# expensive & unnecessary

climate risk horizons

***Koradi extension will increase Maharashtra's power bills, costing the state ₹6,000 CR more than clean power options***

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# contact

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# suggested citations

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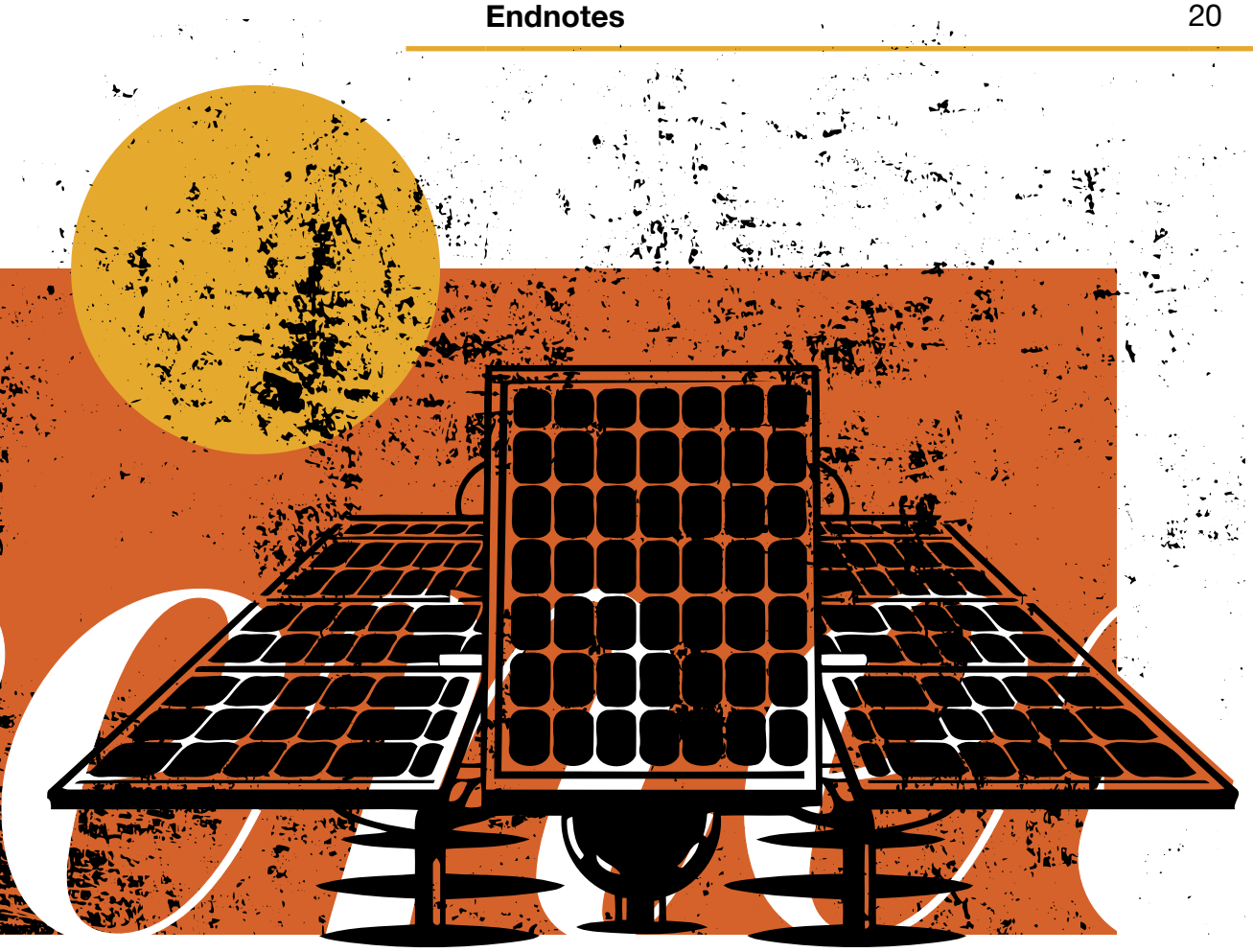
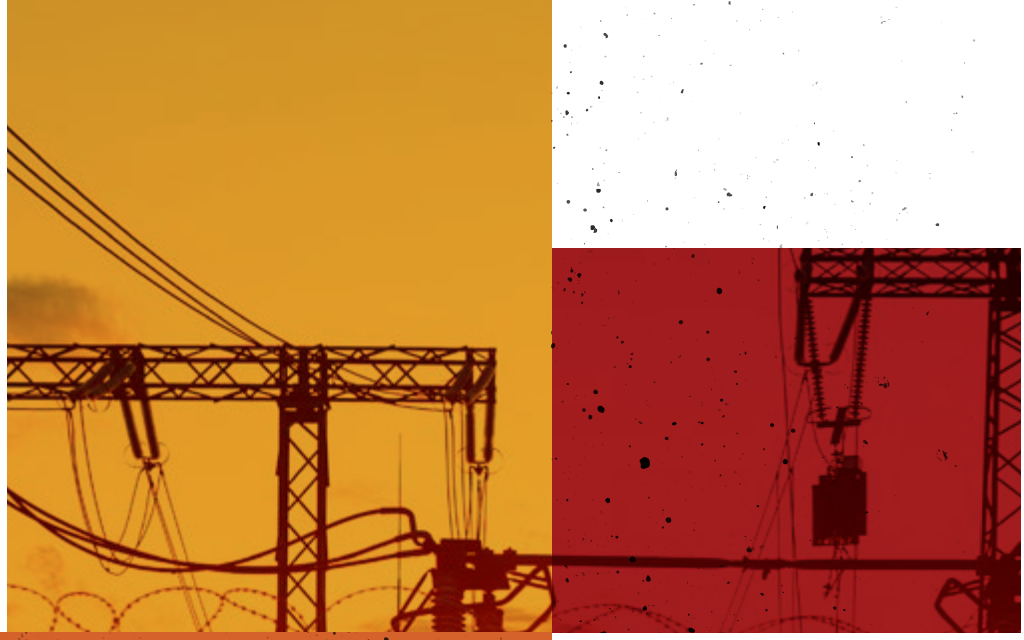


