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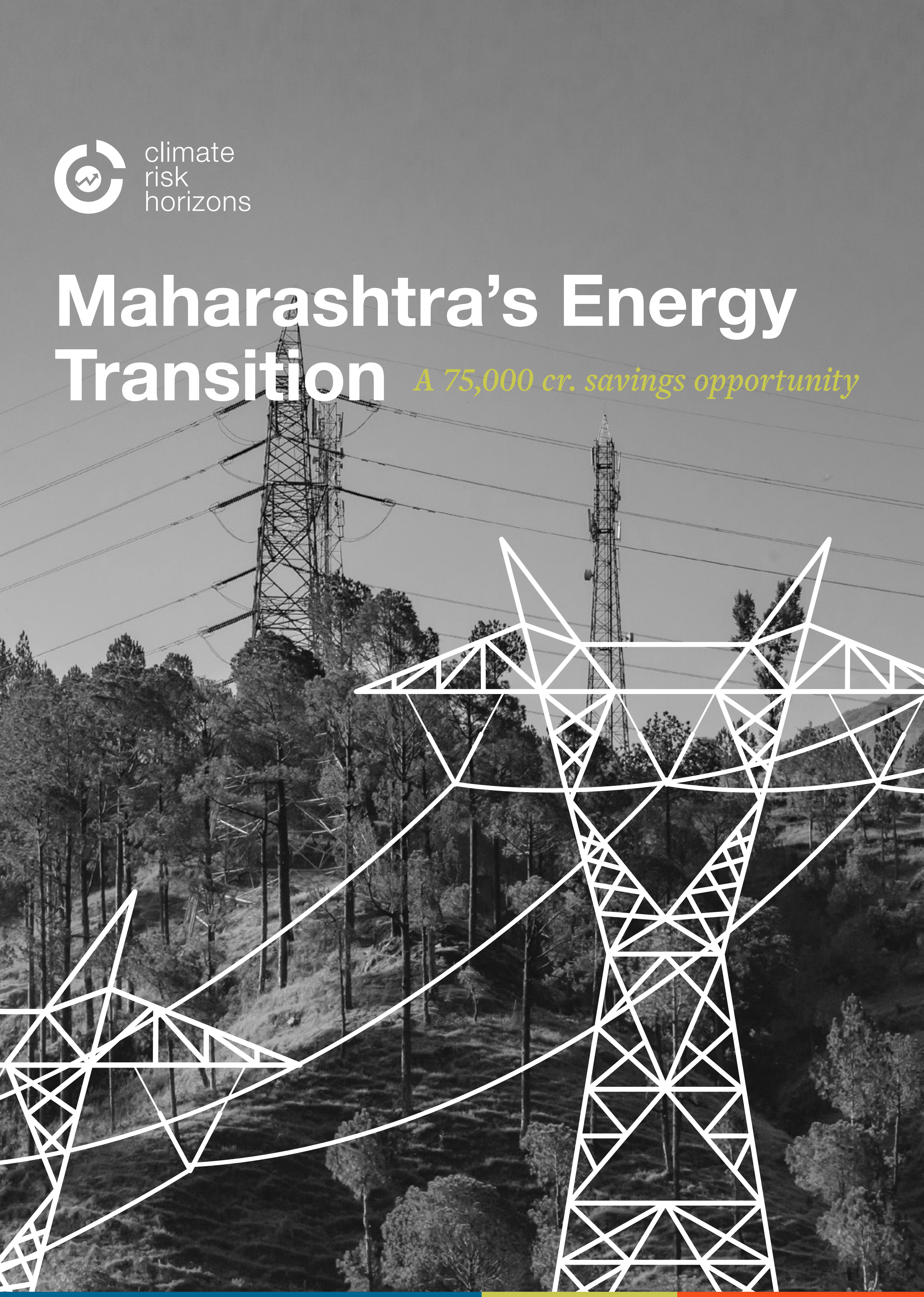
Maharashtra's Energy Transition

A 75,000 cr. savings opportunity



Authors

Ashish Fernandes
CEO & Lead Analyst, Climate Risk Horizons
ashish.fernandes@climateriskhorizons.com

Harshit Sharma
Lead Researcher, Climate Risk Horizons
harshit.sharma@climateriskhorizons.com

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01 Executive summary

In February 2021, Maharashtra's Minister for Environment & Tourism, Aaditya Thackeray said that by 2025, nearly 25% of the state's energy would be met from solar,[1] marking a significant jump in ambition, as the Maharashtra Electricity Regulatory Commission's approved Renewable Purchase Obligation by 2025 is 13.5% for solar, and 11.5% for non-solar renewable energy.

Surplus electricity generation capacity, air pollution regulations and cheap renewable energy offer Maharashtra an opportunity to save Rs.16,000 cr. in 5 years, and over Rs.75,000 cr. in the coming decade

As one of India's most advanced industrial states, Maharashtra has been making steady progress towards a clean energy transition through solar agricultural feeders, solarisation of diesel pumps and procurement of new solar power through competitive bidding processes. However, as this analysis will show, there are several win-win measures that the state government and the state discom MSEDCL can take to accelerate the energy transition while delivering public benefits in terms of lower priced electricity and reduced air pollution. The financial costs from air pollution in India are now well documented—an estimated 5.4% of GDP.[2] Maharashtra, like the rest of India, is already facing the financial impacts of a changing climate. In 2019, the state saw flood events that caused the loss of over 945 million ha.[3] of crops and the loss of at least 377 lives, with Mumbai alone hit by five "extreme rainfall" days.[4] Even as hundreds of thousands were displaced by floods in the western part of the state in 2019, the eastern regions of Vidarbha and Marathwada were in the midst of a severe drought.[5] The cumulative financial impact from loss of life, property and economic disruptions is undermining the economic and social development of the state.[6] Mitigating future climate disruption and planning infrastructure to adapt to this changed future is essential.

Maharashtra also has one of the largest coal power fleets in the country, with 9.75 GW of coal power operated by the state-owned Mahagenco, in addition to 11.58 GW of privately owned coal plants and 3.64 GW operated by NTPC.

In February 2020, Finance Minister Nirmala Sitharaman announced that utilities would be urged to shut down old and polluting power plants in order to meet air pollution targets. CRH has shown in previous analysis[7] that shutting down older coal power plants will also have tangible financial benefits for most discoms, state governments and consumers, apart from improving the overall utilisation rates of the rest of the (younger, more efficient) coal fleet.

So far, there has been little public response from state governments to the Centre's urging, and few firm commitments to shutting down old power plants. A likely reason is that state discoms and generators want to hold on to 'backup' assets in the name of grid stability and projected demand growth. This has led discoms to continue to rely on old, inefficient plants. In this analysis, we aim to show that this fear is unfounded and outdated both because of the current energy surplus scenario, and because more cost-efficient alternatives (new renewable energy as well as power purchases in the real time market) are now available to deal with probable growth in electricity demand and any short term demand-supply gaps.

As of 31 March 2021, MSEDCL, the main distribution company delivering electricity to most of the state, had overdues of approximately ₹10,000 cr. Getting MSEDCL on sound financial ground is critical to Maharashtra's energy transition and economic growth. For adequate and equitable provision of electricity to all sections of society, reducing costs across the generation and supply system is essential.

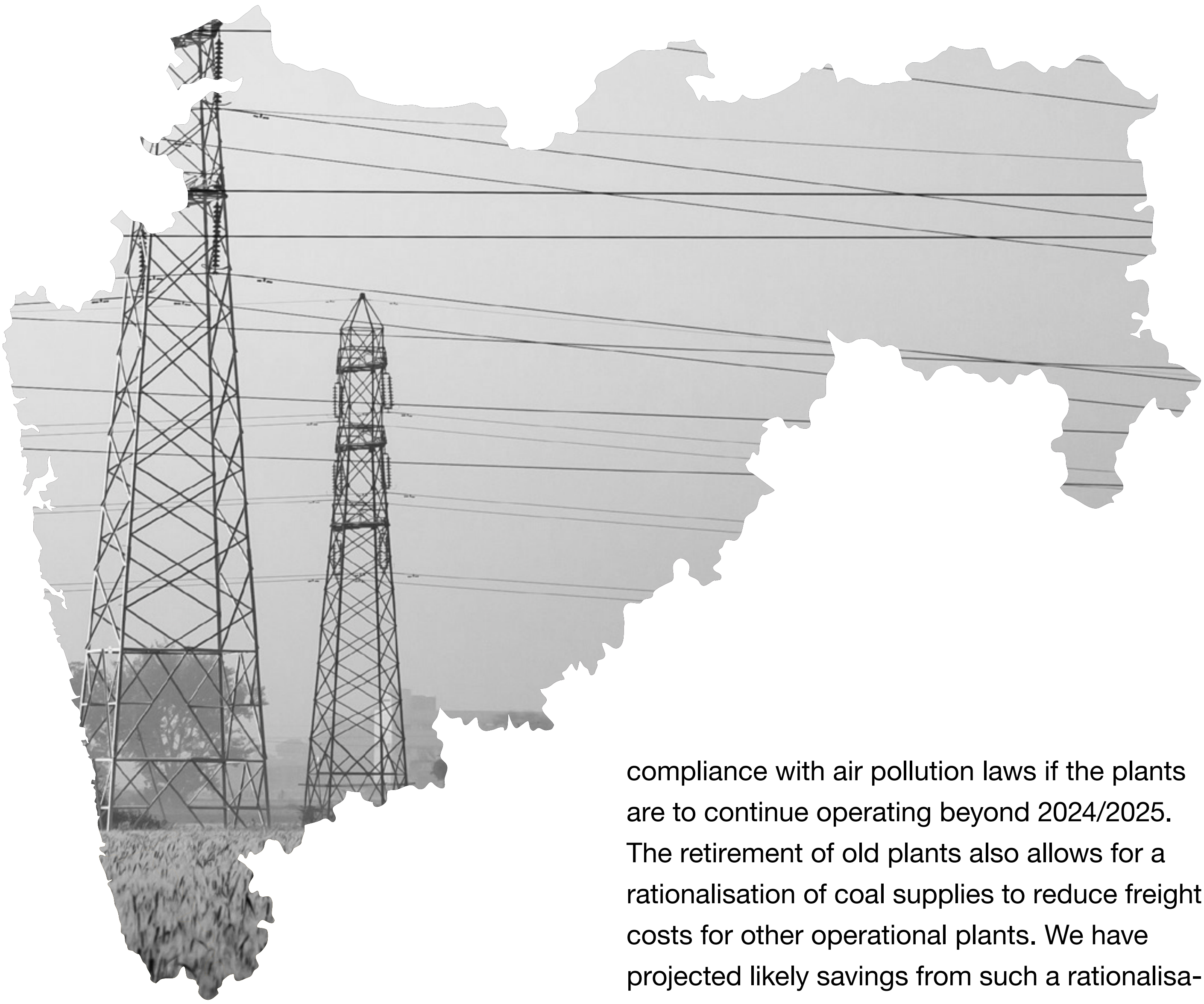
Power purchase accounts for the bulk of system costs, making avenues to reduce the cost of power generation critical.

