

INDIA'S ZOMBIE THREAT

27 GW of unnecessary planned coal power plants threaten India's RE goals

EMBER



climate
risk
horizons

About this report

This report estimates electricity requirements by the end of this decade and compares it with the Central Electricity Authority (CEA's) Optimal Generation Capacity Mix (OGCM) report forecasts. It examines whether India needs more new coal power plants under the current circumstances to meet its power requirements in FY 2030 and estimates savings that can accrue by investing in clean energy technologies better suited to address India's growing electricity demand instead of unnecessary new coal plants. The analysis in this report was done based on the electricity generation data and broad thermal power status reports from the CEA database, peak demand data from the Ministry of Power (MoP) and the data on future RE+storage costs from Lawrence Berkeley National Laboratory.

Authors

Aditya Lolla, Senior Electricity Policy Analyst, Ember.

Ashish Fernandes, CEO, Climate Risk Horizons.

Abhishek Raj, Analyst, Climate Risk Horizons.

Published date

September 2021

Disclaimer

The information in this report is complete and correct to the best of our knowledge, but if you spot an error, please email info@ember-climate.org

This report is published under a Creative Commons ShareAlike Attribution Licence (CC BY-SA 4.0). You are actively encouraged to share and adapt the report, but you must credit the authors and title, and you must share any material you create under the same licence.

Document design & layout by Wilf Lytton

Copyright © Ember, 2021

Executive Summary

India's power sector landscape has changed markedly in the last few years—both in its electricity demand profile and the economics of electricity production. Analysis by Ember and Climate Risk Horizons (CRH) shows that 27 GW of pre-permit and permitted new coal power plant proposals are now superfluous to requirements and will likely end up as “zombie” plants— assets that will be neither dead nor alive. These surplus plants, if built, will suck in scarce resources and impede India's renewable energy (RE) ambitions. But they can be cancelled without needing to sacrifice the power system's ability to meet future demand.

Key findings

1. **India does not require additional new coal capacity to meet expected demand growth by FY 2030.** Even if India's power demand grows 5% annually, in line with the most optimistic International Energy Agency (IEA) projection, coal-fired generation in FY 2030 will be lower than in FY 2020 as long as India achieves its non-coal generation targets. In effect, more coal capacity beyond what's already under construction isn't needed to meet the aggregate demand growth by FY 2030.
2. **India can meet its peak demand in FY 2030 without building the “zombie” coal plants.** India's peak demand would reach 301 GW by FY 2030, assuming it grows at an annual growth rate 5% in line with the Central Electricity Authority (CEA) projections. This is about 40 GW less than the OGCM forecast. If this peak occurs during sunlight hours as recent studies predict, India's planned solar capacity can cover much of it. Even if it occurs in the evening, substituting the “zombie” coal plants with additional battery storage capacity represents a more flexible, cheaper option.
3. **India can free up Rs. 247,421 cr in capex by killing the “zombie” coal projects.** These surplus plants, if built, will require an estimated Rs. 247,421 cr (US \$33 billion) of investment. They will lock consumers into expensive contracts and jeopardise India's RE goals by adding to the system's overcapacity.
4. **India can make annual savings of Rs. 43,219 cr by investing in renewables and storage, instead of “zombie” coal projects.** Substituting 27 GW of coal with battery storage will save the Indian power system Rs. 43,219 cr (US \$6 billion) a year in terms of reduced power purchase cost. In addition, building 30 GW of additional battery storage rather than the “zombie” coal plants will require an estimated Rs. 109,800 cr (US \$15 billion) capex, implying a savings by way of avoided investment of nearly Rs 137,621 crore (US \$18 billion).

"As India recovers from the disruption caused by the COVID-19 pandemic, how the country uses scarce public resources will be absolutely crucial. By avoiding the unnecessary "zombie" coal plants, India can not only save lakhs of crores of rupees, but also lower power costs and reiterate its commitment to the success of its clean energy transition goals"

Aditya Lolla, Senior Electricity Policy Analyst, Ember

"The financial risks associated with new coal plants are manifold—for developers, lenders, discoms and the Indian economy at large. With the current generation overcapacity in the system, adding additional new coal will jeopardise the growth of the RE industry and with it, India's ambitious 450 GW target."

Abhishek Raj, Analyst, Climate Risk Horizons

The 27 GW of new coal being proposed at an investment value of 250,000 cr (\$33 billion) represent a significant threat to the Indian economy, not just in terms of misallocation of scarce capital, but also due to the lock in effect of expensive electricity and ancillary impacts on the renewable energy industry. This must be avoided especially as the Indian financial sector is yet to recover from the Non Performing Asset crisis created by excessive coal construction in the last decade.

Ashish Fernandes, CEO, Climate Risk Horizons

Contents

CHAPTER 1	
Introduction: India's new energy paradigm	4
CHAPTER 2	
New coal not required to meet future power demand	7
2.1 Demand growth	7
2.2 Peak demand	8
CHAPTER 3	
New coal more expensive than clean energy options	11
3.1 Wasted "zombie" coal investments	11
3.2 Renewable investment opportunities	15
CHAPTER 4	
Discussion	18
References	19