# list of abbreviations

| | |
|---|---|
| **₹/INR** | Indian National Rupees |
| **ACS** | Average Cost of Supply |
| **ARR** | Average Realisable Revenue |
| **BESS** | Battery Energy Storage System |
| **CR.** | Crore |
| **CUF** | Capacity Utilisation Factor |
| **FY** | Financial Year |
| **IPP** | Independent Power Producers |
| **kWh** | Kilowatt Hour |
| **L1** | Lowest Bid |
| **MAHAGENCO** | Maharashtra State Power Generation Co. Ltd. |
| **MERC** | Maharashtra Electricity Regulatory Commission |
| **MSEDCL** | Maharashtra State Electricity Distribution Co. Ltd. |
| **MSW** | Municipal Solid Waste |
| **MU** | Million Units |
| **MW** | Megawatt |
| **MWh** | Megawatt Hour |
| **O & M** | Operation and Maintenance |
| **PAF** | Plant Availability Factor |
| **PLF** | Plant Load Factor |
| **PV** | Photovoltaic (solar) |
| **RE** | Renewable Energy |
| **REMC** | Railway Energy Management Company |
| **ROE** | Return on Equity |
| **RPO** | Renewable Purchase Obligation |
| **RTC** | Round The Clock |
| **SECI** | Solar Energy Corporation of India |
| **SynCON** | Synchronous Condenser |
| **TPS** | Thermal Power Station |
| **WC** | Working Capital |



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# executive summary

*MSEDCL has announced its intention to proceed with the construction of the Koradi Extension, comprising two units of 660 MW each, at an estimated cost of ₹10,625 CR. This brief analyses the financial implications of this proposal for MSEDCL, the state government and power consumers.*

## key points:

#01

MSEDCL's proposed Koradi Extension will impose a significant financial burden on electricity consumers by way of higher tariffs and fixed costs that must be paid irrespective of utilisation levels.

#04

Substituting planned power supply from these proposed thermal units with a mix of renewable energy and storage will save the state between ₹6,000 to ₹7,100 CR. on power purchase costs for the first five years of operation alone, depending on PLF levels.

