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Uttar Pradesh: A State Critical for India's Energy Transition

Playing Catch-Up on Solar

Executive Summary

Uttar Pradesh (UP) has seen strong growth in power demand in the past decade and now accounts for a tenth of the country's total power requirements. However, the state's renewable energy (RE) capacity has grown at a snail's pace and as a result, UP has fallen behind other large state electricity markets in terms of delivering on RE targets.

UP now needs to ramp up RE installations to not only meet its own RE targets but also to avoid holding back India's performance on its targets of 175 gigawatts (GW) of RE capacity by 2022 and 500GW of non-fossil fuel capacity by 2030.

The key findings of this report are:

- As of October 2021, UP achieved 30% of its capacity commissioning target of 14.1GW by 2022. That was the lowest among the top six power demand states which account for half of India's electricity requirement.

- UP will meet the majority of its future electricity demand growth with solar, *if* it meets its solar targets. By FY2029/30, the state's electricity production is estimated to grow by 47 terawatt hours (TWh) and about 88% of this will come from solar if the state achieves its 23.5GW by 2030 target. UP would need to add about 2.5GW solar every year on average to hit this target. However, cancellation of RE power purchase agreements (PPAs) in recent years threaten to derail the progress

Uttar Pradesh will meet the majority of its future electricity demand growth with solar, if it meets its solar targets.

- Meeting its 2030 solar target will allow UP to avoid locking in resources to build new coal plants beyond those under construction. The plant load factor (PLF) of UP's 23.7GW coal fleet is already falling, having dropped from 68%

to 61% in the last five years. While coal-fired power may have been necessary to meet the state's growing power demand in the last decade, heavy reliance on coal now leaves its power system vulnerable to any disruptions, even those caused outside the state. Coal shortages in India in October 2021 forced UP to purchase very expensive power at Rs22/kWh in the open market.

Improving the financial and operational performances of UP's distribution companies (Discoms) is the key to transforming UP's electricity sector. Extraordinarily high AT&C losses of above 30% and high-power purchase costs continue to worsen the financial position of the Discoms.

In this report, we make a number of recommendations for improving the UP discoms' financial situation:

- Discoms could rationalise power purchase costs by retiring old coal-fired power plants and replacing expensive thermal power with cheaper renewable power. Further, promoting distributed solar energy could help discoms avoid grid losses.

- Discoms need to unshackle themselves from expensive, long-term thermal power purchase agreements (PPAs). Discoms can better manage peak demand and grid variability from RE penetration by procuring power from day-ahead, term-ahead and real-time markets in open market platforms such as power exchanges or short-term bilateral contracts.

- Discoms should invest in technology and modernisation of the grid. Installation of 1.1 million smart meters and a reduction in open access wheeling charges are progressive steps to turn around Discoms' weak performance.

- Discoms can reduce their subsidy burden further by reducing cross subsidies and improving targeting of subsidies through direct benefit transfers (DBT).

Table of Contents

Introduction: Current State of India's Clean Electricity Transition

India's electricity sector is on a transitory path with about 103GW of variable renewable energy capacity on its grid, as of October 2021.[1] Following the Paris Climate Agreement of 2015, India's renewable energy sector gained unprecedented momentum. The global deflation in renewable energy costs, innovative financing structures and the Government of India's objective to build 450GW of renewable energy capacity by 2030[2] were the key driving factors for a significant uptake in capacity commissioning. At COP26, India doubled down on this target by announcing a target of 500GW non-fossil fuel capacity by 2030,[3] which presumably includes 450GW of RE capacity.

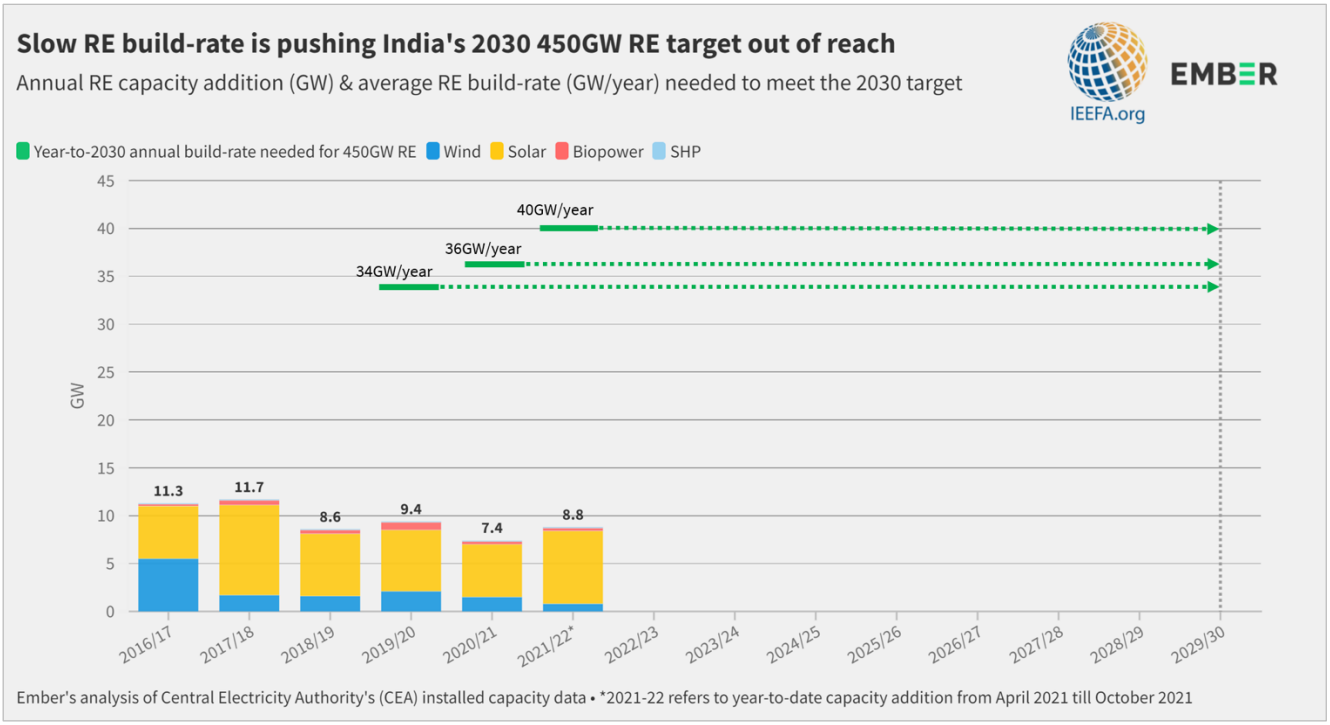
India's clean electricity transition has begun but is falling behind on its renewable energy (RE) capacity targets. India has added about 9.7GW of RE capacity on average every year since FY2016/17. However, the annual build rate needed to meet its 2030 RE capacity target is increasing every year. When the Central Electricity Authority (CEA) made the projection of 450GW of RE capacity by 2030 in its Optimal Generation Capacity Mix (OGCM), published in FY2019/20, India needed to build about 34GW of RE every year on average to meet the 2030 target. Slow progress in the subsequent years means that the build rate needed from FY2021/22 has gone up to 40GW per year.

India has added about 9.7GW of RE capacity on average every year since FY2016/17. However, the annual build rate needed to meet its 2030 RE capacity target is increasing every year.

Short-term policy headwinds in the sector have slowed growth in renewable energy capacity additions in the last couple of years. A flattening of electricity demand growth in FY2019/20 exacerbated by the COVID-19 pandemic in FY2020/21 and the first quarter of FY2021/22 has materially impacted growth in capacity. As of October 2021, India had installed 48GW of solar, 40GW of wind power, 5GW of small hydro power and 10GW of biopower (which includes biomass cogeneration and waste to energy).

[1] Central Electricity Authority. Monthly Installed Capacity report - October 2021. November 2021.
[2] Central Electricity Authority. Report on Optimal Generation Capacity Mix for 2029-30. January 2020.
[3] Prime Minister's Office. National Statement by Prime Minister Shri Narendra Modi at COP26 Summit in Glasgow. November 2021.

Figure 1: India's RE Capacity Additions FY2016/17-FY2021/22 (Oct 2021) & Average RE Build Rate Needed for 450GW RE by 2030



Regulatory hurdles and policy inconsistencies are discouraging new investment and creating bottlenecks for India's RE targets. The ongoing trend of falling RE tariffs has, in recent years, created perverse incentives for Discoms to renegotiate RE PPAs. Despite the warnings issued by the Ministry of New and Renewable Energy (MNRE), Discoms in various states, including Gujarat, Tamil Nadu, Andhra Pradesh, Jharkhand, Karnataka and Uttar Pradesh, reneged on signed PPAs,[4] with regulators failing to step in to prevent these breaches of contract.[5] This introduces a major counterparty risk for power developers, especially in states where the renewable power market is not

The ongoing trend of falling RE tariffs has, in recent years, created perverse incentives for Discoms to renegotiate RE power purchase agreements.

[4] Carboncopy. India bars states from unilaterally cancelling, modifying solar PPAs. 19 September 2019.
[5] Economic Times. Bring policy paper to deal with discoms reluctance on RE PPAs: Par panel. 20 March 2021.

fully developed. Ultimately, this is holding India back in progressing towards its ambitious 175GW RE capacity by 2022 target.