A convergence of factors today allows for win-win solutions that can deliver ambitious outcomes on several fronts: reducing the cost of power purchase (resulting in a reduced subsidy burden on the state government), improving MSEDCL's financial situation, reducing air pollution and setting up the state to be a national and international leader in the energy transition. These opportunities arise due to the convergence of three factors:

i Surplus coal power capacity
ii Extremely cheap renewables coupled with the declining costs of battery storage systems
iii The deadline by which all coal plants have to be retrofitted to meet air pollution standards

Surplus generation capacity, cheap renewables and an air pollution crisis combine to offer Maharashtra the opportunity to be a leader in the energy transition

This puts the state in a position to phase out its older coal plants over the next two years, and replace scheduled dispatch from these plants with power from new renewable energy



or from higher utilisation of younger, more efficient assets, either state-owned or private. This analysis of Maharashtra's coal fleet attempts a guiding framework to identify which power plants can be phased out in the near term at a net financial benefit to the state and its consumers.

These financial benefits are on account of replacing higher cost power from older plants with cheaper options, as well as avoiding costs from retrofits that are needed to ensure compliance with air pollution laws if the plants are to continue operating beyond 2024/2025. The retirement of old plants also allows for a rationalisation of coal supplies to reduce freight costs for other operational plants. We have projected likely savings from such a rationalisation exercise. In addition, we have suggested ways of approaching the fixed costs payable to the retiring units. We also assess potential savings from freezing expenditure on the one new coal unit under construction in Maharashtra, which is destined to be economically uncompetitive with cheaper sources of electricity.

Lastly, we have also enumerated potential savings from a longer term project to phase out the most expensive coal power plants, irrespective of age.

Key findings

#1

Retiring 4,020 MW of coal power units over 20 years of age and replacing their scheduled generation with new renewable energy would save over ₹10,000 cr. over a five-year period. These savings accrue in two ways:

→ *Rs.2,000 cr. in avoided retrofit costs that would otherwise be required to meet the emission norms*

→ *An additional Rs.1,600 cr. savings per year, assuming an average replacement tariff of Rs.3/kWh. Over a typical five-year tariff period this amounts to Rs.8,000 cr. for a total savings of over Rs.10,000 cr.*

TABLE 1

Coal plants in Maharashtra 20 years or older, that can be phased out with potential savings, based on FY 2022 tariff and dispatch

	Power station/unit	MW	Age	Tariff (₹/kWh)	Savings from replacement with RE (₹cr. p.a.)	Savings from avoided retrofit (₹cr., one-time)
1	Bhusawal TPS unit 3*	210	37	*	132.48	111.3
2	Chandrapur units 3,4	420	33–34	4	228.65	222.6
3	Chandrapur units 5,6,7	1500	22–28	3.15	124.40	727.5
4	Khaparkheda units 1–4	840	20–30	3.89	398.64	445.2
5	Koradi unit 6	210	37	4.95	104.35	111.3
6	Koradi unit 7	210	36	4.95	104.35	111.3
7	Nashik unit 3	210	40	5.86	189.47	111.3
8	Nashik unit 4	210	39	5.87	189.28	111.3
9	Nashik unit 5	210	38	6.25	185.01	111.3
	Total	**4020**			**1656.64**	**2063.1**

* Zero dispatch in tariff order. Variable cost varies from 3.9 to 4.3 between FY 22–FY 25. Annual fixed cost per tariff order ranges between ₹132 cr. and ₹153 cr. per annum.

#2

Retiring these old units provides Mahagenco with flexibility to rationalise coal supplies, by replacing coal from distant mines with supplies from mines closer to the remaining operational coal fleet. We estimate that this rationalisation can yield a further savings of approximately ₹627 cr. and possibly as much as ₹967 cr. annually.

#3

Halting construction of the 660 MW Bhusawal Unit 6 will save ₹3,158 cr. of projected expenditure. This unit is at a relatively early stage of construction and as we show later in the report, is neither required nor competitive with alternative electricity sources. Mahagenco also has regulatory approval to build two more units at Koradi, which would cost approximately ₹11,000 cr. if sanctioned by the state government.

#4

A 10-year project to phase out the most expensive coal power plants (irrespective of age) and replace them with renewable energy can yield significant savings. If scheduled generation from all plants with tariffs at ₹4/kWh or higher were to be gradually replaced with power from renewables at an average of ₹3/kWh, there would be a potential savings of over ₹60,000 cr. over five years (based on projected FY 2025 power tariffs) in terms of reduced power purchase costs by Maharashtra State Electricity Distribution Company Limited (refer to Table 8). Tapping into these potential savings should be part of longer term planning, through a gradual phase out of expensive coal contracts on a case by case basis.

TABLE 2
Summary of savings

Summary of potential savings for MSEDCL and state government	
Avoided retrofits by phasing out plants 20 years and older	₹2,063 cr.
Replace lost generation from plants 20 years and older with renewable energy	₹1,656 cr. (p.a.) ₹8,280 cr. (5 years)
Coal supply rationalisation to reduce freight charges	₹627–967 cr. (p.a.)
Freezing expenditure on Bhusawal Unit 6 plant under construction	₹3,158 cr.
First year savings	**₹7,504 cr. ₹16,636 cr. (over 5 years)**
Phase out all coal plants with tariffs >₹4kWh and replace with power at ₹3/kWh (between 2025–2030)	**₹12,528 cr. (p.a.) ₹62,641 cr. (5 years)**

Implications for state budget and deficits

This planned transition can save the state tens of thousands of crores. Cumulatively, a 10-year plan to phase out the oldest and most expensive coal power generators can save the state ₹7,500 cr. in Year 1, ₹16,000 cr. over the first five years, and approximately ₹60,000 cr. in the next five, for a total saving of over ₹75,000 cr. over 10 years.

This comes at a time when Covid-19 is causing an unprecedented financial crisis for the state, with tax revenues falling sharply. To put the potential savings into perspective, India Ratings estimates Maharashtra's fiscal slippage for FY2021, due mainly to Covid-19, at ₹33,000 cr.[8]

The ₹7,500 cr. saved in Year 1 would be enough to cover:

→ *Complete Covid vaccination for 75% Maharashtra's population (based on Rs.400/ dose pricing)*[9]

→ *Over 75% of the approximately Rs.10,000 cr. electricity subsidy to farmers*[10] *and to industrial units in Vidarbha.*[11]

The ₹16,000 savings over the first five years would be sufficient to cover:

→ *Over 50% of the 2019 farm loan waiver scheme announced by the Maharashtra government (expected to cover about Rs.29,000 cr. in distressed loans).*[12]

The ₹75,000 cr. savings over ten years would be sufficient to cover:

→ *Maharashtra's current fiscal deficit, which in FY2020 was Rs.78,617 cr.*[13]

02 Recommendations

The Maharashtra government must work towards a 10-year plan aimed at making MSEDCL profitable while advancing social goals of affordable, reliable electricity, reduced air pollution and reduced carbon emissions. This plan should include, inter alia, the following key elements:

01 »

Accelerated phase out of older, inefficient, polluting coal plants and an assessment of the financial benefits of repurposing these sites.

All of the plants at or near the end of their life are owned by the state government. Due to their age and general inefficiencies, the variable cost of power from most of these units is high. Rather than incurring additional capex on retrofits for these plants to get them to meet the 2015 air emission norms and maintain their operational readiness, the government could instead undertake to shut them down by December 2022, and generate immediate savings and reductions in power purchase costs.