#05

Even if the state's power demand situation requires significant utilisation of the new Koradi units, it would be much cheaper to meet this demand from a mix of RE and storage. This would also prevent additional air and water pollution issues, which already impact the existing Koradi coal units and surrounding communities.

#02

It will lock MSEDCL into an annual fixed cost payment of approximately ₹2,000 CR., and over ₹10,000 CR. in the first five years of operation.

#03

Electricity from these units will be expensive, costing approximately ₹7.24/kWh at 55% Plant Load Factor, and ₹6.19/kWh at 75% PLF in the first year of operation. In comparison, round-the-clock power from renewables and storage is now available at ₹3.5 to ₹4.5/kWh.

#06

Building the proposed 1320 MW (660X2) units at Koradi to meet peak electricity requirements of the future will lead to long-term lock-in of a generation source that has high fixed cost payments, and runs on a fuel that is prone to inflationary pressures. It is incompatible with the grid of the future.

# background

## lower power purchase costs are key to MSEDCL's financial stability

TABLE 1
**MSEDCL's improved cost recovery (₹/kWh)**

| | FY 2020 | FY 2021 | FY 2022 |
|---|---|---|---|
| **ACS** | 6.7 | 6.3 | 6.28 |
| **ARR** | 5.73 | 5.11 | 6.36 |
| **Gap** | 0.96 | 1.19 | 0.08 |

**Source:** PFC report on performance of utilities 2021–22

| | FY 2018 | FY 2019 | FY 2020 | FY 2021 | FY 2022 |
|---|---|---|---|---|---|
| **MSEDCL P&L (₹ CR.)** | 492 | 2,886 | 685 | –1,322 | 280 |

**Source:** MSEDCL Statement of accounts

In FY 2022 MSEDCL showed significant improvement in the cash-adjusted ACS-ARR gap after having one of the highest gaps in the country in FY 2021. Although collection efficiency has been a major area of improvement for the utility, bringing down power purchase costs will be crucial to ensuring financial sustainability and lowering the government's subsidy burden. This requires the utility to ensure that future growth in electricity demand is met from the least cost source.

The summary of power purchase costs from various sources in Table 2 shows that state-run power plants are the most expensive source of electricity.

TABLE 2
## Monthly power purchase cost upto February 2023

| Generating Station | ₹/kWh |
|---|---|
| State Sector | 5.09 |
| Central Sector | 4.24 |
| IPP | 4.88 |
| Hydro | 3.02 |
| Wind | 4.48 |
| Bagasse | 6.22 |
| Biomass | 7.24 |
| MSW | 4.88 |
| Solar | 4.49 |
| Others | 2.1 |
| **Total** | **4.74** |

**Source:** MSEDCL

Due to factors such as surplus generation capacity, must run status of renewables and higher variable costs than central generating stations, state-run coal capacity has been underutilised. Moreover, the reliability of these generating stations is also questionable as their Plant Availability Factor has remained below the norm of 83%.

TABLE 3
## MAHAGENCO plant availability and load factors

| | FY 2020 | FY 2021 | FY 2022 |
|---|---|---|---|
| **MAHAGENCO Coal Plant PAF%** | 71% | 78% | 61% |
| | **FY 2021** | **FY 2022** | **FY 2023** |
| **MAHAGENCO Coal Plant PLF%** | 51% | 56% | 62% |

**Source:** CEA and Care Ratings

TABLE 4
**Source-wise installed capacity (MW)**

| Source | FY 2020 | FY 2021 | FY 2022 |
|---|---|---|---|
| In the state | 36,644 | 36,902 | 37,348 |
| Thermal | 21,176 | 21,176 | 20,966 |
| Renewable | 9,588 | 9,846 | 10,502 |
| Hydro | 3,061 | 3,061 | 3,061 |
| Natural gas | 2,819 | 2,819 | 2,819 |
| **Central sector allocation** | **7,831** | **7,944** | **7,944** |

**Source:** Economic Survey of Maharashtra 2021–22

## feasibility of new coal plants in maharashtra

With growing electricity demand, the surplus generation capacity of the state is likely to be exhausted. MAHAGENCO plans to retire a significant portion of its old and inefficient thermal power plants in the years to come. To determine a future electricity mix for the state that minimises the cost of generation, it is important to replace the practice of assuming an 85% PLF while estimating the cost of electricity from new coal plants with more realistic assumptions on utilisation and conditions of operation. Low-capacity utilisations significantly increase the per unit cost of coal generation. Per unit fixed cost of electricity increases as capacity charges are paid for plant availability and not for actual dispatch. Variable costs also increase due to lower efficiency on account of increased Station Heat Rate.

