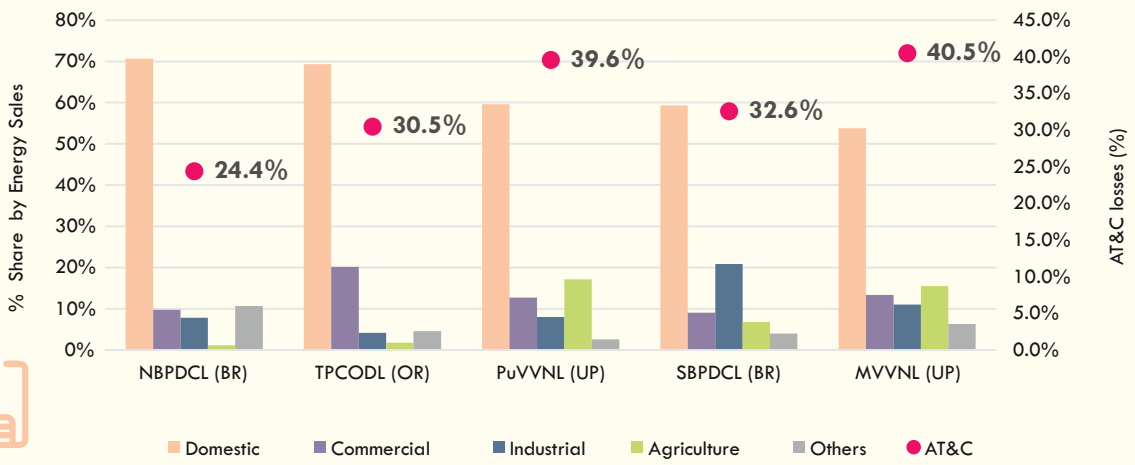
Top 5 states with highest growth in domestic sector energy sales





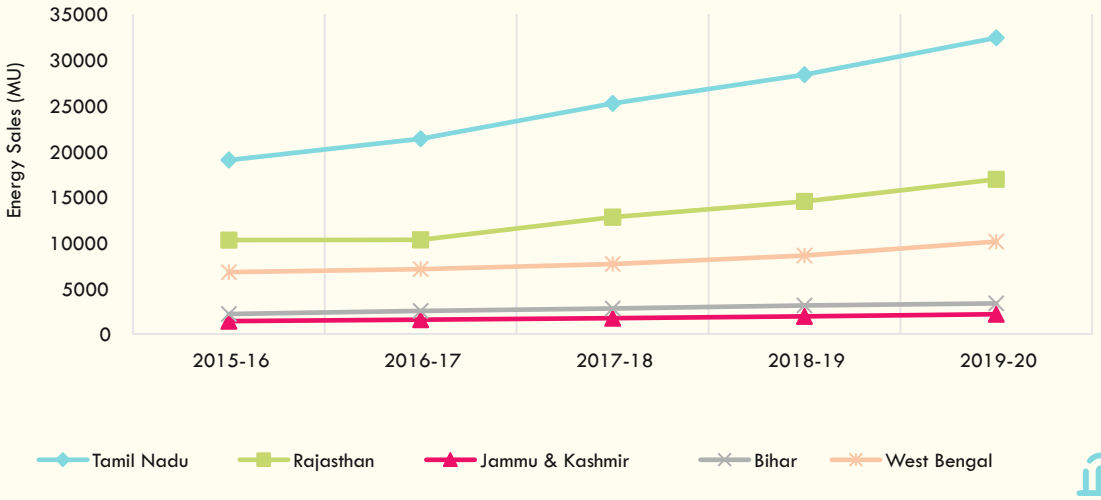
- The states that have seen the highest growth rate of domestic electricity consumption over the last five years (2015-16 to 2019-2020) are Bihar, Uttar Pradesh, Haryana, Andhra Pradesh and Jammu and Kashmir.
- In the case of Bihar and Uttar Pradesh, the reason for the rather steep growth in domestic electricity consumption may be attributed to the penetration of the "Saubhagya Scheme" which has resulted in a substantial improvement of electrification in rural villages and households of Bihar and Uttar Pradesh. As per the Power for All report of Bihar, there were about 1.57 crore un-electrified households in rural areas and 3.06 lakh un-electrified households in urban areas as on March 2015. Similarly, in UP, as on March 2015, there were about 1.09 crore un-electrified households in rural areas and 0.15 crore un-electrified households in urban areas in the state.
- In the case of Haryana and Jammu Kashmir, the growth in domestic consumption has been steady, which perhaps indicates, the completion of household electrification projects. This could also be the case with Andhra Pradesh, with a slight difference. The difference being that with the state bifurcation in 2014, the Government of new Andhra Pradesh at that point in time had focused on developing small towns and villages and also on development of new capital. Further, this necessitated a shift of bureaucracy and other official machinery from Hyderabad (Telangana) to Andhra Pradesh. This perhaps has contributed to the higher domestic demand.