While central government-backed contracts through two intermediaries – Solar Energy Corporation of India (SECI) and NTPC – managed to push RE growth in India, lack of incentives or regulatory mechanisms meant that many state Discoms have not been working in concert with the country's massive RE ambitions. The location-agnostic nature of the SECI and NTPC-backed projects incentivised the developers to locate their projects only in a handful of states with better renewable energy resources, while other states fell behind due to inconsistencies in their renewable development policies.

Moreover, many state utilities, in anticipation of a further decline in solar prices, have been reluctant to sign power sale agreements (PSAs) with SECI, which is the intermediary solar power procurer. As of February 2021, PSAs for about 19GW of solar power projects were yet to be signed. These unsigned PSAs mean that many renewable energy projects tendered by SECI remain in a limbo, having been suspended indefinitely.[6]

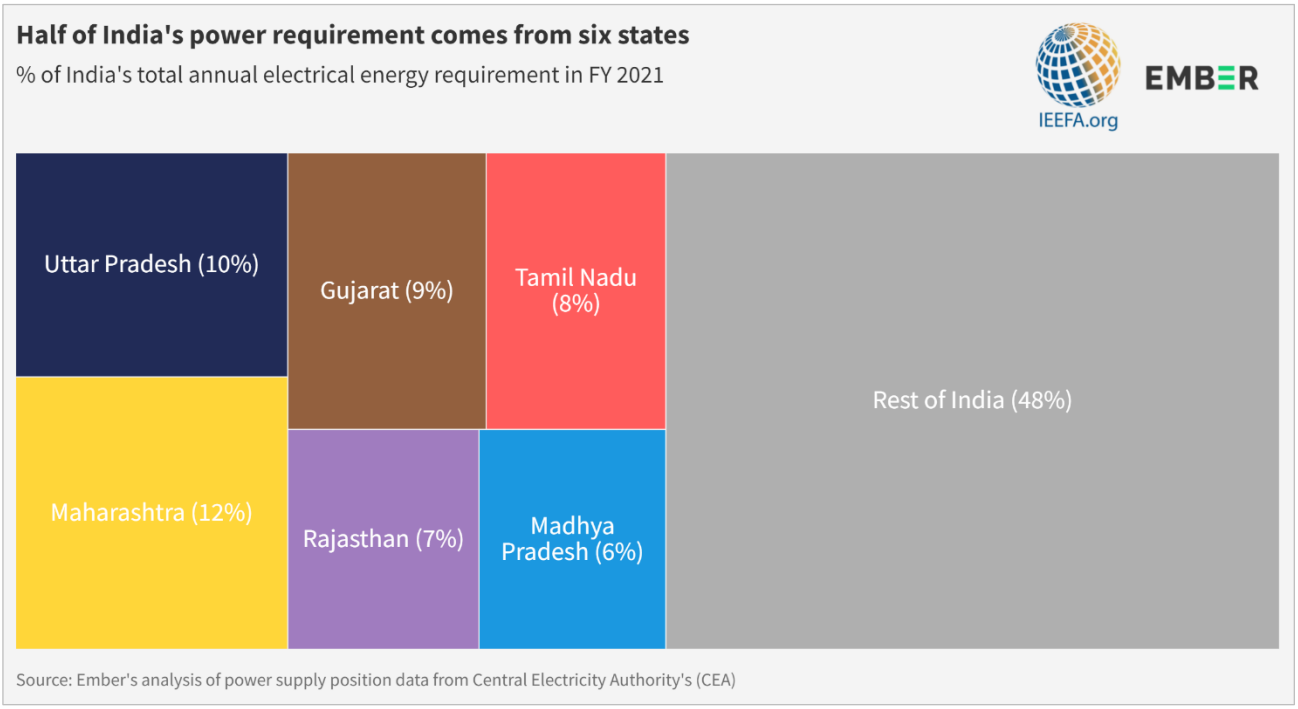
Another issue which held back India's progress towards 175GW RE capacity by 2022 is frequent delays in payment owed by the distribution companies (Discoms) to the RE generators. Poor financial health of many Discoms means that they remain a weak link for India's clean electricity transition which has created a looming threat of RE projects being declared non-performing assets.[7] Ministry of Power data shows that at the end of November 2021, Discoms owed Rs100,303 crore (US$1.3bn) (excluding disputed amounts) to renewable energy generators in overdue payments.[8]

Uttar Pradesh (UP): A State Critical for India's Decarbonisation Journey

About half of India's power requirement in FY2020/21 came from six Indian states – Maharashtra, Uttar Pradesh, Gujarat, Tamil Nadu, Rajasthan and Madhya Pradesh. UP, India's most populous state with 17% of the population, accounted for a tenth of the country's total electricity market – second only after Maharashtra (12%).

[6] IEEFA & JMK Research. India's Power Sale Agreement (PSA) Hold-Up: Fixing a Renewable Energy Bottleneck. March 2021.
[7] Down To Earth. Renewable Energy Piling Dues. November 2019.
[8] Ministry of Power. PRAAPTI Dashboard. November 2021.

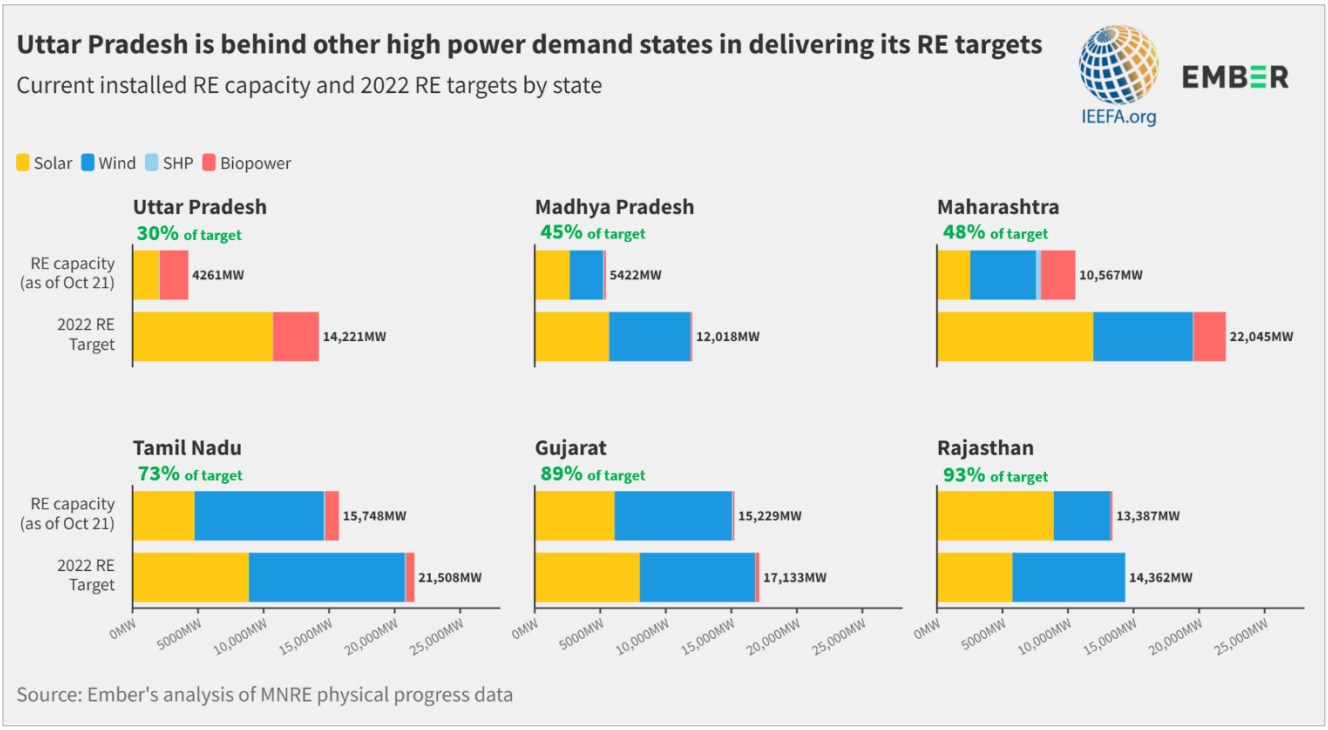
Figure 2: Large Power Consuming States in India



UP is lagging behind the other high electricity demand states in delivering on 2022 RE targets. The uptake of RE has moved at a snail's pace in UP. With only 4.3GW of RE capacity, the state is significantly off-track, with 70% of its capacity commissioning target of 14.1GW by 2022 yet to come online. This means that among the other top power demand states, UP has the most to do in the next 14 months. In terms of progress on achieving their respective 2022 RE commissioning targets, states like Gujarat (86%), Rajasthan (85%), Tamil Nadu (72%), Maharashtra (47%) and Madhya Pradesh (45%) are well ahead of UP.

UP is especially behind on its solar capacity target of 10.7GW by 2022, which is the second largest solar target among all Indian states. As of October 2021, only 19% of this target has been achieved, with UP's total installed solar capacity now standing at about 2GW.