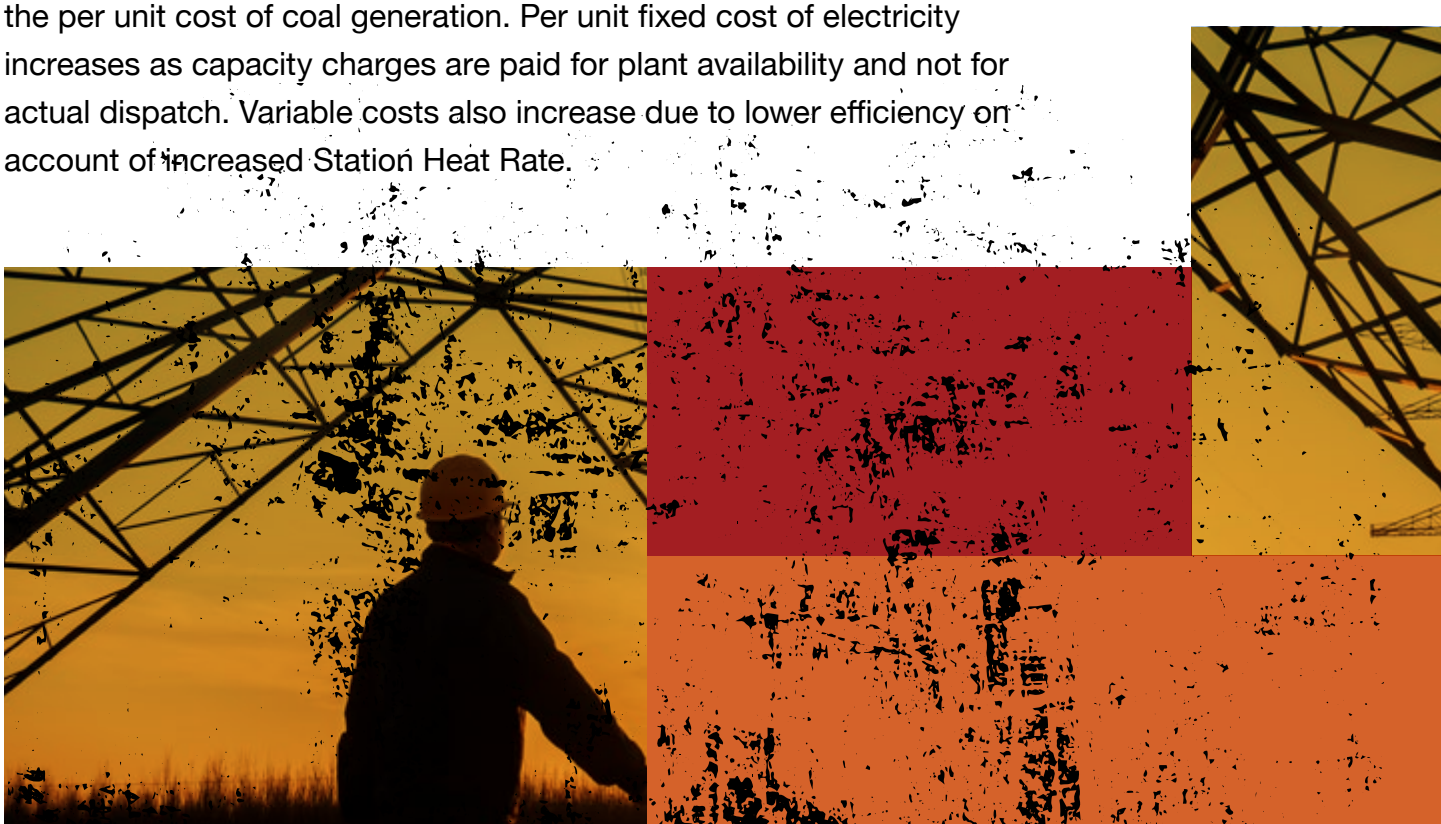


TABLE 5
## Supply of electricity at average peak demand (MW)