DISCOMs with Dominant Domestic Consumers



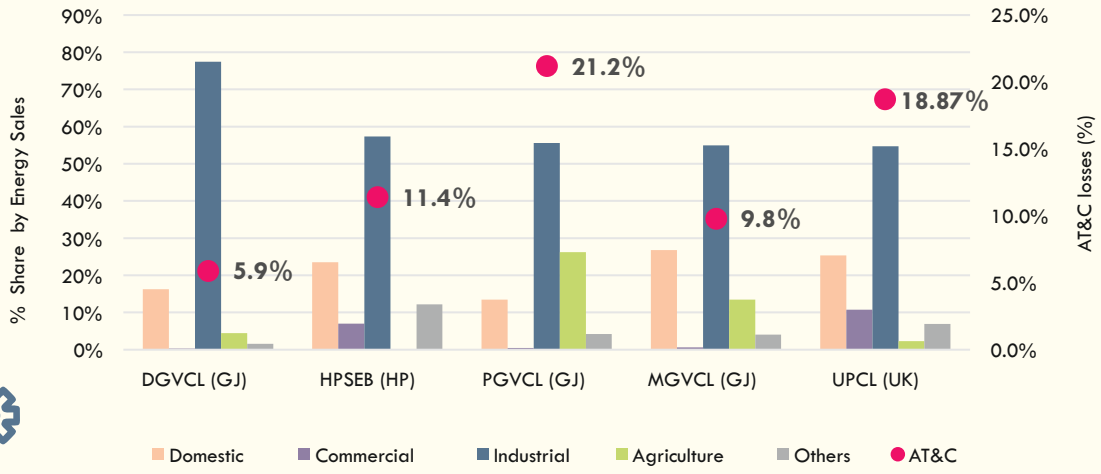
- The above trends can also be seen in the trends of the DISCOMs that have a dominant domestic category of consumers, namely, the DISCOMs of Bihar and Uttar Pradesh along with one DISCOM of Orissa.
- As can be seen from the graph above, North Bihar Power Distribution Company Ltd (NBPDCL) has a total share of 71% of domestic consumer by electricity sales as of FY2020.
- In terms of future growth trends of the Consumer category, while the states of Bihar and Uttar Pradesh could continue to see a growth in consumption, as it further strengthens and ramps up reliable supply of electricity to households, the question arises, as to what could be the new growth centres. Could it be states/DISCOMs such as Delhi, Karnataka, Maharashtra, Gujarat, due to the e-mobility push or the rising cooling demand?