Figure 3: Renewable Energy Capacity Targets vs Achievement in Top 6 Power Demand Indian States

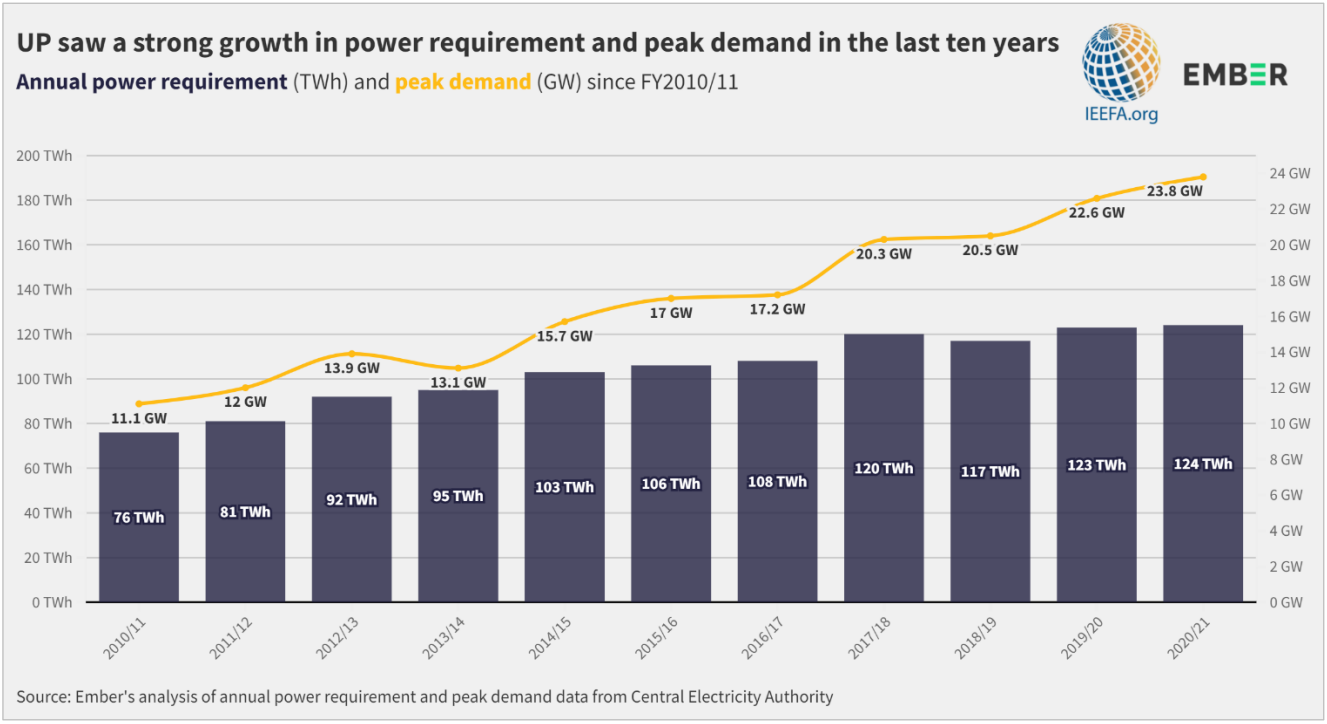


Challenge of Clean Electricity Transition in UP

In the past decade, UP has seen strong growth in both power requirement and peak demand. During this period, the state's total electricity requirement increased by 63%, from about 76TWh in FY2010/11 to 124TWh in FY2020/21. UP's annual peak demand grew even faster as it more than doubled to 23.7GW in FY2020/21, up from 11GW in FY2010/11. This meant that UP's share in all India peak demand in FY2020/21 was 12.5%.

In the past decade, Uttar Pradesh has seen strong growth in both power requirement and peak demand.

Figure 4: UP's Power Annual and Peak Demand Growth Since FY2010/11

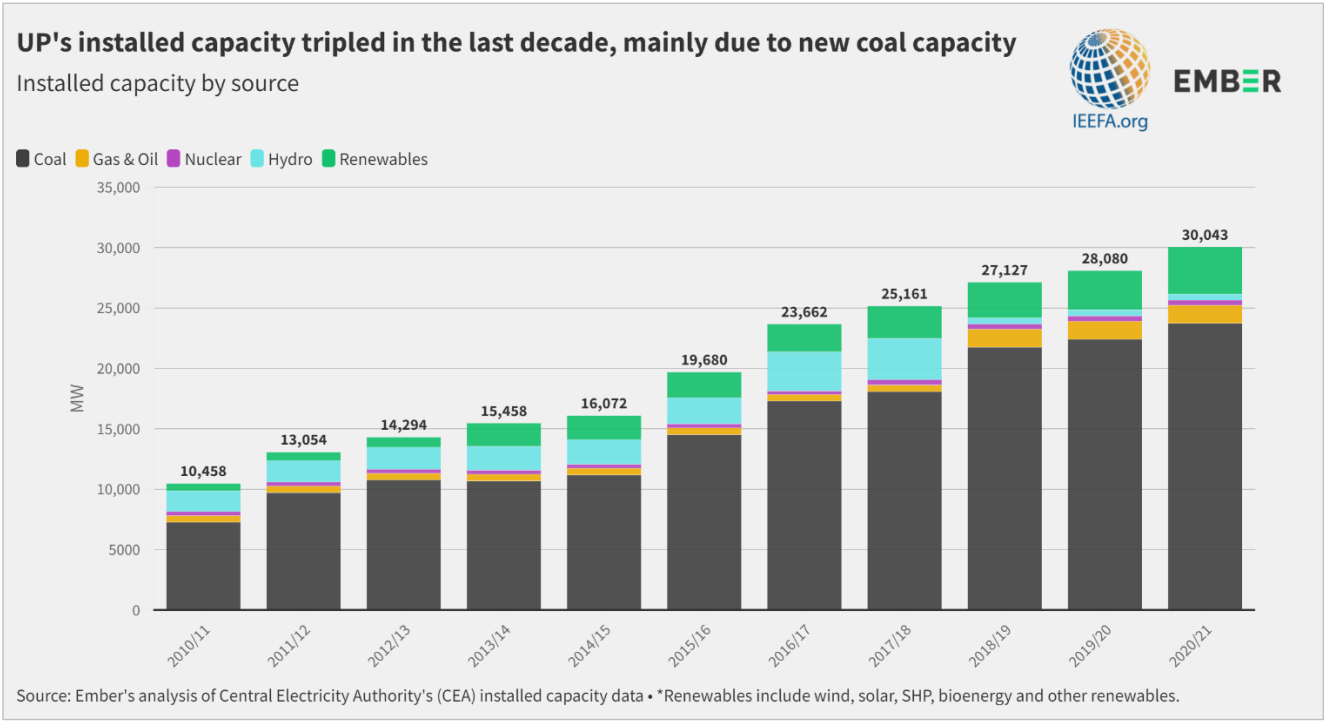


UP met its growing demand in the last decade primarily through coal capacity expansion. UP's installed capacity increased almost three-fold from about 10.5GW in FY2010/11 to 30GW by the end of FY2020/21. About 85% of this increase came from coal as the state's coal capacity increased from 7.3GW to 23.8GW in the last ten years. Of this, only 5.5GW are owned by the state (owned by Uttar Pradesh Rajya Vidyut Utpadan Nigam Limited). 11.4GW are central sector plants (owned by NTPC) while the private sector coal plants add up to 6.8GW.[9]

As such, UP's electricity sector is heavily dominated by coal-fired generation, which contributes to about 90% of its total in-state generation. Moreover, GEM data from July 2021 shows that there was an additional 7.3GW of coal-fired capacity under construction in UP, which is the highest among all the Indian states. It also has a pipeline of 3.3GW which are in pre-permit and permit stages.[10] At a time when India is transitioning to a clean electricity system, this heavy dependence on coal is leading to several challenges for UP.

[9] Central Electricity Authority of India. Monthly Generation Reports. March 2018.
[10] Global Energy Monitor Coal-fired power plant data - July 2021 update. July 2021.

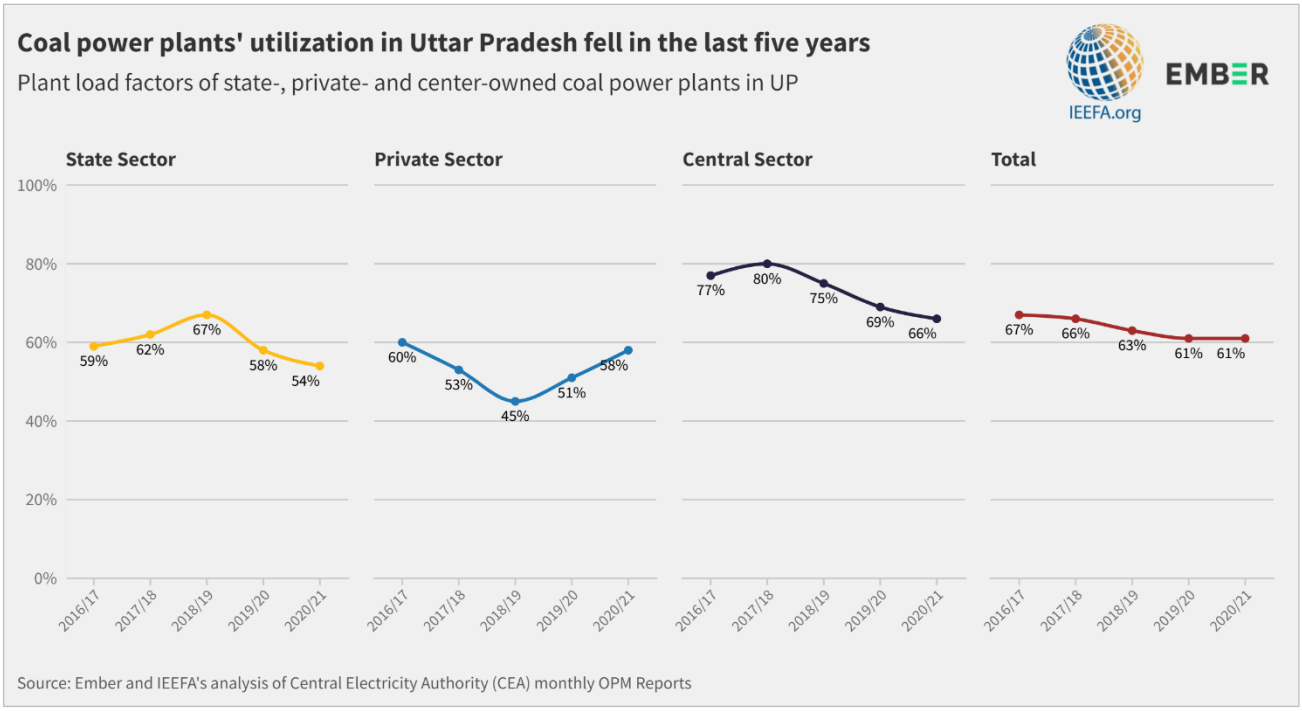
Figure 5: Growth of UP's Installed Power Capacity