| Year | Average peak demand | Supply | Surplus |
|---|---|---|---|
| 2019–20 | 19,103 | 21,771 | 2,668 |
| 2020–21 | 19,250 | 21,881 | 2,631 |
| 2021–22 | 21,221 | 21,750 | 529 |
| 2022–23 | 22,339 | 22,441 | 102 |

**Source:** Economic Survey of Maharashtra 2021–22

Virtually all of MAHAGENCO'S coal fleet now have variable costs that are higher than the cost of renewable energy, as can be seen from Table 6.

TABLE 6
## MERC-approved variable costs of generating stations for FY 2023–24

| Unit | ₹/kWh |
|---|---|
| Bhusawal | 4.41 |
| Chandrapur | 4.1 |
| Kharperkheda | 4.2 |
| Koradi | 3.32 |
| Nashik | 4.65 |
| Uran | 6.76 |
| Paras units 3 and 4 | 3.48 |
| Parli units 6 and 7 | 5.1 |
| Khaperkheda unit 5 | 4.1 |
| Bhusawal units 4 and 5 | 3.71 |
| Koradi units 8–10 | 3.08 |
| Chandrapur units 8 and 9 | 3.44 |
| Parli unit 8 | 5.02 |

**Source:** MERC

RE's main disadvantage compared to coal generation has been its intermittency and lack of 'dispatchability'. Storage enables RE to meet peak demand and respond to variations in demand in a much more flexible manner than coal generation, as baseload thermal plants are bound by constraints such as ramp rates, minimum technical load and start-up time, whereas batteries can provide instant power. For the RE-dominant grid of the future, flexibility in generation and dispatch will be prized. While coal power is not designed for flexible operation, battery storage offers perfect flexibility.

The key argument in favour of new coal has been that it is indispensable to meeting peak loads during evening and night hours when there is no solar generation. However, with the advent of cost-competitive grid-scale battery storage, this argument is now being challenged.

Despite the increasingly apparent technical and commercial viability of renewables and storage, MAHAGENCO has proposed to build 1,320 MW (660x2)[1] at Koradi by utilising vacant land and scrapping existing units that have completed their economic life.

## financial risks with proposed koradi power plant expansion

As per the plant's pre-feasibility report the expected investment for the 1320 MW plant is ₹9,882 CR.[2] This capex requirement for Koradi is lower than the requirement for greenfield investments because of the availability of land. In October, the Maharashtra state government approved a capital outlay of ₹10,625 CR. for the project.[3]

TABLE 7
**Koradi capital expenditure (₹ CR)**

| | Project expenditure | Debt | Equity |
|---|---|---|---|
| Koradi | 10,625 | 8,500 | 2,125 |

The cost of electricity from these new units is estimated based on available project costs, interest rates and the operating costs of similar coal plants in Maharashtra.

**Fixed cost burden:** Assuming the plant commences construction in 2024 and is completed in 2029, the plant will result in a fixed cost burden of about ₹2,000 CR. annually in the first ten years of operation. This cost has to be paid irrespective of plant utilisation levels.

TABLE 8

## Fixed costs for Koradi Extension

| **Koradi: 660 MW** | **₹ CR.** |
|---|---|
| Project expenditure | 10,625 |
| Project equity = project expenditure X 30% | 2,125 |
| **(1) ROE = project equity X 15.5%** | 329 |
| | |
| **Project debt** | 8,500 |
| **(2) Interest on loan = project debt X 11%** | 935 |
| | |
| Working capital = project expenditure X 10% | 1,063 |
| **(3) Interest on WC @11%** | 106 |
| | |
| **(4) Depreciation = 4% of project expenditure** | 425 |
| | |
| Normative O&M cost = 25,00,000/MW | |
| **(5) O&M cost** | 330 |
| | |
| **Fixed cost (1 + 2 + 3 + 4 + 5)** | **2,126** |

This is expected to be between ₹6.08/kWh to ₹7.09/kWh in the first year of operation, depending upon the level of utilisation.