There is significant surplus generation capacity in the electricity system (Maharashtra's entire coal fleet ran at 47.65% PLF in FY 2020, before the onset of Covid-19) to compensate for the loss of generation and address fears of grid stability. MSEDCL should also plan to replace lost generation from retiring units with renewable energy/renewable + storage projects, particularly distributed small to medium scale projects that reduce transmission losses and minimise issues of displacement/land conflict. Given recent price declines, new RE projects will provide electricity at cheaper rates than most existing and all new thermal power, particularly if MSEDCL goes the competitive bidding route with payment guarantee mechanisms.

MSEDCL needs to bring down the average cost of power purchased. This can be done over the medium to long term through a planned phase out of PPAs with tariffs above ₹4/kWh, (irrespective of age of the plant), starting with the most expensive. On a case by case basis, this can be done while upholding the sanctity of contracts, for example, at the end of current contract life. Where all parties are government entities, there could be a case for ending contracts prematurely given the savings that will be generated across the system. Alternatively, contracts can be reconfigured to reward flexible generation through a premium for peaking power supply at times when cheaper renewables are unavailable.

These and other options that lower the average purchase price need to be explored.

02 »

Additional expenditure on the under construction Bhusawal Unit 6 should be halted and the proposed Koradi 11 and 12 units should be permanently cancelled.

Any new coal power plant compliant with air pollution regulations will not be cost competitive with new renewable energy and is unlikely to be run at optimal capacity factors given the power demand scenario and the merit order dispatch benefits enjoyed by renewable power. Despite the expenditure incurred thus far, the state government should consider halting the project and diverting the land for more constructive purposes that can help reduce average power costs, such as converting to solar/wind+battery storage, or synchronous condenser if feasible.

Given the shifting energy economics of coal versus renewables, a like for like replacement of retiring coal units is also not economically justifiable, making the plans for the Koradi Units 11 and 12 obsolete.

03 »

Incentivise community level grid-connected decentralised solar/solarisation of pump sets to meet rural/agricultural demand.

Removal of cross subsidies used to provide cheap or free power for agricultural use can be socially regressive and politically difficult. Meeting a growing proportion of this demand closer to source through distributed solar installations and the solarisation of pump sets are useful ways to reduce transmission losses and subsidies. Savings generated from pursuing the options listed in this report could be invested in meeting rural/agricultural demand via solar PV, yielding a double benefit for discoms and the state government. More fundamentally, policy incentives to encourage regionally appropriate cropping are essential. There has been other research on this,[14,15] so this report will not go further into this aspect, other than to say that adding decentralised, low cost generation has a critical role to play in electricity sector reform, delivering reliable electricity to all and addressing the gap between cost of supply and actual revenue recovery.

04 »

Tap international green finance streams to transition away from coal.

The Maharashtra state government should assess the feasibility of tapping into international green finance flows to fund energy transition investments (solar/wind capacity, battery storage, modernisation of grid infrastructure) that are tied to a parallel commitment to retire old coal assets owned by the state. "Transition bonds" could be used to defray costs associated with coal plant retirement and repurposing of sites and machinery.

In summation, Maharashtra can reduce its dependence on coal at significant benefits to the state exchequer, economic competitiveness, consumers' pockets and public health. Diverting some or all of the savings spelled out above towards cheaper renewable energy, grid modernisation, energy efficiency, rural grid connected solar/wind, energy storage investments etc., would be a more productive use of public money as compared to keeping inefficient and polluting power stations in operation.

03 Background

Three converging factors have made possible what would once have seemed impossible: the phaseout of all of Mahahrashtra's old (>20 years) coal plants over the next two years. These three factors are:

- *A surplus of "firm" generating capacity in the state and on the national grid*
- *The plummeting cost of renewable energy and declining costs of battery storage*
- *The legal mandate for all power plants to instal pollution control technology by December 2022–December 2024.*

FACTOR 01 »

Surplus generation capacity

The existing surplus capacity in the state's generation system has been exacerbated by the slump in electricity demand due to the medium to long term economic impacts of Covid-19. This however provides the state with an opportunity to retire its oldest, most expensive coal plants without fear of being unable to meet likely demand growth.

The state already faces the financial costs of a surfeit of coal generation capacity. The Maharashtra Electricity Regulatory Commission's (MERC) tariff order for FY 2021–FY 2025 dated March 30, 2020[16] warns that the state discom MSEDCL will pay ₹1,120 cr. by way of fixed cost/capacity charges to power plants with zero scheduled dispatch in FY 2022. By 2025, this will rise to nearly ₹1,400 cr.

MERC advice for MSEDCL: Review PPAs and explore options to optimise the impact of the fixed cost of the contracted capacity

The order projects that the state will have approximately 15% surplus electricity available above requirement each year from FY 2021 to FY 2025, at an estimated power purchase cost of approximately 10,000 cr. a year. MERC advises that MSEDCL should "review its PPAs (power purchase agreements) and explore options to optimise the impact of the fixed cost of the contracted capacity, including deferment in cases where no significant work execution has taken place so far."

This surplus capacity is also reflected in the Plant Load Factors for thermal power plants in the state.

TABLE 3

Plant Load Factors of coal power plants in Maharashtra, FY 2018–FY 2020

	FY 2020	FY 2019	FY 2018
PLF	47.65	53.63	50.31

Source: CEA

TABLE 4

Coal power plants located in MH showing age, tariff and utilisation for FY 2020 (data based on Central Electricity Authority reports and MERC tariff order)

Plant Bhusawal {Unit 3} 210 MW | *Age* 37 *Tariff* – | *Utilisation* 2.85%	*Plant* Bhusawal {Unit 4} 500 MW | *Age* 7 *Tariff* ₹5.23 | *Utilisation* 63.72%	*Plant* Bhusawal {Unit 5} 500 MW | *Age* 7 *Tariff* ₹5.5 | *Utilisation* 54.57%
Plant Chandrapur {Units 3,4} 210 MW x 2 | *Age* 34,33 *Tariff* ₹4.00 | *Utilisation* 61.64%	*Plant* Chandrapur {Units 5,6,7} 500 MW x 3 | *Age* 28,27,22 *Tariff* ₹3.15 | *Utilisation* 51.62%	*Plant* Khaparkheda {Units 1–4} 210 MW x 4 | *Age* 30,29,19,18 *Tariff* ₹3.81 | *Utilisation* 52.18%
Plant Khaparkheda {Unit 5} 500 MW | *Age* 8 *Tariff* ₹4.07 | *Utilisation* 72.63%	*Plant* Koradi {Units 6,7} 210 MW x 2 | *Age* 37,36 *Tariff* ₹4.73 | *Utilisation* 13.93%	*Plant* Koradi {Units 8,9,10} 660 MW x 3 | *Age* 4,3,3 *Tariff* ₹3.90 | *Utilisation* 49.05%
Plant Nashik {Unit 3} 210 MW | *Age* 40 *Tariff* ₹5.45 | *Utilisation* 36.78%	*Plant* Nashik {Unit 4} 210 MW | *Age* 39 *Tariff* ₹5.74 | *Utilisation* 48.41%	*Plant* Paras {Units 3,4} 250 MW x 2 | *Age* 12,9 *Tariff* ₹4.70 | *Utilisation* 59.97%
Plant Parli {Units 6,7} 250 MW x 2 | *Age* 12,9 *Tariff* ₹4.00 | *Utilisation* 34.88%	*Plant* Parli {Unit 8} 250 MW | *Age* 3 *Tariff* ₹17.66 | *Utilisation* 38.39%	*Plant* Mauda {Units 1,2} 660 MW x 2 | *Age* 3,2 *Tariff* ₹9.01 | *Utilisation* 41.68%
Plant Mauda {Units 3,4} 500 MW x 2 | *Age* 7,6 *Tariff* ₹4.73 | *Utilisation* 61.87%	*Plant* Solapur {Unit 1} 660 MW | *Age* 2 *Tariff* ₹23.13 | *Utilisation* 10.43%	*Plant* Solapur {Unit 2} 660 MW | *Age* 1 *Tariff* ₹3.75 | *Utilisation* 2.99%

Plant EMCO Warora {Units 1,2} 300 MW x 2 | *Age* 6,6 *Tariff* ₹4.50 | *Utilisation* 76.49%	*Plant* JSW Ratnagiri {Units 1–4} 300 MW x 4 | *Age* 9,9,8,8 *Tariff* ₹3.61 | *Utilisation* 73.15%	*Plant* RattanIndia Amravati {Units 1–5} | 270 MW x 5 *Age* 6,5,4,4,4 *Tariff* ₹6.78 | *Utilisation* 26.96%
Plant Tiroda {Units 1–5} 660 MW x 5 | *Age* 7,6,6,5,5 *Tariff* ₹4.23, ₹2.98, ₹4.32, ₹4.34 *Utilisation* 77.61%	*Plant* RattanIndia Nashik {Units 1–5} 270 MW x 5 | *Age* 5,2,2,2,2 *Tariff* # | *Utilisation* 0%	*Plant* Bela {Unit 1} 270 MW | *Age* 6 *Tariff* # | *Utilisation* 0%
Plant Butibori {Units 1,2} 300 MW x 2 | *Age* 7,6 *Tariff* # | *Utilisation* 0%	*Plant* Dhariwal {Units 1,2} 300 MW x 2 | *Age* 6,5 *Tariff* # | *Utilisation* 61.87%	*Plant* GEPL Gugus {Units 1,2} 60 MW x 2 | *Age* 7,7 *Tariff* # | *Utilisation* 0%
Plant Mihan {Units 1–4} 61.5 MW x 4 | *Age* 7,7,7,7 *Tariff* # | *Utilisation* 0%	*Plant* Shirpur {Unit 1} 150 MW | *Age* 2 *Tariff* # | *Utilisation* 0%	*Plant* Wardha Warora {Units 1–4} 135 MW x 4 | *Age* 9,9,8,8 *Tariff* # | *Utilisation* 2.94%
Plant Trombay {Units 5,8} 500 MW, 250 MW | *Age* 35,10 *Tariff* # | *Utilisation* 69.99%	*Plant* Dahanu {Units 1,2} 250 MW x 2 | *Age* 24,24 *Tariff* # | *Utilisation* 83.32%	* # not in tariff order, no dispatch to MSEDCL