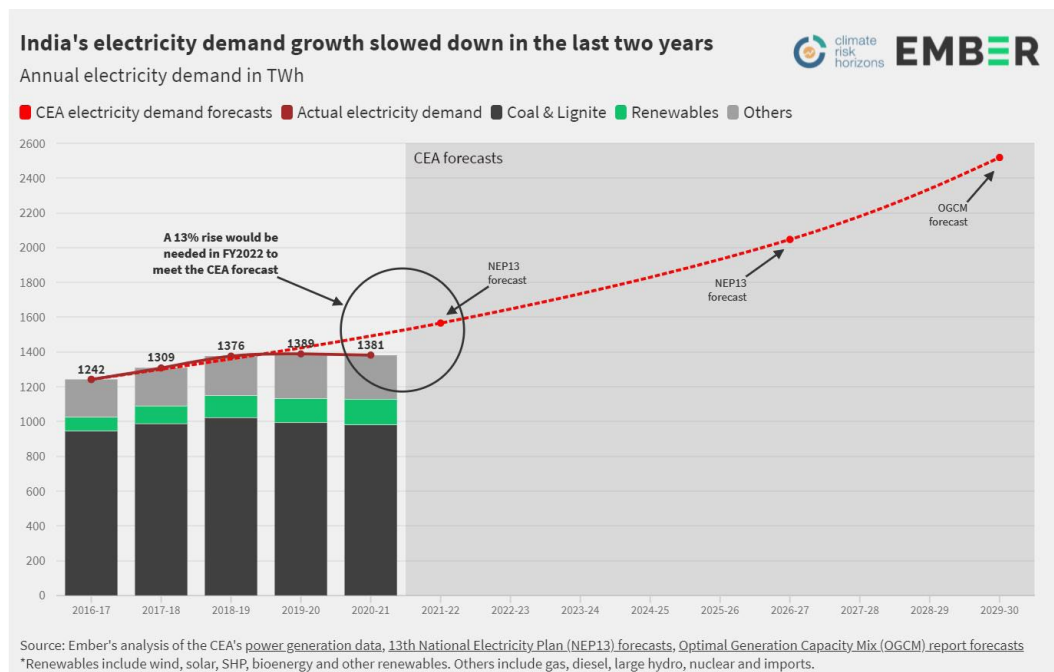
CHAPTER 1

Introduction: India's new energy paradigm

India's power sector landscape has changed markedly in the last few years — both in its power demand profile and the economics of electricity production.

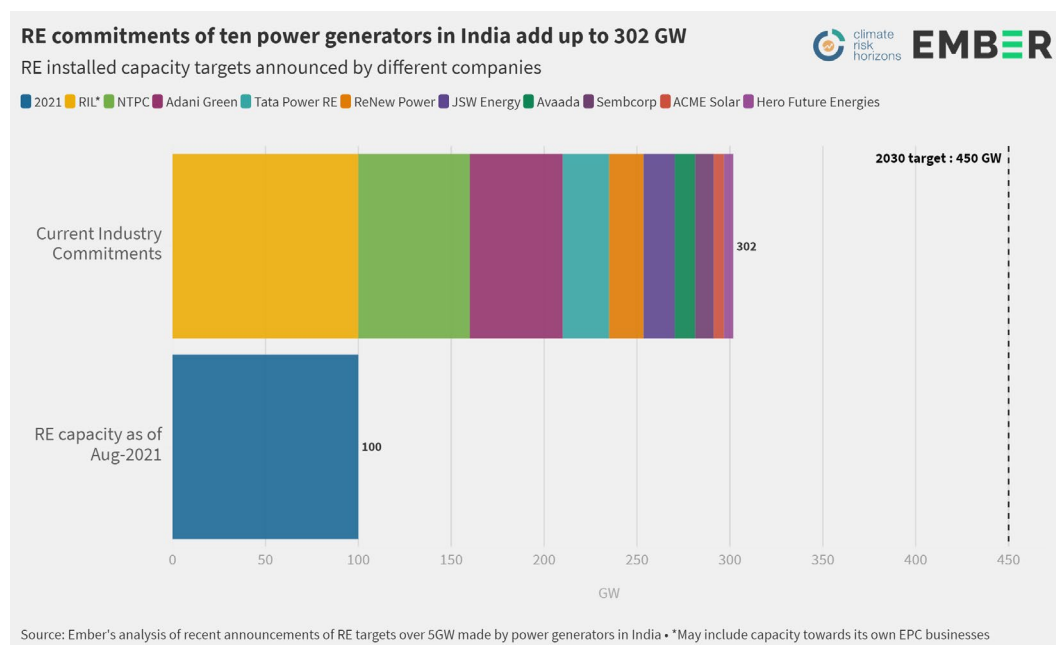
India's electricity demand growth rate has slowed in recent years, diverging significantly from previous Central Electricity Authority (CEA) projections. In its [13th National Electricity Plan \(NEP13\)](#),¹ published in January 2018, the CEA forecast India's electricity demand in FY 2022 to be 1566 TWh, which would have required power demand to grow by about 5% every year during the 13th Plan period (FY 2017 to FY 2022). While it did grow at this rate in the first two years of that period, it rose by only 1% in FY 2020, mainly due to a broader economic slowdown. It then fell by 0.5% in FY 2021 as a result of the disruption caused by the COVID-19 pandemic.

India's electricity demand would have to rise by 13% this year (FY 2022), amid the ongoing pandemic, to meet the NEP13 forecast. This is more than double the 6% growth in FY 2022, which the credit rating agency, ICRA [predicted](#) recently.²



India's power generators are starting to respond to the country's 2030 target of 450 GW renewable energy (RE). About 39 GW of new RE capacity addition is needed annually to reach the target of 450 GW by FY 2030, from the [current level of 100 GW](#)³ (as of August 2021). While the current build rate is falling short, there is cause for optimism with an increasing number of private entities announcing their own RE targets in the last few years. Commitments made by ten different power generators in India now add up to 301 GW.

While some of these targets, from companies like Reliance India Limited (RIL), might not fully count towards India's RE target as they include capacity to support their Engineering, Procurement & Construction (EPC) businesses, there is a growing private sector enthusiasm for RE as a growth industry. This is reflected in the dominance of private entities among this list of RE power generators, where NTPC is the only publicly-held exception.



Building more new coal plants when private investment for coal has dried up will create “zombie” assets. Global Energy Monitor's [Boom and Bust 2021](#) report showed that the private sector withdrew almost entirely from new coal plant construction in India by 2020 due to low coal power capacity factors and the declining costs of clean energy alternatives.⁴ [IEEFA](#) has also predicted that much of India's coal power pipeline faces a severe stranded asset risk.⁵ However, 27 GW of new coal power plant proposals are still being pushed by developers, in addition to [33 GW under active construction](#).⁶ These “zombie” coal plants—not yet alive, but moving through the proposal and permitting pipeline—threaten to rear their heads and devour India's hopes of an efficient energy transition.

Given India's changing electricity demand profile and the changing economics of electricity production, this report examines whether India even needs more coal power plants and how much it can save in terms of avoided capex as well as lower electricity costs by avoiding building these plants, without sacrificing the power system's ability to meet future demand.