TABLE 9

## Tariff estimation for Koradi Extension at 55% and 75% PLF

| | MU |
|---|---|
| Annual generation at 55% PLF | 5,406 |
| Annual generation at 75% PLF | 7,372 |

| Fixed cost (₹ CR) | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 |
|---|---|---|---|---|---|
| **(1) ROE = project equity X 15.5%** | 329 | 329 | 329 | 329 | 329 |
| **(2) Interest on loan = project debt X 12%** | 935 | 873 | 810 | 748 | 686 |
| **(3) Interest on WC @12%** | 106 | 108 | 111 | 113 | 115 |
| **(4) Depreciation = project expenditure X 4%** | 425 | 425 | 425 | 425 | 425 |
| **(5) O&M cost** | 330 | 343 | 357 | 371 | 386 |
| **Total fixed cost** | **2,126** | **2,079** | **2,032** | **1,986** | **1,941** |

| (₹/kWh) | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 |
|---|---|---|---|---|---|
| Per unit fixed cost at 55% PLF | 3.93 | 3.85 | 3.76 | 3.67 | 3.59 |
| Per unit fixed cost at 75% PLF | 2.88 | 2.82 | 2.76 | 2.69 | 2.63 |
| Per unit variable cost | 3.31 | 3.34 | 3.38 | 3.41 | 3.45 |

| (₹/kWh) | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 |
|---|---|---|---|---|---|
| Tariff at 55% PLF | 7.24 | 7.19 | 7.14 | 7.09 | 7.04 |
| Tariff at 75% PLF | 6.19 | 6.16 | 6.13 | 6.11 | 6.08 |

Due to low demand, position in the merit order due to high variable costs and the must run status of renewable energy, the effective cost of generation from Koradi will probably be closer to estimates at 55% PLF than 75% PLF. However, even at the unlikely 75% PLF level, these tariffs are considerably higher than other available sources.

MAHAGENCO'S thermal fleet has remained significantly underutilised over the past three years. This phenomenon highlights the redundancy of baseload thermal plants in an energy system that is transitioning towards renewables. In FY 22 Maharashtra got close to one-fifth of its electricity from renewable sources, with state-run coal plants operating at lower PLFs because of excess capacity, lower position in the merit order, and renewables' 'must run' status. As the share of renewables increases, the utilisation rate of thermal capacity will continue to decline.

## cheaper power purchase options

In October 2019, SECI issued India's first tender for Round The Clock (RTC) supply. The RTC-1 auction concluded with an L1 (lowest bid) tariff of ₹2.9/kWh (3% annual escalation for the first 15 years). The auction required a power supply of 80% annual CUF and 70% monthly CUF. In the following year, SECI auctioned for RTC-2 tender requiring at least 51% from renewable sources with at least 85% annual and peak load availability with bids ranging from ₹3.0/kWh to 4.5/kWh. The RTC-3 tender proposes 90% peak availability (for 4 hours), 90% monthly availability (for 11 months) and 90% annual availability. REMC recently announced winners for 960 MW of RTC RE power at tariffs ranging from ₹3.99 to ₹4.27/kWh.[4]