Even at peak demand times, the CEA had anticipated a 3.5% surplus availability at peak moments for Maharashtra in FY 2021.[17] As Table 5 shows, even during peak load months for the last four years, there has been significant unused thermal generation capacity, with the PLFs of private generators in Maharashtra ranging between 54% and 62%, while that of central and state thermal plants has been between 51% and 77%. Clearly, while capacity factors at the central and state plants are higher than the annual average, there is still enough headroom for increased generation across all three categories, but most particularly with the private sector plants.

TABLE 5

Demand and Plant Load Factors in peak months

	Peak month	Average peak demand (MW)*	PLF (Thermal | Peak month)			
			State	Central	Private	Combined
FY 2018	April	21,953	61.38	77.32	54.02	59.45
FY 2019	October	23,419	51.51	63.11	62.45	58.06
FY 2020	February	23,043	60.82	45.75	55.96	56.37
FY 2021	April	24, 317	68.87	69.27	56.53	63.24

* Average of daily peaks in the relevant peak demand month, based on State Load Dispatch Centre data.

Since FY 2018, the state's actual peak electricity demand has been growing at a lower than expected CAGR of 2.5%. However, even the data above is averaged over a peak month. Maharashtra's highest ever peak demand, based on the State Load Dispatch Centre's Daily System report, was 25,644 MW at 12 p.m. on 08/04/21.[18] The state was able to meet this peak with zero load shedding and still had 3,702 MW of surplus thermal capacity in total contracted to MSEDCL,[19] spread across the private sector (202 MW) and state sector (3,123 MW of coal and 377 MW gas). Another 1,866 MW of private coal plants in Maharashtra sit idle with no PPAs.

This peak is more than 3,000 MW lower than past projections. For e.g., the National Electricity Plan 2018, which in turn is based on the 19th Electric Power Survey, projected that peak electricity demand in Maharashtra would be 28,866 MW in FY 2022 and 39,928 MW by FY 2027.[20]

The usual argument against the replacement of old coal power with variable renewable energy (i.e., the need for grid balancing power sources) thus does not apply, given that Maharashtra's operating coal fleet has significant unutilised capacities that can be called upon if the need arises, apart from short term purchases on the energy exchange. This provides the state with the chance to retire older, less efficient, more polluting power plants. Given the significant surplus generation capacity in the system, keeping inefficient plants in service is not an optimal way to ensure grid stability.

Electricity demand will likely grow at a faster rate in the coming years as the economy recovers. This additional demand can be met in several ways—ensuring higher utilisation levels of the operational fleet across all three sectors (state, central and private) is the easiest short term solution to meet peak requirements. As detailed on the following pages, the state is also going to be adding significant amounts of renewable energy to the grid over the next 2–3 years. Looking further out, ensuring a supportive policy and investment environment for new renewable energy to grow (including RE + storage) is essential, as electricity from renewable projects will be at significantly lower rates than existing coal power, particularly if there is a guaranteed offtake and payment agreement with MSEDCL. Increased power purchase from the open market to smooth over short-term disparities is an increasingly attractive option given the progress that has been made on grid integration and real time and day ahead markets.

New renewable capacity and increased generation from operational coal units is the cheapest way to meet demand growth

In combination, these solutions can address apprehensions about having enough "firm" power to meet peaking demand.

FACTOR

02 »

Falling cost of renewable energy

New renewable energy (solar PV or wind) is now reliably available at less than ₹3/kWh, with a record low tariff of ₹1.99/kWh set in December 2020.[21] In March 2021, the winnings bids for Gujarat Urja Vikas Nigam Limited's (GUVNL) auction to purchase 500 MW were ₹2.20 and ₹2.21/kWh. These bids were after the announcement of Basic Customs Duty of 15% and 25% respectively for solar cells and modules, which will be effective from April 2022, but there is uncertainty as to whether the BCD was incorporated into the bids, with some reports suggesting a tariff that incorporates the impact of the BCD would be closer to ₹2.50/kWh.[22]

In this analysis, we have assumed a conservative ₹3/kWh for new renewable energy. Even at that level, renewable energy is cheaper than a large segment of existing coal power generation and at 40–50% of the cost of new coal power.

Less recent bids for round the clock renewable energy (with storage) saw a combined tariff of ₹3.6[23]—below a significant proportion of existing coal generation. The Lawrence Berkeley National Laboratory has estimated that solar PV with Li-ion battery storage can deliver electricity at a tariff of ₹3.94 in 2020, dropping to ₹3.32 by 2025 and ₹2.83 by 2030.[24] Even if predicted cost declines do not materialise, existing costs already question the competitiveness and financial viability of any new coal project.

As of September 2020, Maharashtra had a relatively small 1.6 GW of operational solar projects and another 1.2 GW under development.[25] The state's recently released Unconventional Energy Generation Policy sets a target of 17,360 MW of renewable energy by 2025, primarily solar and wind.[26] If renewable energy installations meet or even approach official targets, demand for thermal generation will be impacted.

There are also other government renewable energy schemes under implementation. The Mukhyamantri Saur Krushi Pump Yojana seeks to deploy 100,000 off-grid solar power pumps.[27] This scheme has achieved 60% of its target, and the balance is due to be installed by September 2021,[28] reducing future demand on the grid from electric pumps.

Existing renewable targets and surplus thermal capacity will ensure that demand growth can be met

A parallel scheme, the Mukhyamantri Saur Krushi Vahini Yojana, will more actively seek to meet existing agricultural electricity load through decentralised solar power feeders, by installing 2–10 MW capacity solar projects within 5 kilometres of 33/11 kV MSEDCL substations.[29] As of October 2020, 274 MW has been commissioned. The total capacity that has filed for approval from the Maharashtra Electricity Regulatory Authority is 3,170 MW, of which 1,826 MW has already been approved. Tariffs for commissioned projects range between ₹2.94 and ₹3.15/kWh[30]—a substantial discount compared to thermal power.

Existing Maharashtra government targets for renewable energy, in combination with the existing surplus thermal capacity ensure that future growth in demand can be met even after retiring the older coal plants.

FACTOR 03 »

Legal liability from failure to comply with air emission norms

The third factor creating conditions for a beneficial phase out of old coal plants is the deadline for compliance with air emission norms. The Ministry of Environment, Forests & Climate Change requires air emission controls on all power plants, progress on which has been slow, leading to public protest and monitoring by the courts. Covid-19 has underlined the co-morbidity impacts of air pollution across the Indian population. The public and political pressure to tackle air pollution will grow as pollution levels once again rise to unhealthy levels with the lifting of Covid-19 lockdowns. With public pressure growing, all coal power plants will have to install pollution control technologies, or face growing litigation, loss of social license and public pressure. The Ministry of Environment, Forests & Climate Change on March 31, 2021 amended[31] the deadline by which all power plants need to be compliant with the 2015 air emission standards.

The original date for compliance was 2017, then pushed back to December 2022 and now plants not slated to retire by 2025 will have up to December 2024 to meet emission limits.

CRH's estimate based on the notification is that most Mahagenco plants over the age of 20 years (Koradi, Khaparkheda and Nasik) will still face a deadline of December 2022 for compliance. The older units at Chandrapur might have an additional year to December 2023, and Unit 3 at Bhusawal might have up to December 2024.

Retrofitting all Mahagenco plants with FGDs and low NOx burners will cost an estimated ₹4,700 cr., of which ₹2000 cr. is the share of Mahagenco's older plants. This refers to capex only and does not include running costs. For Mahagenco's old plants, incurring over ₹2,000 cr. to install Pollution Control Technology is simply not wise. An accelerated phase out of these 4,020 MW of plants is a more prudent choice.

In addition to the air pollution regulations, Maharashtra's coal plants also face legal liability from flyash and other discharges, which are the subject of legal proceedings.[32] Shutting down the older plants will prevent recurrences and allow the state to address the legal liabilities already created.

Given recent changes in the economic and energy situation in India and in Maharashtra in particular, this analysis set out to assess the financial benefits and feasibility of a planned phaseout of Maharashtra's oldest coal power plants, as detailed in the Findings section.

Discussion of other costs and benefits

A gradual phaseout of older coal plants and replacement with renewable energy involves other costs and benefits that need further study. A few of these are discussed below.