CHAPTER 2

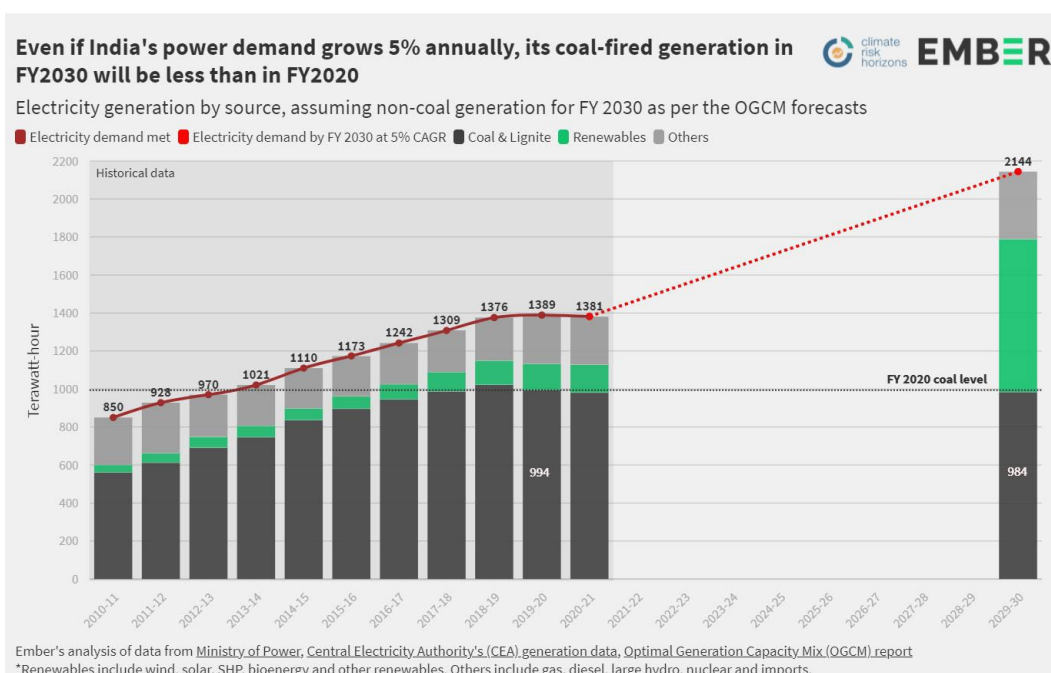
New coal not required to meet future power demand

India can meet power demand growth by FY 2030—as well as expected peak demand—without building “zombie” coal power plants.

2.1 Aggregate electricity demand growth

Even if India's power demand grows 5% annually, meeting the CEA's non-coal generation targets will keep coal-fired generation in FY 2030 lower than in FY 2020. The CEA's [Optimal Generation Capacity Mix](#) (OGCM)⁷ projections show that an increase to 450 GW RE capacity by FY 2030 works out to 805 TWh of RE generation, while other non-coal generation rises to 355 TWh. A 5% annual growth in power demand to FY 2030 would result in a power demand of 2144 TWh in FY 2030, up from 1381 TWh in FY 2021. This means coal-fired generation in FY 2030 would be 984 TWh, which is 10 TWh less than in FY 2020. In other words, the entire power demand growth by FY 2030 can come from RE and non-coal generation.

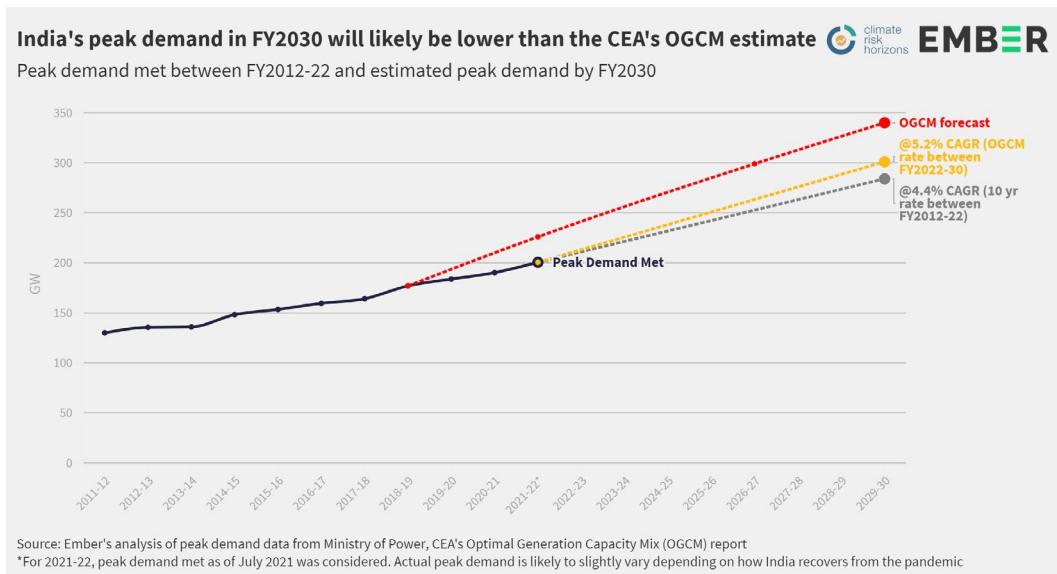
Moreover, 5% is an aggressive growth rate, with coal's role potentially even smaller under a more modest growth scenario. The International Energy Agency (IEA), in its [India Energy Outlook 2021](#) report released last year, estimated that India's electricity demand is likely to grow between 4-5% every year on an average in this decade.⁸ This would be in line with the rate at which India's electricity generation grew in the last ten years, having gone from 850 TWh in FY 2011 to 1382 TWh in FY 2021.



In effect, additional coal capacity beyond what's under construction is not needed to meet the strong aggregate demand growth expected by FY 2030.