Coal power plant utilization has been falling in recent years in UP. In the last five years, the state's average PLF fell from 69% to 61%. This trend broadly holds true across state-, central- and private-owned plants. The average PLF of centre-owned coal plants fell from 77% to 66% in this period. State-owned coal plants, with a PLF that was already quite low at 59% in FY2016/17, fell further to 54% by FY2020/21. Private sector coal plants did not fare any better as their average PLF of 58% in FY2020/21 was also less than in FY2016/17.

In the last five years, the state's average plant load factor fell from 69% to 61%.

Figure 6: Plant Load Factors of Coal Power Fleet in UP



The actual capacity utilization is expected to be even lower as shortages in coal and water are not factored into the PLF calculations. In FY2020/21, UP's 23.7GW coal fleet generated about 120TWh electricity. This suggests that UP utilized 58% of its coal fleet last year. The state's overall electricity market composition for FY2020/21 is summarized in Figure 7 below.

Figure 7: Uttar Pradesh Electricity Sector Composition FY2020/21

Electricity Market Composition 2020/21						
Source	Capacity		Generation		Capacity	YoY change
	GW	% of Total	TWh	% of Total	Utilisation	GW
Coal	23.7	78%	119.6	90.1%	57.5%	1.3
Gas	1.5	5%	2.5	1.9%	18.9%	0.0
Diesel	0.0	0%	0.0	0.0%	0.0%	0.0
Hydro	0.5	2%	1.6	1.2%	35.8%	0.0
Nuclear	0.4	1%	3.3	2.5%	85.2%	0.2
Renewable	4.2	14%	5.7	4.3%	15.4%	0.6
Total	**30.4**	**100%**	**132.7**	**100%**		**2.1**

Source: CEA, IEEFA estimates.

Furthermore, UP does not have in-state coal resources and must buy from neighbouring states including Jharkhand, Bihar, Madhya Pradesh and Odisha. This accounts for a material coal transportation cost as well as adding to the logistical issues of coal-fired power.

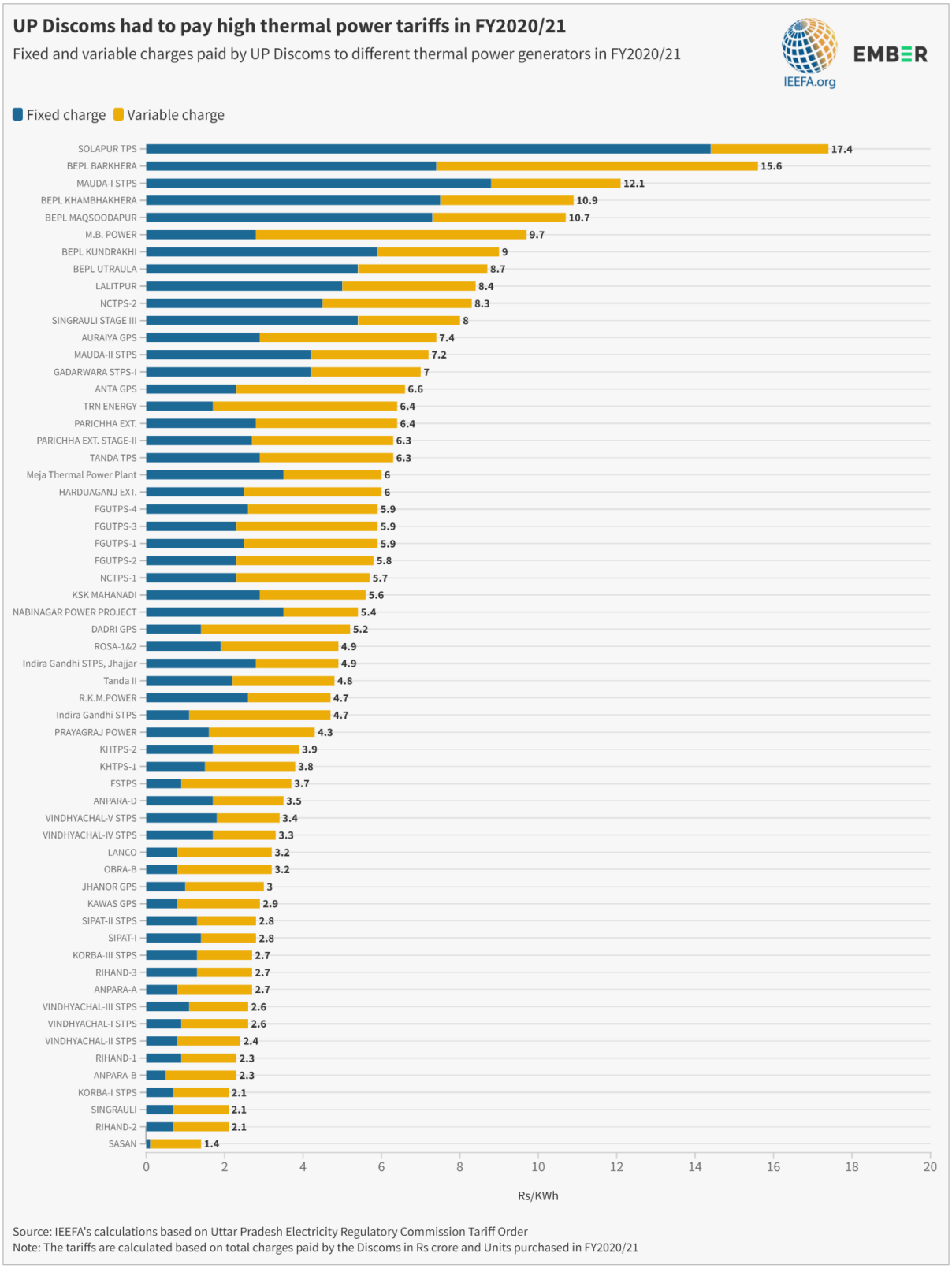
The state also has several PPAs for small amounts of capacity with very high tariff rates of more than Rs6.0/kWh. Figure-8 below shows IEEFA's estimates of thermal power tariffs in FY2020/21, calculated based on total charges paid by the Discoms to thermal power generators in the form of fixed and variable charges. Some of the total annual charges paid resulted in effective tariffs as high as Rs17.4/kWh for Solapur TPS, Rs15.6/kWh for Bajaj Energy's Barkhera plant, RS12.1/kWh for Mauda-I STPS.[11]

The average cost of power from Uttar Pradesh's coal plants (Rs4.5/kWh) is much higher than the solar tariffs of sub-Rs2.5/kWh.

The average cost of power from UP's coal plants (Rs4.5/kWh)[12] is much higher than the solar tariffs of sub-Rs2.5/kWh.

[11] UPERC. Annual Performance Review (Apr) For FY2020/21. 29 June 2021 (page 282-290).
[12] Central Electricity Authority of India. Executive Summary Report. March 2018.

Figure 8: UP Thermal Power Tariffs FY2020/21



Source: IEEFA's calculations based on Uttar Pradesh Electricity Regulatory Commission Tariff Order
Note: The tariffs are calculated based on total charges paid by the Discoms in Rs crore and Units purchased in FY2020/21

Recent country-wide coal shortages exposed the risk of heavy reliance on coal power. The 2021 global energy crisis, driven by supply shortage in energy sector commodities, led to India's power sector facing unprecedented coal shortages in October. By 10 October, roughly two thirds of India's coal-fired capacity (140GW) had critically low coal stockpiles. For UP, as a coal-dominant electricity market, it was even worse, with the CEA data showing critically low coal stockpiles in about 79% of its coal fleet (~19GW).[13]

By this time, UP's power production had already been hit and the state's supply-demand gap even touched 4GW against a peak demand which continued to be more than 20GW.[14] This led to unscheduled rostering in various parts of UP and forced the state government-owned power distribution companies (Discoms) like UPPCL to buy power from the open market on an emergency basis.[15] This meant that UP was buying electricity at a cost as high as Rs22/kWh – a price three times as much as its most expensive contracted coal power tariff.[16]

Overall, UP is in a uniquely disadvantageous position as any coal supply chain disruption – even outside the state – will result in power shortages within the state and importing power to meet the shortfall can be very expensive as the recent crisis showed. UP's power system would be able to absorb such disruptions if its power mix were more diversified, and especially if it delivered on its own solar capacity targets for 2022.