#1

→ *Direct job losses: In the case of coal units being shut, there will need to be an assessment of job losses, and the extent to which these can be absorbed by other parts of Mahagenco's operations. Since most of the units proposed for phaseout have other (younger) operating units in the same complex, it is likely that a significant number of "losses" can be absorbed into other operations at the same site, or other Mahagenco operations in other locations. However, this needs further analysis and verification.*

#2

→ *Indirect job losses: This refers to losses in the coal transportation value chain and are harder to quantify due to the informal nature of these jobs. However, again due to the fact that most locations will continue to have operating coal units these impacts are likely low.*

#3

→ *Capital costs of replacing generation from older coal plants with additional renewable energy: While replacement with cheaper renewable energy will deliver lifetime savings, initial upfront capital costs are high. This can be mitigated by well designed policy and innovative financing.*

#4

→ *Environmental benefits: This analysis has not attempted to enumerate ancillary benefits from a phaseout of older coal plants. Briefly, these would be, a reduction in air pollution, coal dust, coal transport traffic, fly ash generation etc. These pose significant problems to areas with a high concentration of coal power units, (Chandrapur for example).*

#5

→ *Water availability: Barring the Chandrapur and Bhusawal units, all the other candidates for retirement operate in high water stress areas. Most, including Chandrapur, have experienced water-related conflict or outages. The likely benefits to farmers and communities from a reduction in water consumption consequent on the retirement of these plants deserves further study.*

The fixed cost conundrum

The most common argument against retirement of old coal plants holds that any savings will be negligible because only the variable cost (VC) of a coal power plant should be compared to new RE (rather than comparing the total tariff) as fixed costs (FC) are sunk costs that are payable even in the case of plant retirement. This argument holds that since the difference between coal plant VC and new RE is on average relatively small, the savings from a retirement of old coal plants and their replacement with renewable energy will be minor or (in some cases) non-existent.

However, this argument has several flaws. Most obviously, it suffers from limited vision by restricting the discussion to variable costs only, and assuming that repaying fixed costs is inescapable. A cost is a cost, whether sunk or not, and if the objective is to reduce power system costs, fixed costs deserve to be part of the discussion. Secondly, since renewable energy projects are considered only on the basis of an absolute tariff, equating RE's total tariff with coal power's variable costs alone is not a like for like comparison, and one that hides the potential financial benefits of the energy transition.

Rather than accepting fixed costs as an inevitable drain on public resources to keep an inefficient and polluting asset operating for the foreseeable future, we suggest ways to eliminate or reduce them. Since the old coal plants that could be retired in the next few years are all state owned, there is flexibility to explore the following options to address these fixed costs:

→ *Arrive at outstanding fixed cost payable in terms of debt alone. FC is comprised of interest on loans, return on equity, depreciation and operation and maintenance charges. Obviously, when considering the retirement of state-owned assets, the O&M and Return on Equity components of fixed cost can be discarded. A key question thus becomes what is the debt repayable for the asset to be retired. This will then allow further analysis to devise securitization schemes or a debt repayment schedule out of the savings generated from a switch to cheaper renewable energy.*

→ *Even more ambitious and flexible options arise in the case of debt repayable to public sector banks or financial entities, allowing for haircuts and restructuring of this debt and the utilization of transition bonds or securitization to repay remaining dues.*

→ *The variable costs of several of Mahagenco's old coal plants are well above that of new renewable energy tariffs, implying a saving even if fixed costs continue to be paid after retirement of the unit.*

→ *Outstanding debt payments can also be met through proceeds from repurposing of the retired coal plant site and machinery.*

#6

→ *Repurposing of sites and machinery:* *Repurposing of sites and machinery Decommissioning old coal plants frees up land and offers not insignificant monetary value in terms of scrap. Initial research indicates significant likely financial benefits from retiring coal power plants and repurposing the site and equipment. For instance, one assessment[33] based on data from NTPC's Badarpur plant in Delhi suggests that repurposing decommissioned coal plants for either solar, battery energy storage system or synchronous condenser can yield benefits that can cover between 22.5% up to 67.8% of the capital expenditure required.*

A detailed and plant-specific analysis of the possible benefits of repurposing Maharashtra's old coal power plants is required to enable Mahagenco and the state government to assess possible options.

03 Data and methods

The CEA's National Electricity Plan 2018[34] has three lists of plants that should be retired. These lists are:

- *Those considered for retirement by 2022*
- *Those >25 years by 01/11/22 and without space for FGD*
- *Those >25 years by 01/11/22 that should be considered for shutdown during the 2022–27 period. Lowering the threshold for retirement to plants above 20 years of age today (rather than 25 years by 2022) shows stronger system-wide financial benefits.*

The CEA has provided indicative estimates of FGD capex costs,[35] ranging from ₹300,0,000–₹450,000 per MW, depending on unit size. We have assumed that NOx standards for these older plants can be met through retrofitting units with low NOx burners. We have used the estimate by IISD et. al. of ₹800,000 per MW for installation of Low NOx burners.[36] Data on the status of retrofits to meet the 2015 emission norms is taken from the Central Electricity Authority's February 2021[37] monthly FGD implementation status report.

This report relies on the last generation tariff order (dated 30/03/20 for tariff period FY 2021–2025) by the Maharashtra Electricity Regulatory Commission for data on total tariff, fixed costs and variable costs as well as scheduled electricity dispatch.[38] Based on scheduled dispatch in the generation tariff order, we estimate likely net savings or loss per annum after replacing the lost generation from the plants being retired. There is usually some variance between projected figures in tariff orders and actual realised tariff and dispatch figures, but such variations tend to be marginal. The state tariff orders remain the best way to forecast likely cost and generation.

For an assessment of likely savings from retiring all plants supplying expensive power (irrespective of age), we have taken ₹4/kWh as a tariff threshold for replacement, as electricity costing more than this is at least 33% more expensive than alternatives available today.

This assumption is based on renewable energy and renewable energy + storage bids recorded over the last year. New solar/wind tariffs are uniformly in the ₹2–₹2.8/kWh range, and solar + storage tariffs discovered in recent auctions range between ₹3.6–₹4.3.kWh. The solar/wind + storage tariffs can vary significantly depending on the size of storage and the specifics of the storage systems used. Bloomberg New Energy Finance estimates a continued cost reduction for new solar PV by 2025 and 2030 of 14% and 22% respectively, and a decline in costs for solar/wind + battery storage of about 40% by 2030.[39] The CEA also assumes a similar cost trajectory decline for battery energy storage systems by 2030.[40] Lawrence Berkeley National Laboratory estimates solar PV + Li-ion battery storage costs at ₹3.94 in 2020, falling to ₹3.32 by 2025.[41] Given both existing costs and projections of further declines, we have erred on the conservative side by adopting ₹4/kWh as a threshold above which power generation can be considered more expensive than competitive sources.

Similarly, we err on the conservative side by assuming a new renewable energy tariff of ₹3/kWh to replace lost generation from plants being retired. New solar PV and wind energy projects have reliably recorded tariffs below that level, despite significant regulatory uncertainties in 2019 and 2020. Data on the under construction Bhusawal Unit 6 coal plant is sourced from the Central Electricity Authority's Broad Status Report (Jan 2021).[42] Since this is a Mahagenco plant, the ultimate burden of paying for this plant will fall on the state government and consumers.

Assumptions on coal linkage rationalisation

We have calculated likely savings based on a rationalisation of Mahagenco's coal supplies that will be possible once older plants are retired. We have used data from Mahagenco's annual report (FY 2018)[43] which provides details on FSAs signed with Coal India subsidiaries. We have assumed that coal supplies from Western Coalfields Limited were first allotted to older Mahagenco units in the state, and as coal requirements grew with newer units being commissioned, any shortfall in supplies was met with coal from CIL subsidiaries in other states, namely Mahanadi Coalfields and South Eastern Coalfields.

The publicly available data on coal linkages between CIL subsidiaries and Mahagenco plants does not disclose the specific mine from which coal is sourced. Therefore, we have conservatively assumed that non-WCL coal linkages were from the non-WCL mine nearest the power plant in question, a "lowest case" scenario in terms of freight costs. Further, when reallocating the "freed up" coal supply arising from the shut down of an old plant, we have assumed that that coal was originating from the WCL mine farthest to the unit. These assumptions are thus doubly conservative (as it pertains to current freight cost and freight costs after rationalisation) and thus represent a "lowest case" scenario for possible savings from coal linkage rationalisation. When viewed with the "highest case" scenario, this gives an indication of the range of possible savings. We also assume that Mahagenco intends to avail of the entire FSA linkage quantity and that all coal transport is via rail and not road.

To calculate rail distances from mines to power plants we have used the shortest route provided by Rates Branch System[44] of the Indian Railways. The system in many cases also provides a longer rationalised route along with the shortest path, but for sake of simplicity we have used the shortest distance only. Freight rates were determined using Freight Operations Information System[45] of the Indian Railways.