2.2 Peak demand growth

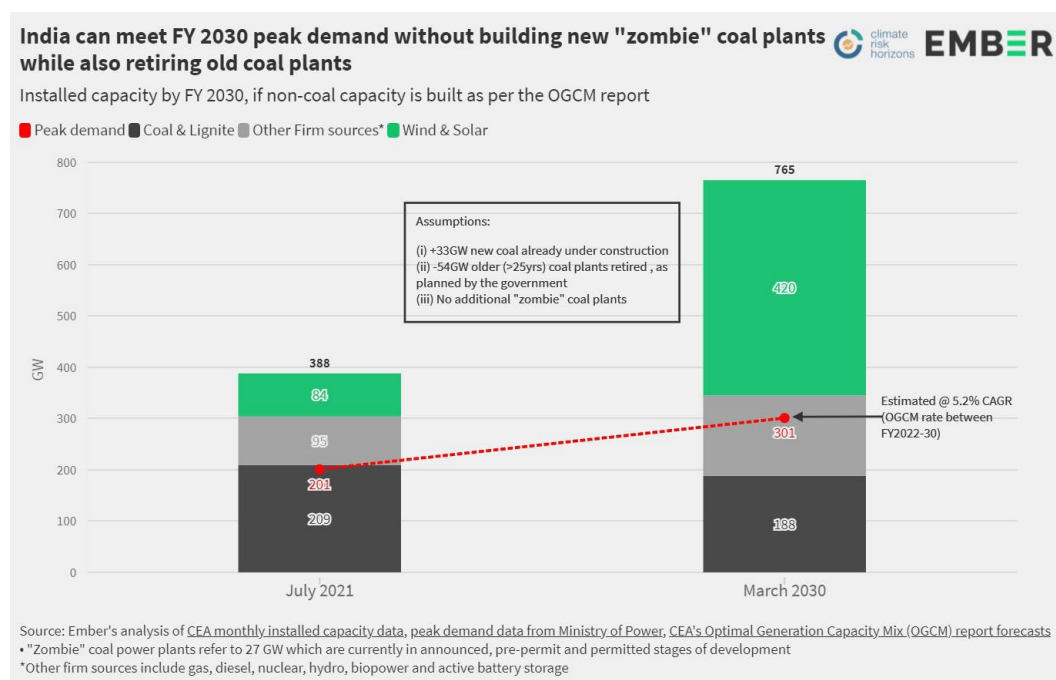
India's peak demand in FY 2030 will likely be lower than the current CEA estimates. While new-build coal is not necessary to meet overall demand growth, it is also important to consider instantaneous capacity requirements. India's ability to meet peak demand in FY 2030 will determine whether India can keep all its lights on. In July 2021, India recorded its highest instantaneous demand of [201 GW](#),⁹ about 25 GW less than what the OGCM report had estimated for FY 2022. The OGCM report forecasts for peak demand show a CAGR of 5.2% between FY 2022-30. At this rate, India's peak demand will rise to about 301 GW in FY 2030, significantly less than the OGCM estimate of 340 GW. If India's peak demand from now till 2030 replicates the average annual growth rate of 4.4% seen in the last ten years, it will touch only 284 GW.



India can meet peak demand in FY 2030 even if it retires its old coal plants and stops building new coal beyond those under construction. India's total installed capacity currently stands at 387 GW, with 209 GW coal (hard coal and lignite), 94 GW other firm capacity (gas, diesel, large hydro, nuclear, bio-power and small hydro) and 84 GW of wind and solar combined. Assuming that India acts on the NEP13 recommendations to retire coal plants older than 25 years, about [54 GW](#) will close by FY 2030.¹⁰ If the 33 GW currently under construction are completed on schedule and no other new coal plants are built, India's coal power capacity will be 188 GW by FY 2030. If India also delivers on the non-coal capacity targets for FY 2030 set out in the OGCM report, other firm capacity will increase to 157 GW (including battery storage) while wind and solar will add up to 420 GW. This means that by FY 2030, India will have a total "firm" capacity of about 346 GW in addition to 420 GW of variable RE to meet an estimated peak demand of 301 GW (see previous section).

The sufficiency of this installed capacity to meet peak demand will be determined by the time of the day when peak demand occurs in FY 2030. Traditionally, peak loads in India were seen during the evenings hours, and the OGCM forecasts are also based on this assumption. But [recent studies](#) suggest that by the 2030s, India's power demand is expected to peak during midday due to higher demand for air-conditioning.¹¹ Moreover, as a result of the disruption caused by different waves of the COVID-19 pandemic, there seems to already have been a shift in India's peak demand to the morning hours, indicating an already evolving load profile. Demand peaks in the nine months leading up to July 2021 [have all come during the sunlight hours](#) between 9am and 1pm.¹² It is premature to conclude that these morning peaks will continue but the prevalence of work from home lifestyles post-COVID and the growth in home air conditioning loads seem likely to lead to an increase in daytime loads. If some of the evening peak demand shifts to the day-time, India's huge solar capacity in FY 2030 will come into play.

But what if India's peak demand of 301 GW continues to occur in the evening hours as the OCGM report has assumed? In this case, India will need firm dispatchable capacity as solar will not be generating electricity during evening hours. Traditionally this demand would be met by coal. However, given current costs and future expected declines, building additional battery storage instead of additional coal plants would be preferable both in terms of cost optimization (see Chapter 3) and grid reliability, since battery storage provides immediate, flexible power without coal power's constraints of ramp times and technical minimums.



The current practice of building more coal capacity to insure against future uncertainties is economically inefficient, as new coal is now decisively uncompetitive with renewable energy and increasingly battery storage. Future technological developments and expected cost declines are sure to further widen the gulf. India runs the risk of wasting large amounts of public finance on assets that will at best be sparingly used and at worst will increase electricity costs and jeopardise achieving the 450 GW RE target. Focusing instead on accelerating energy storage development, shifting demand in response to RE availability and identifying "peaker" coal plants that can run only if needed during peak demand hours would be more cost-effective and resilient to changing energy scenarios.