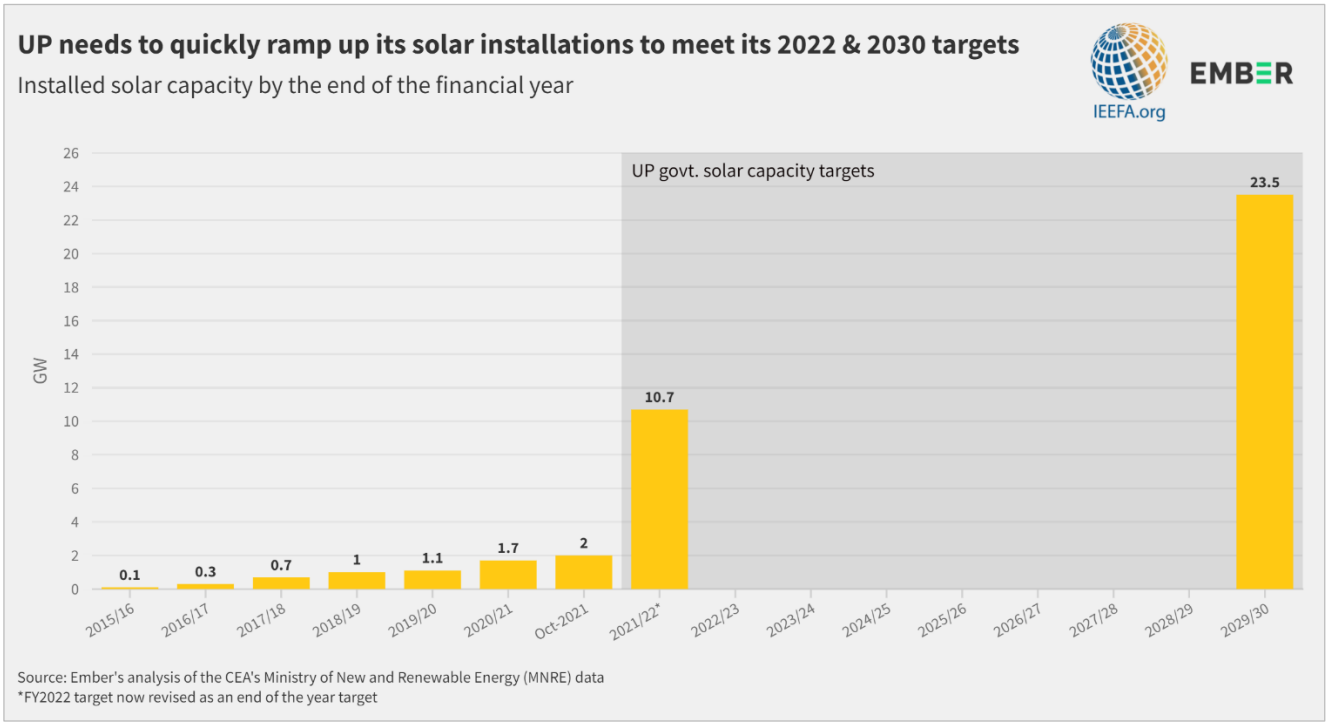
UP needs to significantly ramp up solar power installations to deliver on its solar targets. The state's total solar capacity stands at 2GW, as of October 2021, having risen from 0.1GW at the end of FY2015/16. In order to meet its solar power target of 10.7GW solar by 2022, as enshrined in the "Uttar Pradesh Solar Energy Policy 2017,[17] UP needs to add a massive 8GW of solar capacity in the subsequent 14 months. The average annual build rate between FY2015/16 and FY2020/21 for solar in UP was around 0.3GW. To put this into perspective, UP needed an average solar build rate of 1.8GW per year during this time period to meet the 2022 target.

Uttar Pradesh needs to significantly ramp up solar power installations to deliver on its solar targets.

[13] National Power Portal (NPP) Daily coal reports. 11 October 2021.
[14] Hindustan Times. Coal Shortage hits power production in UP. 12 October 2021.
[15] The Times of India. Coal shortage: Long power cuts in western UP during festive season. 12 October 2021.
[16] ET Energy World. UP buying power at Rs 22 per unit, says CM Yogi Adityanath. 19 October 2021.
[17] UPNEDA. Uttar Pradesh Solar Energy Policy 2017. 2017.

Further, UP is aiming to achieve a total solar capacity of 23.5GW by 2030.[18] This would mean a more than ten-fold increase in solar capacity in the next nine years. To deliver this, the state would need to add about 2.5GW of solar capacity every year on average until 2030.

Figure 9: Uttar Pradesh Solar Power Capacity Growth vs 2022 & 2030 Targets



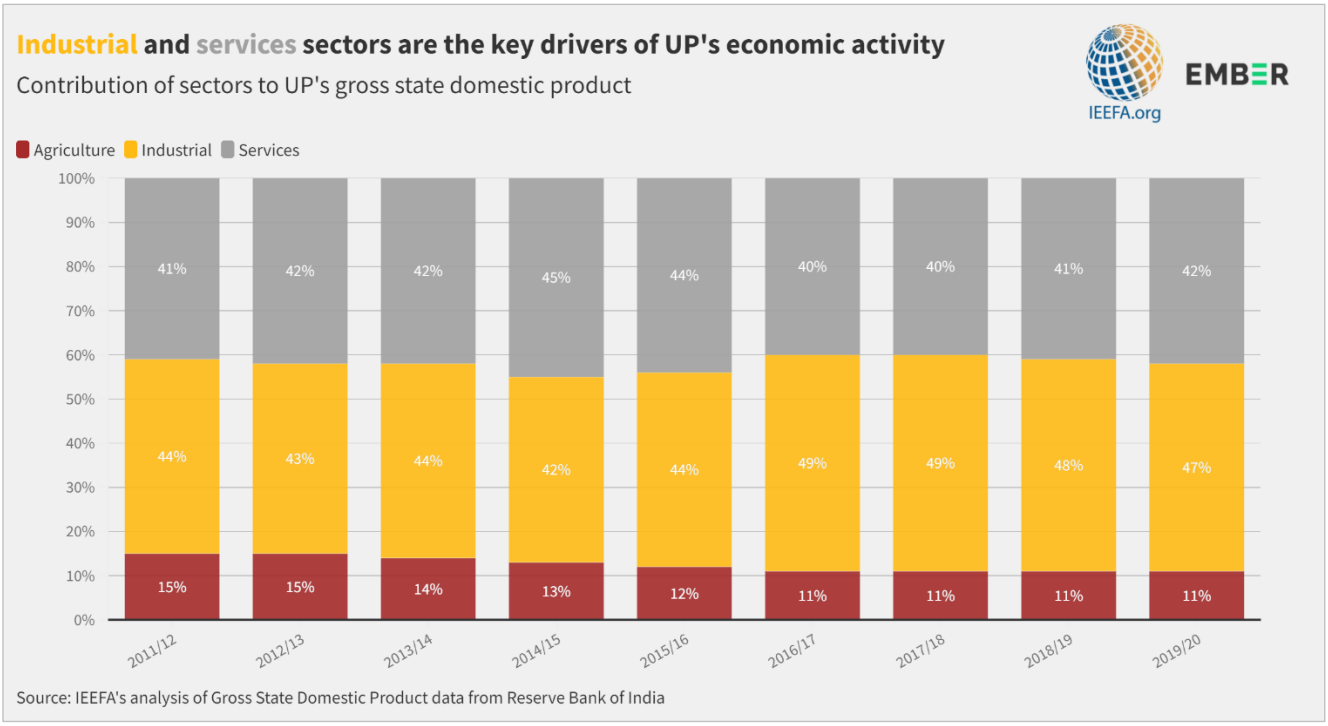
UP's ambitious solar-driven RE policy is being undermined by PPA cancellations. Despite India's solar tariffs setting new record lows of below Rs2/kWh, UP could not take advantage of this deflationary momentum in India's renewable energy sector. In fact, the Uttar Pradesh New and Renewable Energy Development Agency (UPNEDA) even cancelled previously awarded solar power PPAs in the hope of realizing lower tariffs.[19] Such moves would be counterproductive as the solar power auctions lose their sanctity, developers their confidence and UPNEDA its credibility. As of FY2019/20, UP had a 69% deficit in its solar RPO compliance which reflects the fact that such PPA reversals are holding the state back.[20]

[18] PV Magazine. Bidding extended for 200 MW solar in Uttar Pradesh. 10 November 2021.
[19] Financial Express. Solar auction: UP does an AP, denies bidder rights. 02 June 2021.
[20] WBCSD. Corporate Renewable PPAs in India: Market & Policy Update. January 2021.

Meeting Future Demand: IEEFA Electricity Sector Model for Uttar Pradesh

India's electricity demand has grown at about 0.9 times its GDP growth during the last five years. In other words, this is the elasticity of electricity demand growth with respect to economic growth measured in GDP. During the same period, Uttar Pradesh's electricity demand has grown faster, at 1.05 times GDP growth. The state's economy was driven largely by services and industrial sectors over the past decade. During this period, there has been a slight drop in the share of contribution from the agricultural sector to the gross state domestic product.