Top 5 states with highest growth in industrial sector energy sales



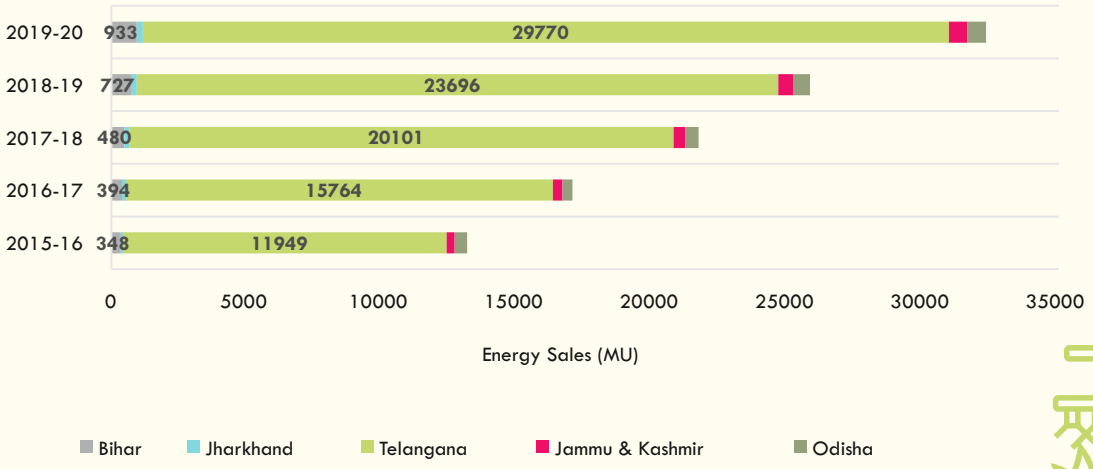
- In the industrial consumption segment, the states that have seen a fair spike in its electricity consumption are primarily Tamil Nadu and Rajasthan.
- This again is perhaps on expected lines, due to creation of new industrial and special economic zones and also incentives given to industries to set up units in the states of Tamil Nadu and Rajasthan. Further, in the case of Rajasthan, the setting up of large new renewable energy projects and resultant setting of electricity transmission infrastructure could also have contributed to the growth in industries. Tamil Nadu reported higher economic growth rate than the national average during 2019-20. Growth in economic activity, being one of the key factors in deciding the power demand of the state.

DISCOMs with dominant Industrial Consumers



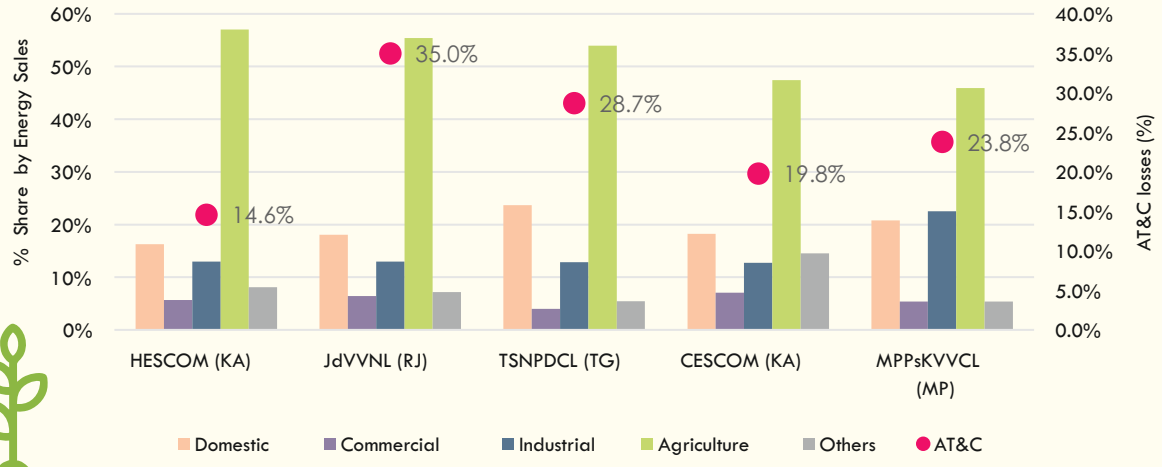
- However, despite that, the DISCOMs of Gujarat continue to harbor the largest share of industrial consumers, with DGVCL having a share of 77% of industrial consumers to its total electricity consumers, with PGVCL having a share of 56% of industrial consumers to its total electricity consumer base and MGVCL having a share of 55% of industrial consumers to its total electricity consumer base.
- While Gujarat and Tamil Nadu could still continue to see the highest industrial consumption, states that have 40% plus share of industrial electricity consumption to their total electricity consumption are Chhattisgarh, Goa, Himachal Pradesh and Uttarakhand. The question is whether, these states could continue to see high industrial activity or would there be new growth centres?