CHAPTER 3

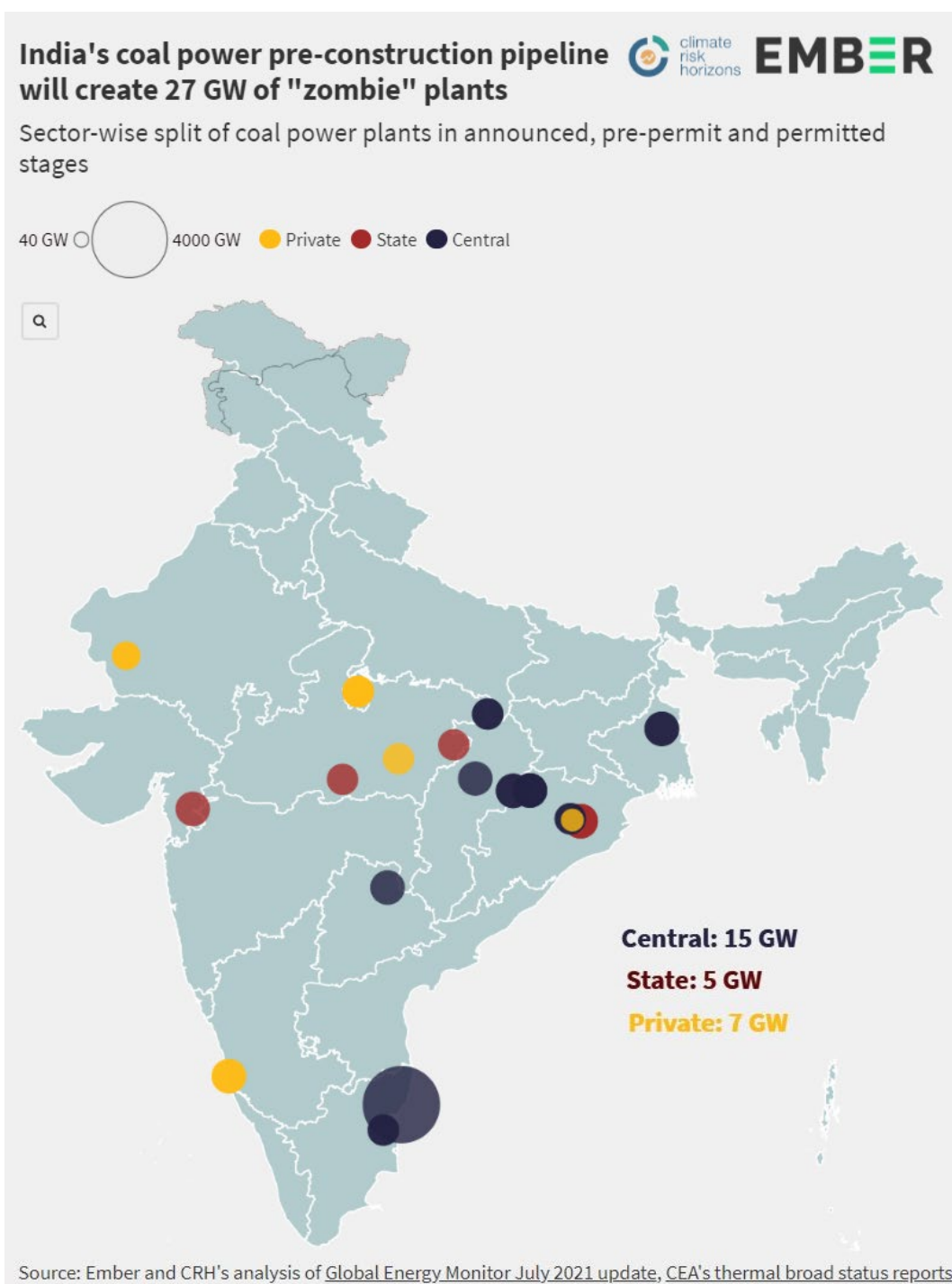
New coal more expensive than clean energy options

Investing in battery storage powered by RE instead of spending Rs. 247,421 cr (US \$33 billion) on zombie coal plants will save India Rs. 43,219 cr (US \$6 billion) annually in power purchase costs.

3.1 Wasted “zombie” coal investments

Building more coal capacity while expanding RE capacity to 450 GW will only create “zombie” coal plants—most of them publicly owned and financed. Of the 27 GW of coal power plants that currently run the risk of turning into “zombie” plants, 15 GW are in the central sector, 5 GW in the state sector and 7 GW in the private sector. 45% are located in the coal mining states of Orissa, Chhattisgarh and Madhya Pradesh, while the remaining capacity will need to transport coal over longer distances via rail and water. These “zombie” coal power plants will end up locking-in costlier, dirty electricity, draining financial resources and, by adding to generation overcapacity, could threaten India’s 450 GW RE goal.

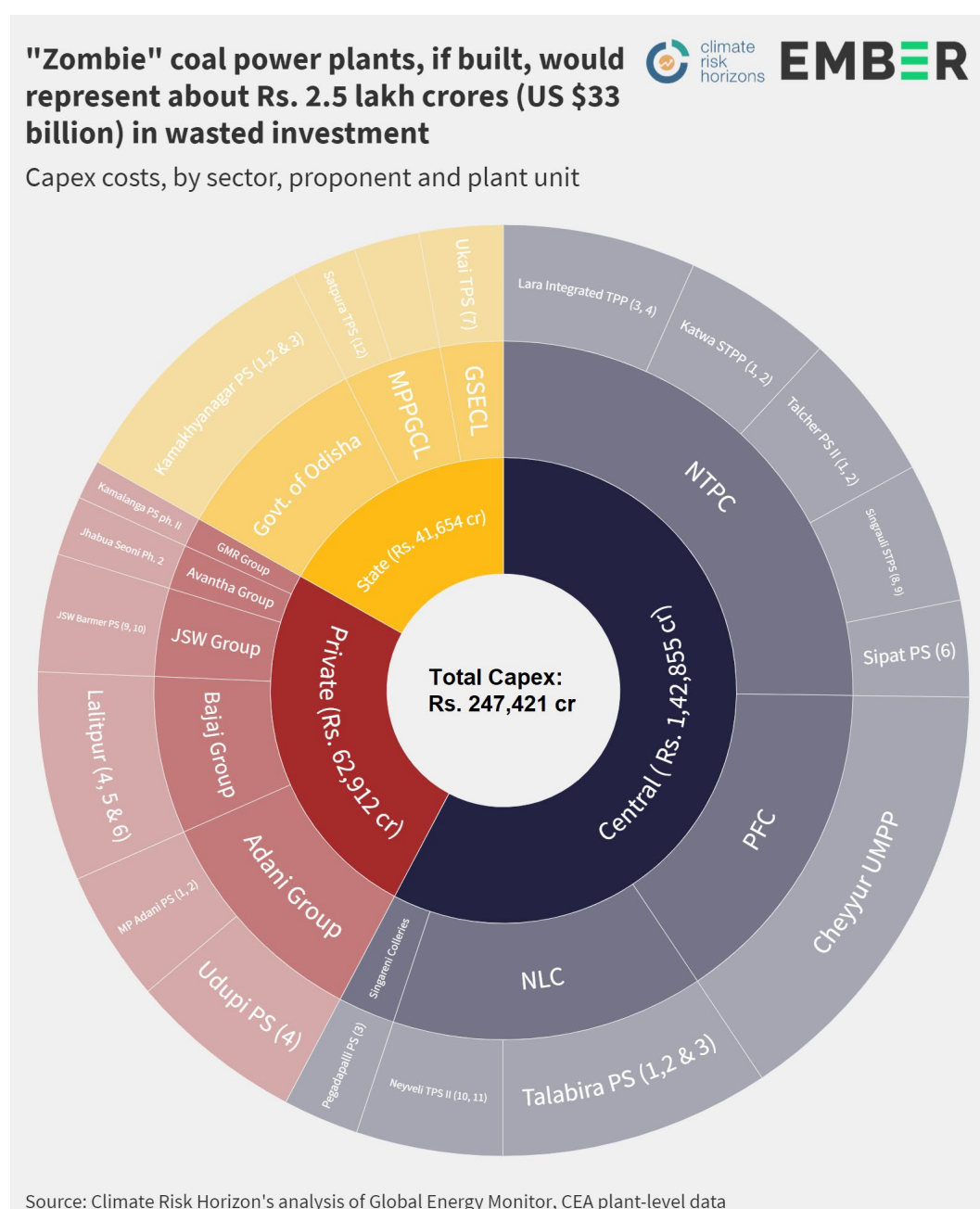
6 GW of this “zombie” pre-construction capacity has been announced, 13 GW is in the pre-permit stage and 8 GW has been granted permits. 51% is an expansion of existing thermal plants and the rest are greenfield projects. NTPC, NLC, PFC and the Adani Group together account for two-thirds of this capacity.