Figure 10: Breakdown of UP's Economic Activity and Contribution to Gross State Domestic Product



In November 2017, the U.S. Energy Information Administration (EIA) published an analysis showing growing evidence of a decoupling between economic activity and electricity demand, and suggesting that improving energy productivity is keeping electricity demand growth below that of GDP.[21] This transition has been under way in many of the member countries involved in the Organization for Economic Cooperation and Development (OECD), as a result of ongoing energy efficiency improvements and with the ongoing economic shift from low-skilled manufacturing to services and more energy efficient manufacturing. UP's economy currently relies equally on services as well as the relatively higher energy-intensive industrial

[21] US Energy Information Administration. Link between growth in economic activity and electricity use is changing around the world. 20 November 2017.

activities. Given the Indian government's emphasis on energy efficiency, IEEFA expects a similar decoupling of economic growth and electricity demand to unfold in UP. Consequently, IEEFA forecasts that the gross electricity to GDP growth ratio will fall to 0.90 times in UP by 2030, as per Figure 11.

Figure 11: Uttar Pradesh Electricity Supply & Demand 2029/30

GDP growth (%)	5.4%
Electricity to GDP multiplier pre-EE	1.05
Electricity demand growth (%)	5.9%
Energy efficiency (%)	-1.0%
Electricity to GDP multiplier inclusive Growth	0.90
Reduced grid AT&C losses	-1.0%

Year ended March	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30
Gross production (TWh)	121.0	123.4	111.1	115.0	119.1	123.3	127.7	132.3	137.0	142.0	147.1
Gross production Growth (%)		2.0%	-9.9%	3.5%	3.5%	3.5%	3.6%	3.6%	3.6%	3.6%	3.6%
AT&C losses (TWh)	36.6	45.7	29.6	29.4	29.3	29.1	28.9	28.6	28.2	27.8	27.4
AT&C losses (%)	30.2%	37.0%	26.6%	25.6%	24.6%	23.6%	22.6%	21.6%	20.6%	19.6%	18.6%
Reduced grid losses		6.8%	-1.0%	-1.0%	-1.0%	-1.0%	-1.0%	-1.0%	-1.0%	-1.0%	-1.0%
Real GDP growth (%)	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%
Electricity multiplier (x)	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05
Electricity growth (%)	5.9%	5.9%	5.9%	5.9%	5.9%	5.9%	5.9%	5.9%	5.9%	5.9%	5.9%
Energy efficiency	-1.0%	-1.0%	-1.0%	-1.0%	-1.0%	-1.0%	-1.0%	-1.0%	-1.0%	-1.0%	-1.0%

Source: IEEFA & Ember estimates.

Factoring in annual energy efficiency gains of about 1%, IEEFA estimates Uttar Pradesh's net electricity demand growth will be 0.90 times its GDP growth in the coming decade. The introduction of LEDs, energy-efficient air conditioners, solar irrigation pumps and better building construction standards could add to this reduction in cost while promoting a less polluting source of procurement.

Additionally, IEEFA's modelling assumes UP will be able to trim their increasingly high aggregate technical & commercial (AT&C) losses from the current level of above 37% to 18.6% in 10 years. In our view, in FY2020/21, UP incurred extraordinarily high AT&C losses of 37%. However, the UDAY dashboard reports lower AT&C losses for first six months of FY2021/22 of 28%.[22] We assume the AT&C losses to be below 30% for FY2020/21 in our model to avoid overestimation of demand.

Cutting these losses is an urgent priority, assisted by the federal government's multiple Discom reform programs aiming to improve the financial condition of the country's distribution utilities. By definition, cutting losses from transmission and distribution reduces the requirement for new electricity production. Reducing commercial losses, which mostly occurs due to electricity theft, will require the roll-out of a smart metering system that should immediately reduce such losses.

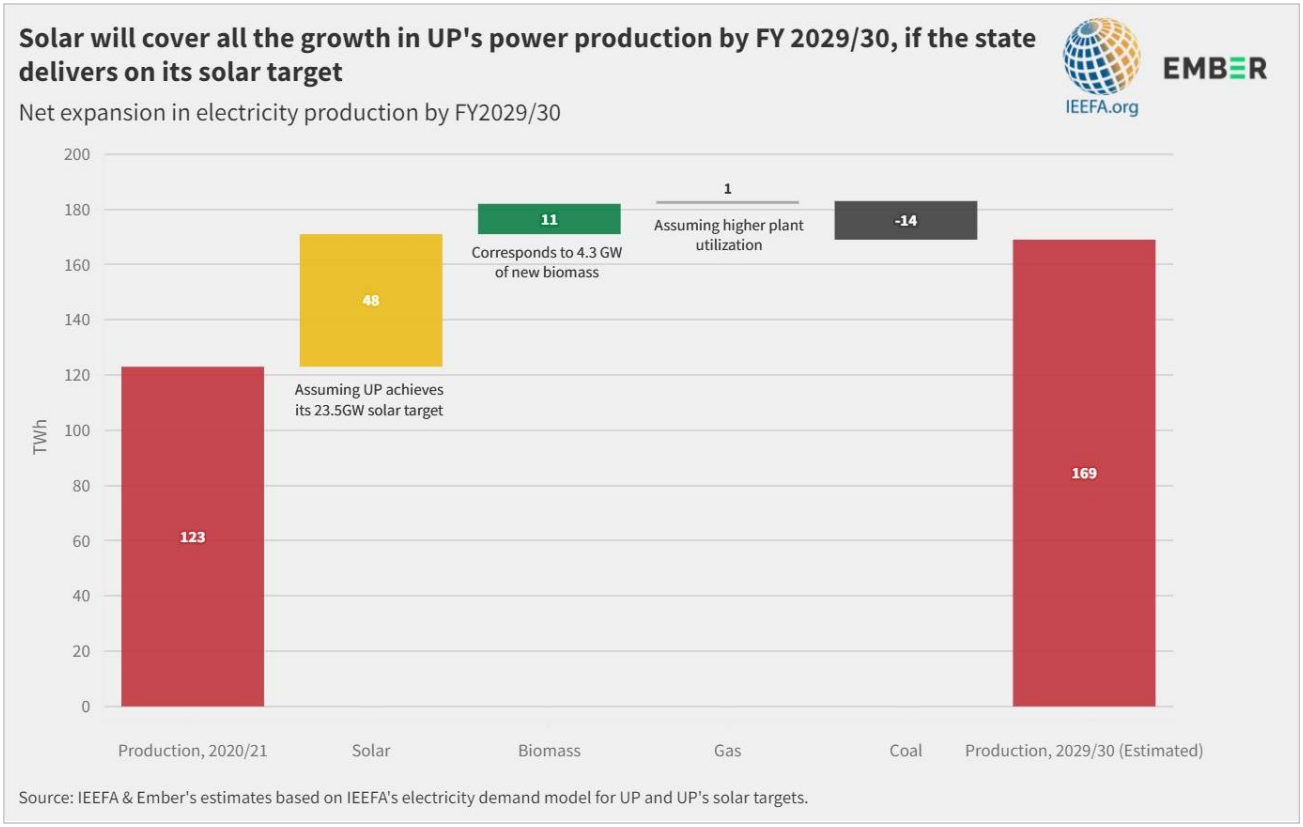
[22] UDAY Dashboard. Uttar Pradesh. 30 September 2021.

The ongoing US$21.5bn nation-wide program – Kisan Urja Suraksha Evam Utthaan Mahaabhiyan (KUSUM) – to distribute 3.5 million solar irrigation pumps, with 1.5 million of these pumps to be connected to the grid and 10GW of grid connected solar capacity for agricultural feeders.[23] This plan has the potential to eventually eradicate heavily subsidised, imported diesel-based pumps, deliver energy savings and provide energy security to India's struggling agriculture industry.

Taking all of this into account, IEEFA projects a net 4.9% CAGR in electricity demand over the coming decade. This translates to a demand increase of 48TWh and the corresponding power production expansion of 46TWh by FY2029/30. Solar will be able to serve all this growth in power production, if UP delivers on its 2030 target of 23.5 GW installed solar capacity. If this is achieved, solar production will add about 48TWh above the current level by FY 2029/30.

Further, we model an addition of 4.3GW of new biomass generation capacity which will add 10TWh above the current. Increased solar and biomass production would mean that coal-fired power production would actually fall by 14TWh by FY2029/30.

Figure 12: Uttar Pradesh Electricity Sector Expansion by FY2029/30



[23] IEEFA. A Renewed Push on Solar-Powered Irrigation Would Accelerate India's Energy Transition. June 2021.

Currently, there is 7.4GW of coal capacity under construction in the state with an additional 3.3GW in the permit and pre-permit stages. But the availability of capital for coal-fired power projects has dried up. Apart from state-owned non-banking financiers – Power Finance Corporation (PFC) and Rural Electrification Corporation (REC) – there is no investor willing to finance coal projects in India.

With financial viability of new coal-fired power plants falling, it is plausible that the plants in the permitting stage will not see the light of the day. IEEFA estimates that roughly half of the 7.3GW under construction capacity will be commissioned by the end of this decade.

Moreover, there is 9.9GW coal capacity in UP that was commissioned pre-2005 and will be due for retirement by 2030. IEEFA estimates all of these plants could be phased out, while the remainder continue to have net negative growth in Uttar Pradesh's coal capacity to about -6.3GW by FY2029/30.