Top 5 states with highest growth in agriculture sector energy sales



- In the agriculture consumption segment, Telangana seem to have outshined all the other states in the growth of its agriculture consumer base, almost tripling its consumers between the years 2015-16 and 2019-20. Power demand has increased exponentially in Telangana after the TRS Government started providing 24x7 free power supply to the agriculture sector from January 2018 in the state. There were 19 lakh agriculture connections at the time of formation of Telangana in 2014. In the past 7 years, 5.86 lakh new connections were added. The major contributor to the growth in agriculture consumers are largely from the districts that fall under the jurisdiction of the Telangana State North Power Distribution Company Limited, and the districts that are largely agrarian in nature.
- With its many power sector reforms in the last few years, Bihar has also increased its energy sales to the agriculture sector by almost 3 times from 348 MU in 2015-16 to 933 MU in 2019-20.

DISCOMs with dominant Agricultural Consumers



The other DISCOMs that also have a large share of agricultural consumers are the Hubli Electricity Supply Company, Chamundeshwari Electricity Supply Company (Mysore), Jodhpur Vidyut Vitran Nigam Limited and Jabalpur utility which also covers predominantly areas that are rich in agriculture.

2.4.3 Consumer Tariff Trends

Rationalisation of Electricity Consumer Tariffs has been a much talked about issue, with suggestions ranging from simplification of the electricity tariff structure to providing cost-reflective tariffs. Other suggestions that have also been made in the past is to reduce the differential pricing between various category of consumers and instead introduce concepts such as time of the day tariffs and so on.

This section looks at various consumer tariff bands for the various categories of consumers across the various DISCOMs of India.

The tariff band for the various category of consumers is as below -

Domestic Consumer

Rs. 1.00 per kWh to a high of **Rs. 11.70** per kWh

Industrial Consumer

Rs. 2.60 per kWh to **Rs. 10.80** per kWh

Commercial Consumer

Rs. 1.90 per kWh to **Rs. 18.40** per kWh

Agricultural Consumer

Rs. 0.10 per kWh to **Rs. 11.30** per kWh

The following graphic presents an all India picture of the various tariffs band and average billing rate across various states/DISCOMs for the four main consumer categories.

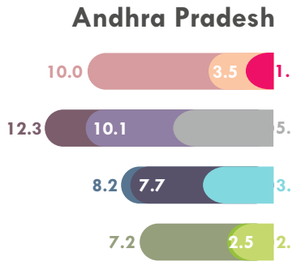
- While most states have kept the domestic electricity tariff levels at the lowest consumption band in the range of Rs. 1.00 to Rs. 2.50 per kWh, only four states namely, Assam, Nagaland, Jharkhand and Bihar have the lowest tariff for domestic consumer at above Rs. 4.00 per kWh.
- In contrast, while most states have the lowest tariff band for commercial consumer in the range of Rs. 4.50 per kWh to Rs.7.80 per kWh, Kerala has the lowest tariff band for commercial consumer which is almost on par with its domestic consumer at Rs. 1.90 per kWh.
- The state that has the lowest tariff for the first band of consumption for industrial consumers is Gujarat at Rs. 2.60 per kWh, while it is Rs. 8.10 in Uttar Pradesh.
- Interestingly, Punjab has the highest tariff rate for the agriculture consumer at Rs. 5.70 per kWh.