India can free up Rs. 247,421 crores of capital by killing the “zombie” coal projects. This is the level of investment required for the “zombie” coal plants under conservative cost assumptions. The benefits of the avoided capex by cancelling these surplus projects will be spread across the central (Rs. 142,855 crores), state (Rs. 41,654 crores) and private (Rs. 62,912 crores) sectors. This capital can be more productively allocated to other energy technologies such as RE and battery storage.

It is predominantly public money that is financing unviable new coal projects in India, as private sector banks have all but ceased new coal lending. Government-owned PFC has emerged as the largest financier of new coal projects. Four new coal power plants with a total capacity of 8.8 GW commenced construction in India in 2019, and all have received funding from PFC. Public sector generators like NTPC and NLC that benefit from sovereign credit ratings have also been raising funds from the debt market (domestic and international) to finance capital expenditure, including ongoing construction.

Of the private sector investment on 'zombie' coal plants, JSW Energy - which has publicly stated it will not build any new coal plants - is proposing a Rs. 10,130 cr Barmer coal expansion project in Rajasthan. Meanwhile Adani and Bajaj Group are proposing Rs. 26,286 cr and Rs. 17,998 cr respectively on new coal plants.



Building “zombie” coal plants will lock in expensive electricity and threaten RE targets. If the proposed plants commence construction, they run the risk of turning into Non Performing Assets due to a lack of effective demand. In the event that they are commissioned they will either lie idle or operate at or below technical minimums. This will have the dual impact of raising costs across the electricity system and hampering the growth of renewables, jeopardising India’s 450 GW target.

Capacity utilization of India’s coal fleet has already been [steadily declining](#); the country’s coal fleet has been running at PLFs of 61%, 56% and 53% respectively for FY 2019 through FY 2021¹³. This is due to lower than anticipated demand growth in recent years and increasing RE generation. RE has a must-run status in India and must be dispatched before thermal generation (subject to technical minimum constraints).

Zombie plants, if built, will operate at or below 55% PLF. If India achieves its 450 GW RE target, then 188 GW of coal power operating at 60% PLF will be adequate to meet the country’s projected demand in 2030, based on 5% annual power demand growth to FY 2030 (see Chapter 2). In this case, the “zombie” plants will be surplus to requirements and are unlikely to operate above 55% PLF. In the event that older (pre-2020) coal plants are backed down in order to boost capacity factors at the newer (“zombie”) plants, the overall generation costs across the system will rise, as the newer plants will provide power at higher tariffs since the older plants will be significantly depreciated.

Estimation of levelized cost (LCOE) of new thermal capacity is usually done at 85% PLF, but since the “zombie” plants will operate at a PLF much lower than 85%, their per-unit cost of generation will be higher. Firstly, this is because the capacity charges have to be paid irrespective of utilization, so per-unit fixed cost increases at low PLF. Secondly, the efficiency of generation is also reduced as plants are required to operate at a higher Station Heat Rate which results in more coal consumption per unit of generation. For example, LCOE of a generic new coal power plant will escalate from Rs 4.71 at 85% PLF to Rs 6.25 at 55% PLF.¹⁴ Thermal power in general is inflationary in nature due to increase in coal price and rail freight, whereas flat tariffs are the norm in India for solar PV and wind.

“Zombie” plants could jeopardise renewable energy. Although renewable energy has must-run status, it is often curtailed if thermal generation cannot be backed down further, such as when coal plants are already running at their technical minimum of 55% PLF. This RE curtailment is [already an issue](#) for developers in states like Karnataka and Tamil Nadu.¹⁵ Once a thermal Power Purchase Agreement (PPA) is signed, a distribution company (DISCOM) is locked into paying fixed costs irrespective of plant utilization levels.

This mitigates the financial risk for coal power generators, but significantly increases the burden on DISCOMs and their state governments. Crucially, it also makes new RE PPAs less attractive as DISCOMs are already on the hook for the fixed-cost component of coal PPAs. Recognising this problem, India's Central Electricity Regulatory Commission (CERC) [recently signalled](#) that DISCOMs can exit PPAs signed with old plants once their term is over, allowing them the flexibility to source lower-cost power, including from renewable energy.¹⁶ If 27 GW of “zombie” coal plants are built, the financial burden on DISCOMs will almost certainly make them less likely to sign RE PPAs, jeopardising the 450 GW / 2030 target.