This will push up the utilisation of UP's coal-fired fleet to a more financially viable rate of 67%.

Figure 13: UP's Electricity Sector Composition FY2029/30

Electricity Market Composition 2029/30					
Source	Capacity		Generation & Share		Capacity
	GW	% of Total	TWh	% of Total	Utilisation
Coal	13.8	29%	64.7	47.1%	53%
Gas	1.5	3%	2.0	1.4%	15%
Diesel	0.0	0%	0.0	0.0%	0%
Hydro	0.5	1%	1.6	1.1%	34%
Nuclear	0.4	1%	3.6	2.6%	94%
Renewable	31.9	66%	65.7	47.7%	23%
Total	**48.2**	**100%**	**137.5**	**100%**	

Source: IEEFA & Ember estimates.

Financially Ailing State-Owned Power Distribution Companies

Uttar Pradesh Power Distribution Sector is composed of five state-owned power distribution companies (Discoms) – Dakshinanchal Vidyut Vitaran Nigam Limited (DVVNL), Madhyananchal Vidyut Vitaran Nigam Limited (MVVNL), Pashchimananchal Vidyut Vitaran Nigam Limited (PVVNL), Purvananchal Vidyut Vitaran Nigam Limited (PVVNL), and Kanpur Electricity Company Limited.

UP Discoms Market Structure

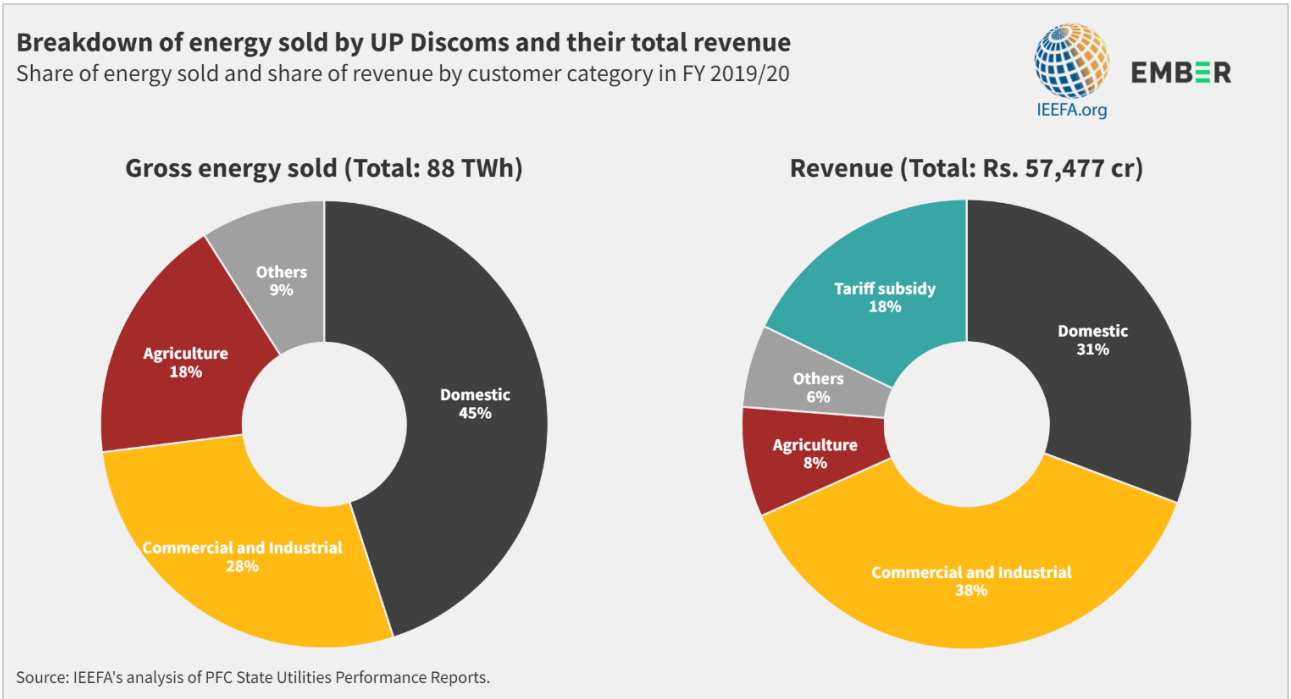
The state-owned Discoms broadly cater to three different customer categories with differing tariffs (see Figure 14) agricultural, domestic (residential), and commercial and industrial (C&I).

C&I and domestic customers cross-subsidise agricultural customers by paying higher tariffs or paying state regulated tariffs. C&I and domestic consumers form 28% and 45% of the total customer base respectively and contribute 38% and 31% of the total revenue for the Discoms from energy sales.

The cross subsidy surcharges have risen from Rs0.6/kWh in FY2016/17 to Rs1.5/kWh in FY2020/21.[24]

The subsidies formed 18% of the total revenue in FY2019/20, illustrating Discoms' huge dependence on state-sponsored subsidies.

Figure 14: Customer Category-wise Breakdown of Energy Sold vs Revenue FY2019/20

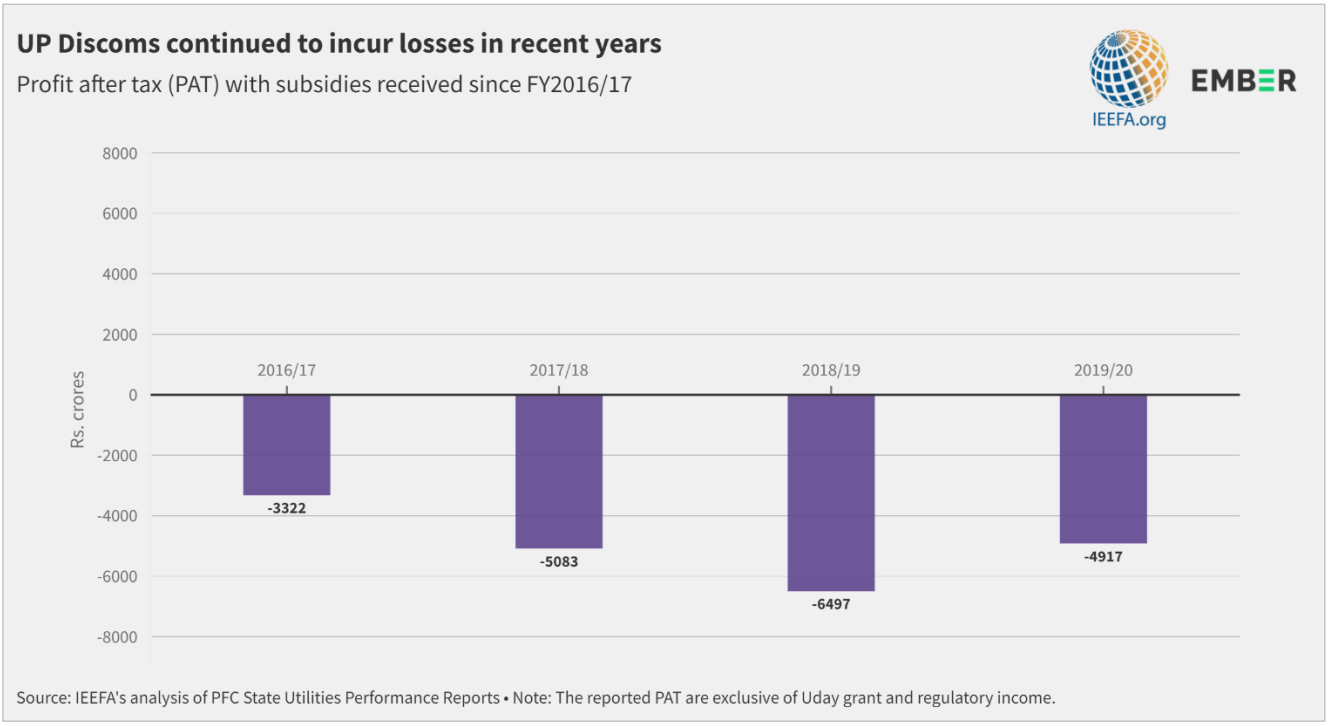


Financial Performance

Expensive and unreliable coal-fired generation has put tremendous pressure on the finances of UP's state-owned power Discoms. In FY2019/20, the UP Discoms incurred a loss of Rs4,917 crore (US$660m), even after accounting for massive tariff subsidies support of Rs10,120 crore (US$1.36bn).

[24] WBCSD. Corporate Renewable PPAs in India: Market & Policy Update. January 2021.

Figure 15: UP Discoms' Financial Performance



Performance Metrics

ACS-ARR Gap

The gap between average cost of supply (ACS) per unit and average revenue realised (ARR) per unit is one of the most important performance parameters for power distribution in India. A negative ACS-ARR gap reflects profitability of Discoms as they realise higher revenue than the procurement cost.

High average power purchase cost of Rs7.85/kWh versus revenue realisation of Rs7.27/kWh reflects a per unit profitability gap of Rs0.56/kWh for UP Discoms in FY2019/20.[25] (Uday Dashboard reports an ACS-ARR gap of Rs0.40/kWh. However, the dashboard does not provide details on revenue, cost and subsidy structure).

The profitability gap has improved over the last four year (See Figure 16). However, we note that the subsidy support has also almost doubled from Rs5,800 crore in FY2017/18 to Rs10,120 crore in FY2019/20.