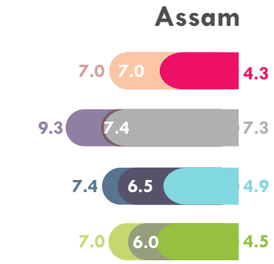
What seems to come out from the tariff structure that it is indeed a large band which could be narrowed with rationalization in terms of reducing the differential between consumer categories and also in term of simplifying the tariffs, however, factoring in the social and economic fabric of various states and its requirements.

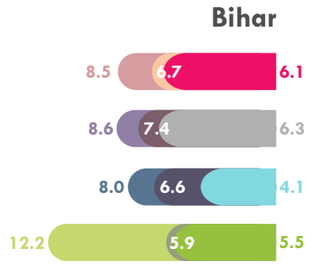
Statewise Retail Tariffs

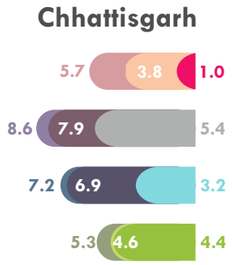
2019-20

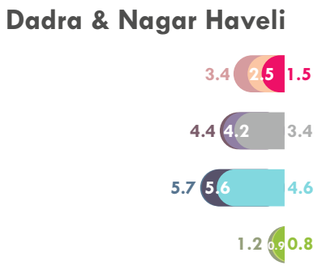
Average Billing Rate
(Rs/KWh)