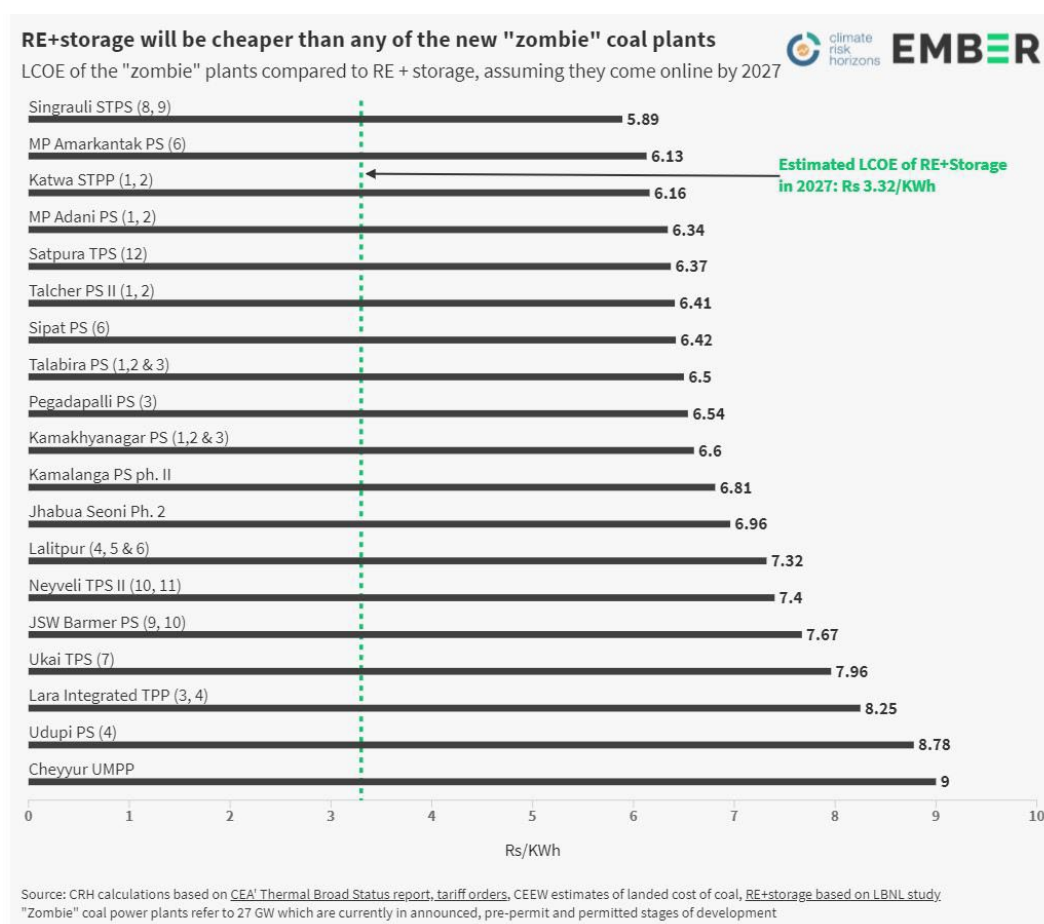
3.2 Renewable investment opportunities

RE+battery storage is cheaper than new coal power. The main advantage of thermal power over wind and solar has been round-the-clock dispatchable generation, in particular the ability to cater to evening peak periods (7pm-10 pm). With the declining cost of lithium-ion batteries, RE+Storage can now substitute for new thermal capacity by providing dispatchable power at a lower cost at these times. Apart from being cheaper, RE+Storage is also more flexible than baseload thermal capacity in providing instant dispatchable power as thermal plants have constraints such as ramp rates, minimum thermal load and start up and shut down time.

In 2020, the [winning bid](#) in India for 300 MW of RE with battery storage was Rs.4.3/kWh—below any new coal tariff.¹⁷ The volume weighted average battery pack cost fell 85% between 2010-18 and is expected to decline further over the next decade according to [Bloomberg New Energy Finance](#).¹⁸

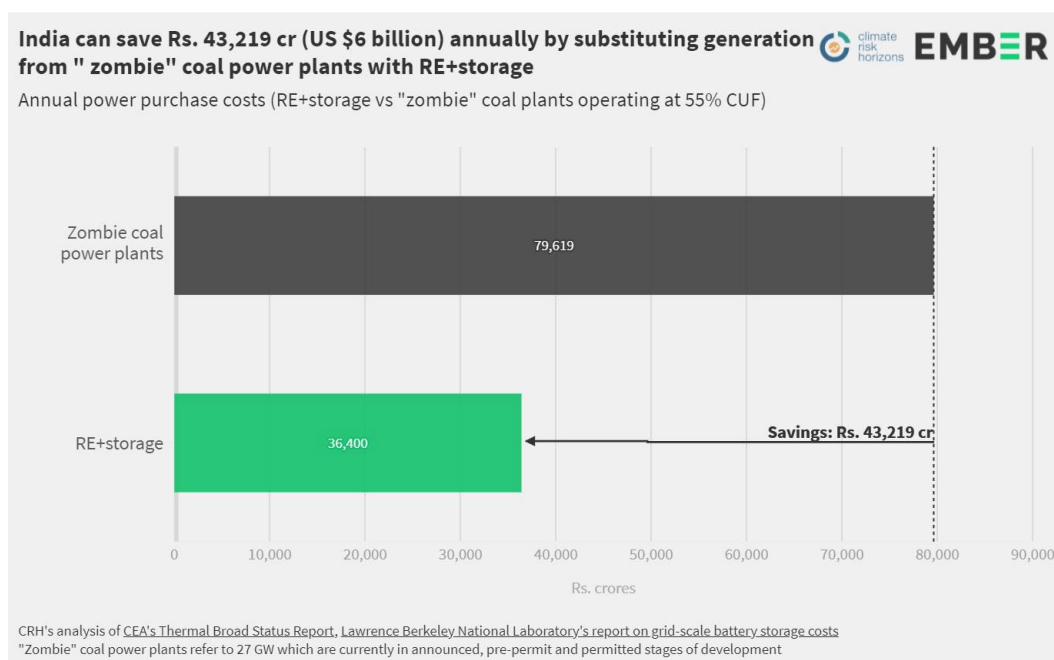
Moreover, the Lawrence Berkeley National Laboratory has [estimated](#) a tariff of Rs. 3.3/kWh in 2025 for PV+battery storage, dropping to Rs.2.8 in 2030, with 25% of the PV energy stored in the battery.¹⁹ At these rates, any new coal plant will not be competitive with PV+storage on an LCOE basis. If battery costs continue to decline as projected, the cost advantage of PV+storage will only grow. If DISCOMs do enter into new coal contracts they will, in effect, be locking customers into expensive electricity and forsaking cheaper (and cleaner) options. Given the long-running issues faced by loss-making DISCOMs, and the expectation that state and central governments will absorb those losses, this has implications for government finances as well.

The estimated LCOE of Rs 3.3/kwh from PV+storage in 2025 is significantly cheaper than all the proposed “zombie” plants. The LCOE from each of the 27 GW of “zombie” plants (assuming a commissioning date in 2027) will range from Rs. 5.89 to Rs 9/kWh, using conservative inflation assumptions and a capacity factor of 55%.