04 Findings

01 » Rs.10,000 cr. = Saving from retiring coal plants over 20 years of age

Retiring all coal power units over 20 years of age would yield savings of ₹10,000 cr. over a five-year period. These savings accrue in two ways:

→ *Shutting down 4,020 MW of old coal plants saves over Rs.2,000 cr. in avoided retrofit costs. These are costs on pollution control equipment that must be incurred by 2022, or 2024, at the latest. Prior to the recent amendment in the deadlines, Mahagenco was already likely in legal violation of the emission standards for some of its plants.*

→ *If scheduled dispatch (based on the approved tariff order) from these plants were to be replaced with new renewable energy at prevalent rates, this would save at least an additional Rs.1,600 cr. per year, assuming an average replacement tariff of Rs.3/kWh. Over a typical five-year tariff period this amounts to Rs.8,000 cr. It is possible that savings could be higher as recent RE tariffs have been reliably lower than Rs.3/kWh.*

FIGURE 1

Savings from replacing old TPPs with RE; avoided retrofit cost in cr.

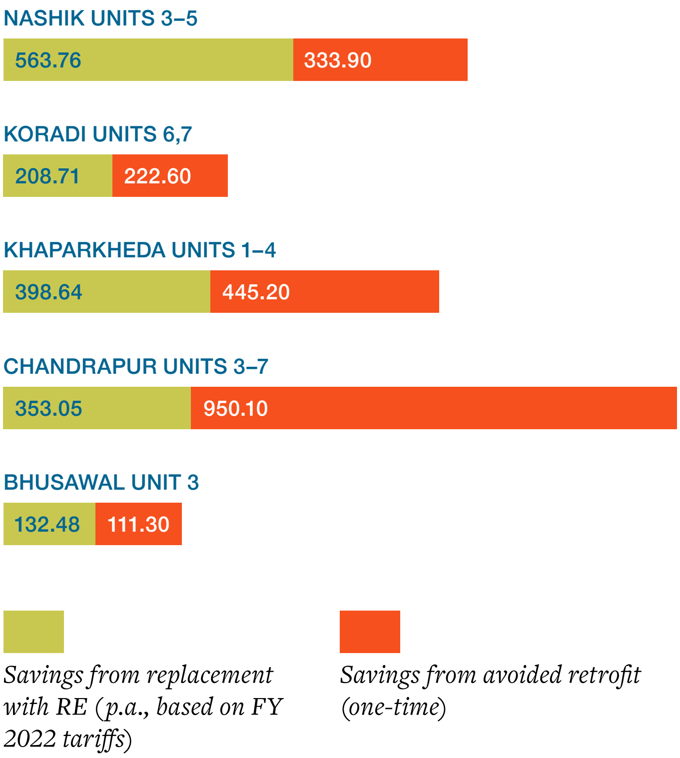


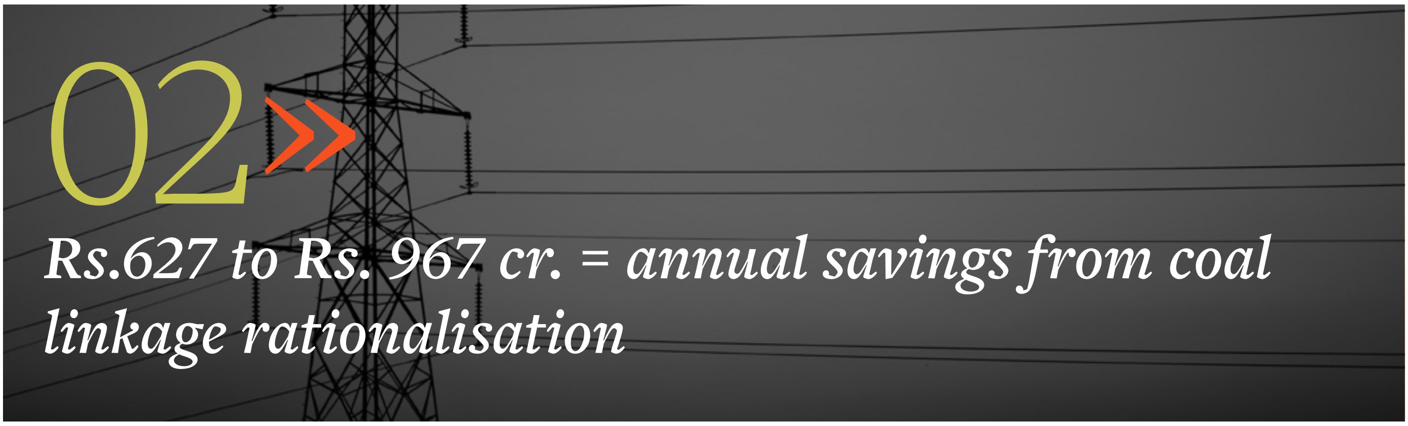
TABLE 6

Coal plants in Maharashtra 20 years or older that can be phased out with potential savings, based on FY 2022 tariff and dispatch

No.	Power station	MW	Age	Tariff	Savings from replacement with RE (p.a)	Savings from avoided retrofit (one-time)
01	Bhusawal TPS Unit 3*	210	37 years	*	₹132.48 cr.	₹111.3 cr.
02	Chandrapur Units 3–4	420	33,34 years	₹4/kWh	₹228.65 cr.	₹222.6 cr.
03	Chandrapur Units 5–7	1500	22–28 years	₹3.15/kWh	₹124.40 cr.	₹727.5 cr.
04	Khaparkheda Units 1–4	840	20–30 years	₹3.89/kWh	₹398.64 cr.	₹445.2 cr.
05	Koradi Unit 6	210	37 years	₹4.95/kWh	₹104.35 cr.	₹111.3 cr.
06	Koradi Unit 7	210	36 years	₹4.95/kWh	₹104.35 cr.	₹111.3 cr.
07	Nashik Unit 3	210	40 years	₹5.86/kWh	₹189.47 cr.	₹111.3 cr.
08	Nashik Unit 4	210	39 years	₹5.87/kWh	₹189.28 cr.	₹111.3 cr.
09	Nashik Unit 5	210	38 years	₹6.25/kWh	₹185.01 cr.	₹111.3 cr.

Total 4020 MW | **Total savings from RE p.a.** ₹1656.64 | **Total one-time savings from avoided retrofit** ₹2063.1 cr.

*Zero dispatch in tariff order. Variable cost varies from 3.9 to 4.3 between FY 2022–FY 2025. Annual fixed cost per tariff order ranges between ₹132 cr. and ₹153 cr. per annum.



02 »
Rs.627 to Rs. 967 cr. = annual savings from coal linkage rationalisation

Coal freight charges are significant determinants of final power tariff. Retiring the old units identified in this analysis frees up coal supplies and allows a rationalisation of coal linkages for Mahagenco's remaining operational fleet, such that coal from distant mines in Odisha and Chattisgarh can be replaced with supplies from closer mines, reducing freight costs. These reductions will help lower variable costs and total tariffs.

Retiring Mahagenco's old units frees up approximately 12.56 mtpa of coal, eliminating the need for purchases from Odisha and Chhattisgarh, reducing freight costs

Mahagenco currently has supply agreements with SECL and MCL for a total of 12.77 mtpa, of which 9.5 mtpa is allocated to younger plants not due for retirement. Retiring Mahagenco's older units will free up approximately 12.56 mtpa of coal currently supplied by WCL to these units. This will permit coal from nearer WCL mines to replace coal purchases from SECL and MCL. This will result in at least a 2,191 km. freight distance reduction under the most conservative assumptions for distance between mine and plant. This translates into an annual savings of at least ₹627 cr. This number could potentially be as high as ₹967 cr. under less conservative assumptions, as detailed in the Data & Methods section.

TABLE 7

Estimated coal freight savings after linkage rationalisation (conservative scenario)

CURRENT SCENARIO							AFTER RATIONALISATION		
Plant	**FSA SECL (MTPA)**	**Nearest SECL mine (km)**	**Freight cost from SECL mine (cr.)**	**FSA MCL (MTPA)**	**Nearest MCL mine (km)**	**Freight cost from MCL mine (cr.)**	**Farthest WCL mine and distance (km.)**	**Freight cost WCL mine (cr.)**	**Savings (cr.)**
Chandrapur	.91	Korba, (638)	₹127.28	N.A.	N.A.	N.A.	Chhindwara (350)	₹72.55	₹54.74
Koradi	1.851	Umaria, (522)	₹227.30	1.1	Basundhra, (675)	₹151.96	Beetul (190)	₹156.33	₹222.93
Khaparkheda	2.001	Umaria, (528)	₹245.72	3.88	Basundhra, (681)	₹198.81	Beetul (196)	₹181.18	₹263.35
Bhusawal	2.312	Umaria, (701)	₹324.28	N.A.	N.A.	N.A.	Chandrapur (432)	₹238.24	₹86.04
							TOTAL		₹627.1

03»

Rs.3,158 cr. = savings from halting new coal plant construction

Maharashtra has in total 5,430 MW of coal officially under construction according to the Central Electricity Authority. However, most of these are private plants whose status is uncertain, as no work has occurred at the site for several years. These plants are not only now unviable, they would not be competitive even if they were revived. Assuming none of the stalled projects are revived, the only one under active construction is the 660 MW Unit 6 of Bhusawal Thermal Power (Mahagenco) which is at a relatively early stages of construction, with less than 1/3rd of projected expenditure incurred.

As of January 2021, out of a projected expenditure of ₹4,550 cr. for Unit 6, Mahagenco has already spent ₹1,392 cr. Halting the project could save up to ₹3,158 cr. Given the surplus generation capacity that Maharashtra is faced with, there is no reason for this plant, as MERC has warned in the past. This unit risks increasing MSEDCL's fixed cost burden and locking consumers into another high-priced contract despite low aggregate demand. The state government would be justified in freezing further expenditure on this project given the changed economic scenario due to Covid-19.