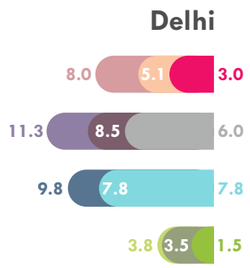


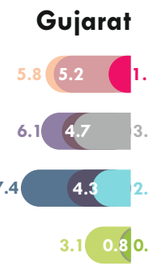


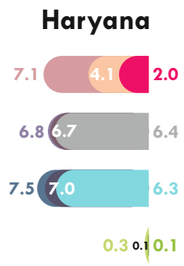


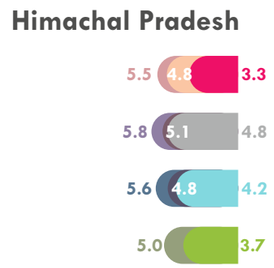


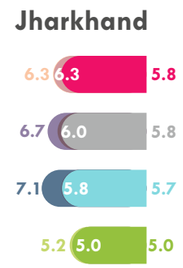


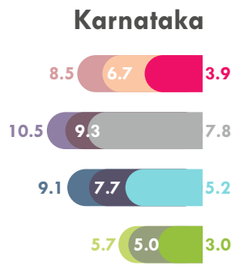


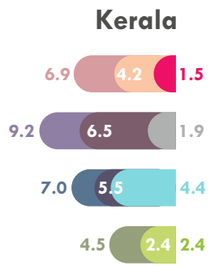


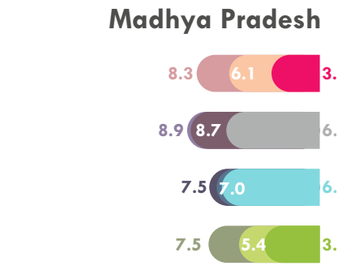


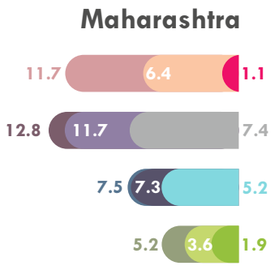


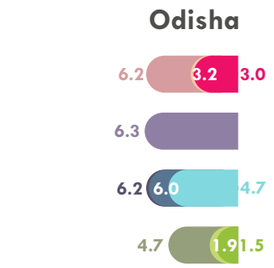


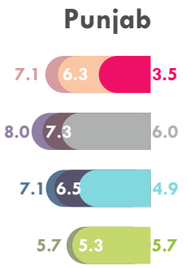


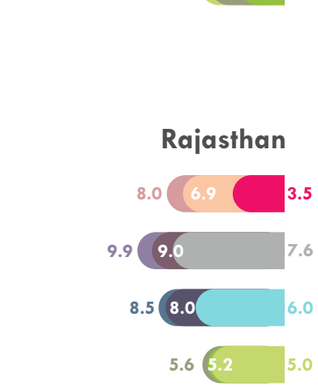


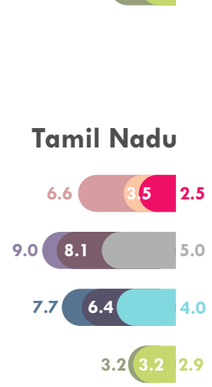


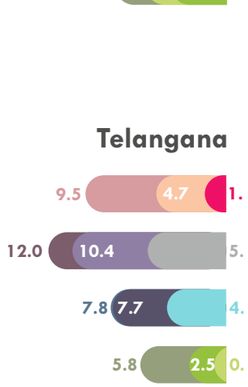


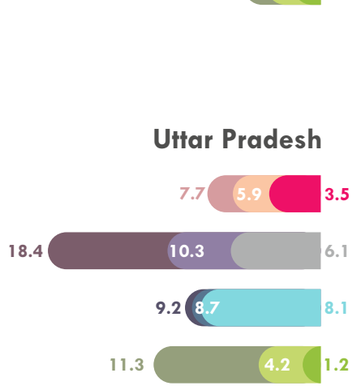


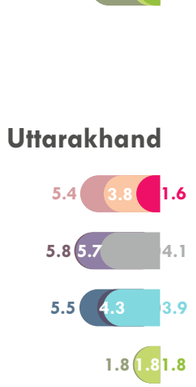


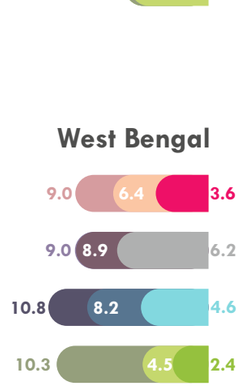


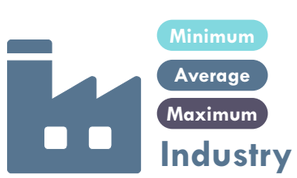












Conclusion

There is huge potential for states to achieve the desired levels of efficiency in decarbonizing their power sector. However, there is a need to re-look at state level potential, demographics, socio-political economy, challenges and opportunities to fast track our clean energy ambition. For any meaningful transition, the Central and State Governments goals and visions need to be better aligned and well-coordinated. The central Government needs to guide states to carve their own visions of development, in a way that further reverberates with goals of climate change mitigation.

Unless clean energy finds its way across the state value chain, distribution companies come to the forefront, and key state-level entities act as facilitators; national clean energy and sustainable development ambitions will not be met. It is time that the state-level actors acknowledge current trends - rising number of distributed generation assets, accelerated technological developments, shifting consumer preferences, demand side developments (on-site generation, super-efficient equipment, etc.), disruptive business models, and a rapidly evolving fuel market – and undertake strategic actions to transform themselves into entities that can deliver the services in the emerging scenario.

Image Courtesy - GEDA, Climate Change Department, Government of Gujarat

KEY INSIGHTS

that emerge from the series

A

Not all states are at the same level of decarbonizing. While the southern states have done aggressive RE in the last few years, the western region continues to build it RE capacity further to support its large industrial demand. For the northern and eastern region, it is still a long way to realize its clean energy targets, with conflicting goals to provide energy access and assure just transition.

B

For India to achieve its ambitious targets, a bottom-up planning involving states and sub-national actors is ineliminable. This would further ensure pooling of resources and expertise to provide realistic, time-bound and actionable solutions towards decarbonizing the power sector.

C

Careful assessment of the various systemic, technology and economic related benefits and challenges of renewable power vs coal-based capacities needs to be done for drawing a roadmap to achieve any of the new or older targets.

D

Involvement of consumers to understand demand patterns and better communication will help in faster penetration of clean energy.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*Wherever required, data and information has been taken from Vasudha Power Info Hub - www.vasudhapower.in

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