The Indian power system can cumulatively save Rs. 43,219 cr annually on power purchase costs by substituting power purchases from the 27 GW of zombie plants with RE+battery storage. The total cost of power purchase from "zombie" plants operating at 55% PLF will add up to approximately Rs 79,619 Cr, while the same quantum of power can be provided by storage co-located with PV for approximately Rs 36,400 Cr. In fact, investing in 30 GW of additional battery storage co-located with renewables would cost an estimated Rs 109,800 Cr in 2025, (calculated based on LBNL's study). This is significantly less than the estimated capex of 247,421 cr. needed to construct the 27 GW of zombie coal plants. The 30 GW storage route would free up approximately Rs.140,000 crore of capital that can then be more productively deployed towards RE/storage/grid strengthening, demand side management etc.

INDIA'S ZOMBIE THREAT



This estimate of savings does not take into account other costs that discoms might incur by opting for new coal instead of RE, such as financial penalties for failing to meet Renewable Purchase Obligations (RPO) as proposed in the Electricity (Amendment) Bill, 2021. The Power Minister [recently suggested](#) the penalties would be significant—as much as Rs.0.5 to Rs.1 per kWh of shortfall, in order to drive RE purchases.²⁰ At such levels, DISCOMs that have signed excess coal PPAs will have to choose between paying RPO penalties or purchasing new RE while also paying the fixed costs from surplus coal PPAs.

CHAPTER 4

Discussion

The economics of India's electricity generation sector have changed drastically in the last five years. Clearly, many parts of the electricity system have yet to adapt to that change: system inertia on the part of coal power players (both government and private) and regulators has meant that new coal power proposals have continued to move through the system. This raises the risk of creating 27 GW of coal “zombies”: power plants that if built will waste public finance, lock consumers into expensive contracts and threaten India's ambitious RE targets.

This report has not taken into account factors that are difficult to predict in the absence of sufficient data. These include the possibility of future energy efficiency gains (particularly in terms of buildings and cooling technologies); the success or the failure of demand side management and peak load shifting that might arise from time-of-day electricity pricing, smart meters and smart plugs; and efficiency gains for solar PV and wind installations. Advances in any of these areas would make the task of moving and managing loads to maximise RE easier. Similarly, offshore wind has not been factored in as India does not yet have any offshore wind installations. The offshore [wind target for 2030](#) is 30GW,²¹ and [preliminary studies](#) suggest an unsubsidised LCOE of Rs.7 to Rs 9/kWh, with higher deployment costs expected to be offset by higher capacity factors,²² addressing the variability aspect of renewable energy.

The main variable that would undermine the ability of RE to meet future demand would be growth rates that exceed projections. However, as discussed in Chapter 1, the long-run pattern has been of Indian electricity growth rates lagging, not exceeding, projections. Another potential challenge would be unexpected price escalations for RE and storage technologies, but this is unlikely given the growing strength and diversification of the global clean energy industry.

Based on the best available data and projections, it is clear that India can benefit by pursuing investments in renewables and storage, instead of additional coal plants beyond those in construction.

Sending a clear signal that new coal projects are not required and should not be built is essential to the success of India's RE deployment and its growing importance for the global RE industry.

India's government must step in to prevent the creation of additional Non Performing Assets in the power sector, by clearly communicating that the era of new coal power construction is over and that public resources will only be mobilised to encourage investments in the clean energy transition.

References

1. CEA, *National Electricity Plan, Generation*, Central Electricity Authority, Gol, 2018.
2. ICRA, *Electricity demand growth estimated at 6.0% and generation capacity addition estimated at 17-18 GW for FY2022*, ICRA Ratings, 2021.
3. MNRE, India achieves 100 GW Milestone of Installed Renewable Energy Capacity, *MNRE*, 2021. Available at: <https://pib.gov.in/PressReleasePage.aspx?PRID=1745254>
4. GEM, *Boom or Bust 2021*, Global Energy Monitor, 2021.
5. IEEFA, *New Coal-fired Power Plants in India: Reality or Just Numbers?*, IEEFA 2021.
6. CEA, *Thermal broad status report - June 2021*, Central Electricity Authority, 2021.
7. CEA, *Report on Optimal Generation Capacity Mix for 2029-30*, Central Electricity Authority, 2020.
8. IEA, *India Energy Outlook 2021*, World Energy Outlook Special Report, International Energy Agency, 2021
9. POSOCO, Daily Report-7 July, Power System Operation Corporation Limited, 2021.
10. Lolla, A, *Peaking Coal?*, Ember, 2021.
11. BloombergNEF, *India's Clean Power Revolution*, Bloomberg Philanthropies, 2020.
12. POSOCO, *Daily Reports*, Power System Operation Corporation Limited, 2021.
13. MoP, Power Sector at a Glance - All India, Ministry of Power, 2021, Available at: <https://powermin.gov.in/en/content/power-sector-glance-all-india>,
14. CRH calculations based on CEA data of project cost and fuel source
15. Mercom, 'After Tamil Nadu, NSEFI Writes to Karnataka About Solar Projects Facing Curtailment', *Mercom India*, 21 June 2019. Available at: <https://mercomindia.com/nsefi-karnataka-solar-curtailment/>
16. ENS, 'Discoms free to exit power purchase pact after term ends', *The Indian Express*, 07 July 2021.
17. Mercom, 'Greenko, ReNew Win SECI's 1.2 GW Solar, Wind Auction with Storage for Peak Power Supply', *Mercom India*, 31 January 2020. Available at: <https://mercomindia.com/greenko-renew-win-seci-solar-wind-auction-with-storage/>

18. Goldie-Scot, L, 'A Behind the Scenes Take on Lithium-ion Battery Prices', *Bloomberg New Energy Finance*, 05 March 2019. Available at: <https://about.bnef.com/blog/behind-scenes-take-lithium-ion-battery-prices/>
19. Berkeley Lab, *Estimating the Cost of Grid-Scale Lithium-Ion Battery Storage in India*, Lawrence Berkeley National Laboratory.
20. Saur Energy, 'RPO Fines Will Lead to Exponentially High Demand: RK Singh', *Saur Energy International*, 29 June 2020. Available at: <https://www.saurenergy.com/solar-energy-policy-india/rpo-fines-will-lead-to-exponentially-high-demand-rk-singh>
21. MNRE, 'Offshore Wind', *Ministry of New and Renewable Energy, India*. Available at: <https://mnre.gov.in/wind/offshore-wind/>
22. Gulia, J and Jain, S, *Offshore Wind Energy in India*, JMK Research and Analytics, 2019.