Unit 6 at Bhusawal will not be competitive and given surplus power scenario risks locking MSEDCL and consumers into another high-priced contract

Further, Mahagenco still has plans[46] to build two new 660 MW Units at Koradi (11 & 12), despite media reports suggesting these are temporarily on hold.[47] Reviving these units would be a costly mistake, as the projected investment would be in the region of ₹11,000 cr., and the likely tariff upon completion would probably be over ₹5/kWh.

04»

Rs.60,000 cr. = five-year savings from replacing all power with tariffs >Rs.4/kWh with new renewable energy

Affordable power is essential for both industrial and domestic consumers. Predictable, low electricity costs are essential to expanding the small and medium scale industries that provide the bulk of employment and livelihoods across urban and semi-urban India, and to sustain government programmes meant to boost small-scale enterprises and industry. Any reduction in power purchase cost also implies a reduction in the state government's subsidy burden, and a reduction in the cross subsidy that industries currently pay. With this in mind, it is useful to assess the savings potential of a 10-year plan to gradually replace the most expensive coal power purchased by MSEDCL with new renewable energy.

As mentioned earlier, recent tariffs discovered for solar and wind in India have been in the ₹2–3/kWh range. Bloomberg New Energy Finance estimates a continued cost reduction for new solar PV by 2025 and 2030 of 14% and 22% respectively, and a decline in costs for solar/wind + battery storage of about 40% by 2030.[48] The CEA also assumes a similar cost trajectory decline for battery energy storage systems by 2030.[49] Despite these expected cost reductions, this analysis errs on the conservative side by assuming a new renewable energy tariff of ₹3/kWh for the next decade.

Against a ₹3/kWh renewable energy tariff benchmark, any power plant with a tariff above ₹4/kwh is uncompetitive. Again, we believe this to be a conservative comparison, as opposed to a more aggressive cut off of ₹3.0 or 3.5/kWh.

The long term savings potential if Maharashtra gradually phased out power purchases from coal plants charging tariffs above ₹4/kWh and replaced that volume of electricity with renewable power at ₹3/kWh (or lower) is obviously significant. Such a massive change cannot be carried out rapidly but should be part of long-term economic planning over a 5–10 year horizon by the discom and state government, in order to lower the cost of electricity and boost economic and social indicators.

Using FY 2025 as the base year, we estimate that replacing all power purchased at ₹4 and above with new renewable energy at ₹3 (or less) will yield savings of approximately ₹12,500 cr. p.a. or over ₹62,000 cr. over a five-year period. These estimates are based on anticipated tariff and dispatch levels for 2025 given by MERC in its multi-year tariff order already referenced. Of course, by 2025 it is likely that new renewable energy + storage would be significantly less than ₹3/kWh and that coal power tariffs would have escalated further, making the potential savings larger.

Using FY 2025 as the base year, we estimate that replacing all power purchased at Rs.4 and above with new renewable energy at Rs.3 (or less) will yield savings of approximately Rs.12,500 cr.

Replacing expensive coal power generation with renewable energy can be done on a case by case basis at the end of current contract life. In the case of contracts not due to expire for decades, contracts could also be reconfigured to reward flexible generation through a premium for peaking power supply and a reduction in dispatch when renewable sources are plentiful. In cases where all parties are government entities, early termination of the contract by mutual agreement might be justifiable in order to generate savings across the system, and meet larger objectives of air pollution control, reduced electricity costs and decarbonisation. The possibility of raising transition bonds or securitisation with lower financing charges to retire existing debt/buyout contracts is also gathering interest.[50]

While this is the size of the "savings basket" available, the extent to which these savings can be realised will depend on many factors, including the options available to exit expensive contracts and the political will to explore them.

TABLE 8

Potential savings from replacement of all thermal power >Rs.4/kWh with RE at or below Rs.3/kWh (based on expected dispatch and tariff for FY 2025, per MERC tariff order)

	Plant	Variable cost	Tariff	Scheduled dispatch (MU)	Total cost	Estimated savings by phaseout and replacement with RE = ₹3/kWh (annual)
01	Khaparkheda Unit 4	₹3.09/kWh	₹4.15/kWh	4467.2	₹1853.92 cr.	₹513.76 cr.
02	Khaparkheda Unit 5	₹2.71/kWh	₹4.21/kWh	3,352.22	₹1411.34 cr.	₹405.674 cr.
03	Chandrapur Units 3 and 4	₹2.78/kWh	₹4.34/kWh	1,145.55	₹994.86 cr.	₹651.195 cr.
04	Chandrapur Units 8 and 9	₹2.7/kWh	₹4.25/kWh	6,845.26	₹2822.68 cr.	₹769.102 cr.
05	Tiroda TPS (125 MW contracted)	₹3.29/kWh	₹4.39/kWh	870.25	₹382.38 cr.	₹121.305 cr.
06	Tiroda TPS (1200 MW contracted)	₹3.29/kWh	₹4.46/kWh	7,862.98	₹3,509.04 cr.	₹1,150.15 cr.

No.	Plant	Variable cost	Tariff	Scheduled dispatch (MU)	Total cost	Estimated savings by phaseout and replacement with RE = ₹3/kWh (annual)
07	Tiroda TPS (440 MW contracted)	₹3.36/kWh	₹4.72/kWh	3,063.28	₹1445.44 cr.	₹526.456 cr.
08	EMCO Warora (GMR) TPS**	₹3.3/kWh	₹5.47/kWh	1,370.06	₹749.62 cr.	₹338.602 cr.
09	Paras Power Station Unit 3	₹3.31/kWh	₹4.69/kWh	1586.88	₹743.71 cr.	₹267.646 cr.
10	Paras Power Station Unit 4	₹3.31/kWh	₹4.69/kWh	1586.88	₹743.71 cr.	₹267.646 cr.
11	Parli Units 6 and 7	₹4.48/kWh	–	–	₹421.2 cr.	₹421.2 cr.
12	Koradi TPS Unit 6	₹3.49/kWh	₹5.38/kWh	534.79	₹287.59 cr.	₹127.153 cr.
13	Koradi TPS Unit 7	₹3.49/kWh	₹5.41/kWh	526.99	₹284.86 cr.	₹126.763 cr.
14	Koradi TPS Unit 8	₹2.53/kWh	₹4.01/kWh	3261.91	₹1308.95 cr.	₹330.377 cr.