The Discoms have locked themselves in long-term power purchase agreements (PPA) that compel them to pay enormous capacity charges for coal-fired power plants. In FY2020/21, the UP Discoms incurred a cost of Rs16,670 crore (US$2.2bn)

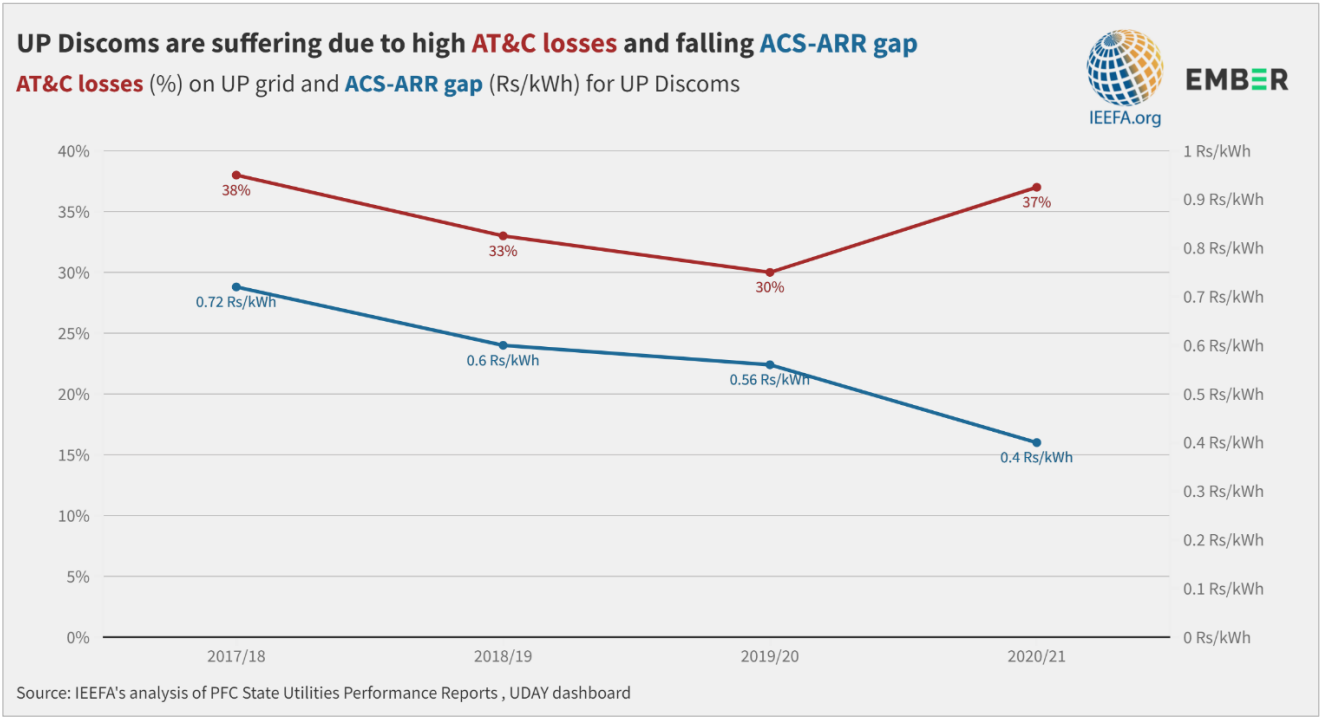
[25] PFC. Report on Performance of Power Utilities 2019-20 (Annexure 1.2 (b))

in capacity charges (fixed charges) for thermal power plants.[26]

AT&C Losses

High aggregate technical and commercial (AT&C) losses on the grid have been a big driver of Discom losses. The AT&C losses in UP have consistently been one of the highest in the country. After a marginal improvement in FY2019/20, AT&C losses again sharply increased to 37% in FY2020/21.

Figure 16: AT&C Losses and ACS-ARR Gap for UP Discoms



To address the massive problem of high AT&C losses, the Uttar Pradesh Electricity Regulatory Commission (UPERC) has emphasised a state-wide roll-out of smart meters.

Smart meters capture a customer's electricity usage at regular intervals and transmit data in real time, eliminating the need for monthly manual meter reading. Smart meters can also enable remote connection and disconnection, and pinpoint abnormal usage or discrepancies between sanctioned load and connected load.

Smart meters could also strengthen implementation of tariffs differentiated on the time-of-day and monitor excess rooftop solar generation and net-metering.

UP Discoms have opted for an OPEX model with the central government-owned

[26] UPERC. Annual Performance Review (Apr) For FY2020/21. 29 June 2021 (page 282-290)

Energy Efficiency Services Limited (EESL) to roll out smart meters.

According to the UDAY Dashboard, there are already 10.1 million smart meters installed in Uttar Pradesh – a remarkable achievement for the UP Discoms.

Smart meters would help in reducing the AT&C losses by improving the billing efficiency and reducing theft of electricity. They also improve customer experience and would benefit Discoms by enabling data analytics, management information systems (MIS), and monitoring of exceptions and savings on faster detection of defective meters leading to reduction in assessed bills.

Turning Around Discoms

Improving financial and operational performances of UP's Discoms is at the heart of transforming UP's electricity sector. There is no silver bullet to solve the Discoms' problems, however, we recommend key focus areas for UP Discoms to turn around their financial situation.

Reducing Power Purchase Costs

UP Discoms need to optimise its power purchase costs by taking less power from high-cost state- and centre-owned generators. The state needs to retire its old plants which consume much more coal per kilowatt hour than modern plants, as well as causing air, fly-ash, and water pollution.

Due to lack of in-state coal mining, Uttar Pradesh's state-owned coal plants incur the high cost of coal transportation, reflected in high variable charges of Rs3.3-4.5/kWh.

Also, the long-term contractual liability of capacity charges of thermal power plants inhibits Discoms' ability to contract new cheaper renewable energy capacity.

The state government also needs to put a policy framework in place and incentivise states to retire old thermal plants without putting a financial burden on states.

Given the state's high solar energy potential, Uttar Pradesh should promote the deployment of more large-scale, grid-connected solar energy projects. It should also encourage decentralized renewable energy production through rooftop solar and or solar irrigation pumps to help Discoms avoid grid losses.

Only 19% of the total 2GW of solar capacity installed in UP (as of October 2021) is in the form of distributed or rooftop capacity.[27] Growth in distributed solar capacity is advantageous to limit transmit and distribution losses as the power is produced and consumed at the load.

Also, there is no visibility on information related to the progress of the solar irrigation scheme (KUSUM) in UP. In our view, this is a key focus area because solar pumps not only help from the supply side of incremental agricultural power

[27] MNRE. Physical Progress. October 2021.

demand but also reduce the cross-subsidy burden on the C&I consumers.[28]

Because renewable energy is now more competitive than power generation using domestic coal, the Discoms can progressively reduce costs by raising the proportion of renewable energy in their power purchasing.

Promoting Open Access for C&I Consumers

In IEEFA's view, open access charges reflect a state's readiness to transform its electricity sector by adopting low-cost, low-emission, renewable energy sources.

In a positive development, the UPERC has reduced the open access wheeling charges and defined differentiated wheeling charges for different voltage levels. UPERC reduced the flat open access wheeling charge of Rs1.32/unit in FY2020/21 to Rs0.75/kWh for loads connected at 11kV and Rs0.47/kWh for loads connected above 11kV.[29]

Moreover, the proposed amendments to the Electricity Act aim to progressively do away with cross-subsidisation using direct benefit transfers (DBTs) to the lowest-paying consumers.

This will reduce Discoms' dependence on high-paying industrial consumers to subsidise lower-paying consumer categories. Additionally, the availability of cheaper renewables is already increasing the penetration of open access consumers. In this scenario, the Discoms are better off having policies that support the open access mechanism.

From an economic growth perspective, higher power costs could discourage industrial customers from operating in a given state. Hence, directing Discoms to employ open access-friendly policies is in a state government's interest.

Taking Advantage of the Open Market

The Ministry of Power's recent move to nationally pool India's electricity market by introducing a market-based economic dispatch (MBED) model (effective from April 2022) will bring competition in the power procurement market. MBED will ensure that the least-cost power generators are dispatched first, effectively bringing the overall cost of procurement down for the Discoms.[30]

Also, introduction of day-ahead, term-ahead and real-time markets on the open market platforms such as Indian Energy Exchange (IEX) provide Discoms with an option to gradually unshackle themselves from expensive, long-term PPAs. The term-ahead markets provide Discoms with the flexibility to schedule (buy or sell) their power purchase on daily, weekly and intraday basis. The green term-ahead

[28] IEEFA. A Renewed Push on Solar-Powered Irrigation Would Accelerate India's Energy Transition. June 2021.
[29] UPERC. Tariff order FY2020/21. 29 June 2021.
[30] IEEFA. Finessing India's Power Market Design to be More Competitive. September 2021.

market (GTAM) allows Discoms to buy clean power to even meet their renewable purchase obligation (RPO) targets.

About IEEFA

The Institute for Energy Economics and Financial Analysis (IEEFA) examines issues related to energy markets, trends and policies. The Institute's mission is to accelerate the transition to a diverse, sustainable and profitable energy economy. www.ieefa.org

About Ember

Ember is an independent, not-for-profit climate and energy think tank that produces cutting-edge research and high impact, politically viable policies that aim to accelerate the global transition from coal to clean electricity. ember-climate.org

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