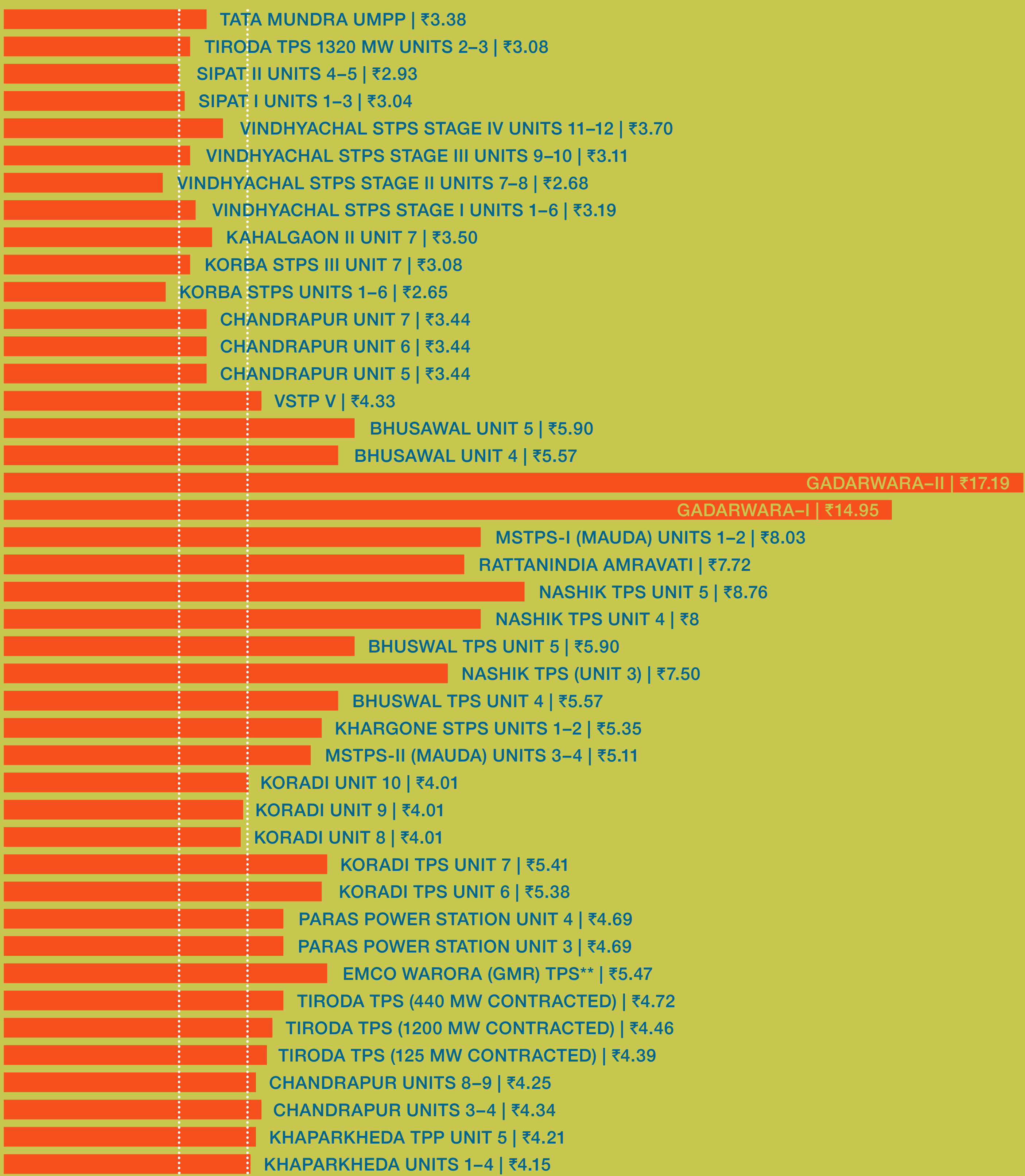
15	**Plant** Koradi TPS Unit 9	**Variable cost** ₹2.53/kWh	**Tariff** ₹4.01/kWh
Scheduled dispatch (MU) 3261.91	**Total cost** ₹1308.95 cr.	**Estimated savings by phaseout and replacement with RE = ₹3/kWh (annual)** **₹330.377 cr.**	
16	**Plant** Koradi TPS Unit 10	**Variable cost** ₹2.53/kWh	**Tariff** ₹4.01/kWh
Scheduled dispatch (MU) 3261.91	**Total cost** ₹1308.95 cr.	**Estimated savings by phaseout and replacement with RE = ₹3/kWh (annual)** **₹330.377 cr.**	
17	**Plant** MSTPS-II (Mauda) Units 3 and 4	**Variable cost** ₹3.37/kWh	**Tariff** ₹5.11/kWh
Scheduled dispatch (MU) 3375.58	**Total cost** ₹1724.91 cr.	**Estimated savings by phaseout and replacement with RE = ₹3/kWh (annual)** **₹712.236 cr.**	
18	**Plant** Khargone STPS Units 1 and 2	**Variable cost** ₹3.33/kWh	**Tariff** ₹5.35/kWh
Scheduled dispatch (MU) 342.52	**Total cost** ₹183.38 cr.	**Estimated savings by phaseout and replacement with RE = ₹3/kWh (annual)** **₹80.624 cr.**	
19	**Plant** Bhuswal TPS Unit 4	**Variable cost** ₹3.61/kWh	**Tariff** ₹5.57/kWh
Scheduled dispatch (MU) 2,636.78	**Total cost** ₹1467.66 cr.	**Estimated savings by phaseout and replacement with RE = ₹3/kWh (annual)** **₹676.626 cr.**	
20	**Plant** Nashik TPS Unit 3	**Variable cost** ₹3.75/kWh	**Tariff** ₹7.5/kWh
Scheduled dispatch (MU) 442.62	**Total cost** ₹331.86 cr.	**Estimated savings by phaseout and replacement with RE = ₹3/kWh (annual)** **₹199.074 cr.**	
21	**Plant** Bhuswal TPS Unit 5	**Variable cost** ₹3.61/kWh	**Tariff** ₹5.9/kWh
Scheduled dispatch (MU) 2,253.57	**Total cost** ₹1329.14 cr.	**Estimated savings by phaseout and replacement with RE = ₹3/kWh (annual)** **₹653.069 cr.**	
22	**Plant** Nashik TPS Unit 4	**Variable cost** ₹3.75/kWh	**Tariff** ₹8.0/kWh
Scheduled dispatch (MU) 390.64	**Total cost** ₹312.36 cr.	**Estimated savings by phaseout and replacement with RE = ₹3/kWh (annual)** **₹195.168 cr.**	

23	**Plant** Nashik TPS Unit 5		**Variable cost** ₹3.75/kWh	**Tariff** ₹8.76/kWh
Scheduled dispatch (MU) 331.07		**Total cost** ₹290 cr.	**Estimated savings by phaseout and replacement with RE = ₹3/kWh (annual)** ₹190.679 cr.	
24	**Plant** Rattanindia Amravati		**Variable cost** ₹3.93/kWh	**Tariff** ₹7.72/kWh
Scheduled dispatch (MU) 1,830.93		**Total cost** ₹1412.66 cr.	**Estimated savings by phaseout and replacement with RE = ₹3/kWh (annual)** ₹863.381 cr.	
25	**Plant** MSTPS-I (Mauda) Units 1 and 2		**Variable cost** ₹3.61/kWh	**Tariff** ₹8.03/kWh
Scheduled dispatch (MU) 1228.24		**Total cost** ₹986.34 cr.	**Estimated savings by phaseout and replacement with RE = ₹3/kWh (annual)** ₹617.868 cr.	
26	**Plant** Gadarwara-I		**Variable cost** ₹3.88/kWh	**Tariff** ₹14.95/kWh
Scheduled dispatch (MU) 28.62		**Total cost** ₹42.78 cr.	**Estimated savings by phaseout and replacement with RE = ₹3/kWh (annual)** ₹34.194 cr.	
27	**Plant** Gadarwara-II		**Variable cost** ₹3.88/kWh	**Tariff** ₹17.19/kWh
Scheduled dispatch (MU) 23.8		**Total cost** ₹40.91 cr.	**Estimated savings by phaseout and replacement with RE = ₹3/kWh (annual)** ₹33.77 cr.	
28	**Plant** Parli Replacement Unit 8		**Variable cost** ₹4.29/kWh	**Tariff** –
Scheduled dispatch (MU) –		**Total cost** ₹328.88 cr.	**Estimated savings by phaseout and replacement with RE = ₹3/kWh (annual)** ₹328.88 cr.	
29	**Plant** Solapur Power Station Unit 1		**Variable cost** ₹4.13/kWh	**Tariff** ₹340.26/kWh
Scheduled dispatch (MU) 14.47		**Total cost** ₹492.51 cr.	**Estimated savings by phaseout and replacement with RE = ₹3/kWh (annual)** ₹488.169 cr.	
30	**Plant** Solapur Power Station Unit 2		**Variable cost** ₹4.13/kWh	**Tariff** –
Scheduled dispatch (MU) –		**Total cost** ₹486.54 cr.	**Estimated savings by phaseout and replacement with RE = ₹3/kWh (annual)** ₹486.54 cr.	

31	**Plant** Bhuswal TPS Unit 3	**Variable cost** ₹4.3/kWh	**Tariff** –
Scheduled dispatch (MU) –	**Total cost** ₹153.33 cr.	**Estimated savings by phaseout and replacement with RE = ₹3/kWh (annual)** ₹153.33 cr.	
32	**Plant** Bhuswal TPS Unit 4	**Variable cost** ₹3.61/kWh	**Tariff** ₹5.57/kWh
Scheduled dispatch (MU) 2,636.78	**Total cost** ₹1,467.66 cr.	**Estimated savings by phaseout and replacement with RE = ₹3/kWh (annual)** ₹676.63 cr.	
33	**Plant** Bhuswal TPS Unit 5	**Variable cost** ₹3.61/kWh	**Tariff** ₹5.9/kWh
Scheduled dispatch (MU) 2,253.57	**Total cost** ₹1,329.14 cr.	**Estimated savings by phaseout and replacement with RE = ₹3/kWh (annual)** ₹653.069 cr.	
34	**Plant** VSTP V	**Variable cost** ₹1.97/kWh	**Tariff** ₹4.33/kWh
Scheduled dispatch (MU) 1,028.26	**Total cost** ₹445.31 cr.	**Estimated savings by phaseout and replacement with RE = ₹3/kWh (annual)** ₹136.832 cr.	

FIGURE 2

FY 2025 tariffs of MSEDCL's coal power purchases, plotted against a benchmark Renewable Energy / RE + storage tariff of Rs. 3–4



05 Conclusions

#1

Phasing out coal plants that are 20 years or older will provide immediate and significant savings to MSEDCL and electricity consumers. These savings are in the form of avoided retrofit costs and lower power purchase costs through replacement with new renewable energy.

#2

Since all the plants in this age cohort are government-owned, phasing them out is largely a matter of political will on the part of the state.

#3

Halting further expenditure on the Bhusawal Unit 6 plant that is in the early stages of construction will ensure that MSEDCL does not lock consumers into an expensive Power Purchase Agreement and additional fixed cost obligations in a situation of surplus power.

#4

Short term pain incurred from these measures, (such as government owned generators having to shutter a plant earlier than expected) should be viewed against the significant savings that will accrue to the discom and consumers.

#5

Apart from the direct financial savings, there are significant ancillary benefits in terms of reduced pollution, greater water availability for other uses and the possible diversion of land for other productive use.

#6

Financing models that can aid the retirement of older, expensive coal plants can play a role in speeding up Maharashtra's energy transition.

#7

Ambitious action on old coal plant retirement will profile Maharashtra as a leader in India's fight against air pollution and climate change.

06 Endnotes

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Climate Risk Horizons

16th Cross, № 40, off 8th Main Road,
Malleshwaram, Bengaluru Karnataka 560.055
Website www.climateriskhorizons.com
Email ashish.fernandes@climateriskhorizons.com
harshit.sharma@climateriskhorizons.com