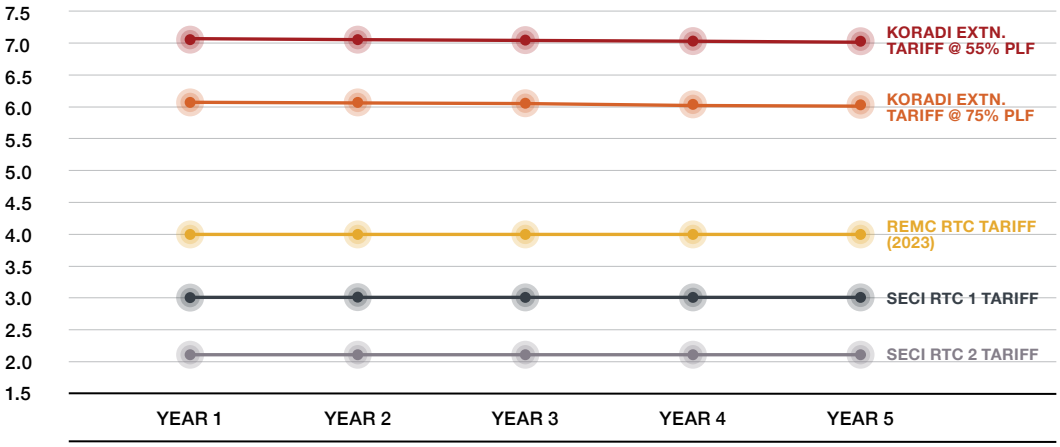
These auctions demonstrate the availability of cheaper and more reliable power than state-run coal plants. Even with a conservative assumption of procuring RTC renewable energy at ₹4.5/kWh, MSEDCL will realise sizable savings in comparison to building new units at Koradi. The savings range from ₹6,000 CR. to ₹7,100 CR. in the first five years of the plant's operation, depending on utilisation levels.

TABLE 10

**Savings from substituting Koradi Extension with RE+storage**

| RE+storage substitution per unit saving at 55% PLF (₹/kWh) | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 |
|---|---|---|---|---|---|
| | 2.74 | 2.69 | 2.64 | 2.59 | 2.54 |
| **RE+storage substitution per unit saving at 75% PLF (₹/kWh)** | **Year 1** | **Year 2** | **Year 3** | **Year 4** | **Year 5** |
| | 1.69 | 1.66 | 1.63 | 1.61 | 1.58 |
| **RE+storage substitution total savings at 55% PLF (₹ CR.)** | **Year 1** | **Year 2** | **Year 3** | **Year 4** | **Year 5** |
| | 1,483 | 1,454 | 1,425 | 1,398 | 1,371 |
| **RE+storage substitution total savings at 75% PLF (₹ CR.)** | **Year 1** | **Year 2** | **Year 3** | **Year 4** | **Year 5** |
| | 1,269 | 1,227 | 1,205 | 1,184 | 1,164 |

## Koradi Extension: more expensive than round-the-clock (RTC) RE options




## alternatives to new coal units at koradi

These estimates suggest that despite the benefit of land availability that results in lower capital expenditure and hence a lower tariff compared to a greenfield project, the cost of generation from the Koradi expansion will be considerably higher than RTC RE.

Previous analysis has demonstrated that repurposing units 6 and 7 at Koradi with Solar PV and Solar PV + Battery Storage (BESS) + Synchronous Condenser can result in benefits of ₹184.24 CR. and ₹343 CR. respectively.[5]

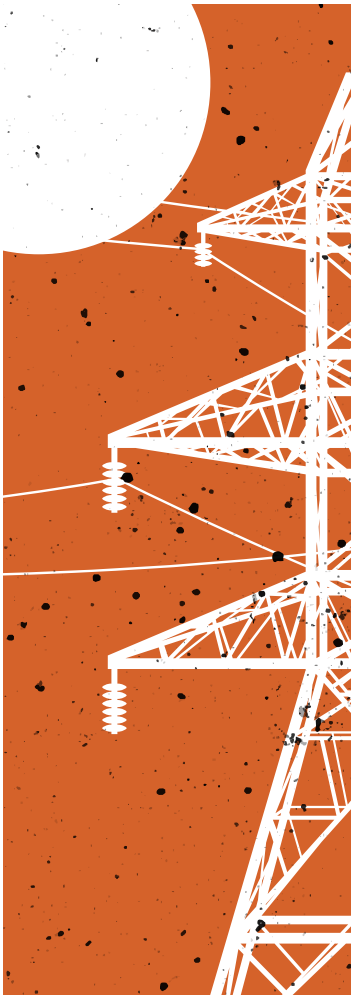


TABLE 11
**Benefits of repurposing options (entire coal plant land) for Koradi TPS units 6 and 7**

| Sl. No. | Item | ₹ CR. | |
|---|---|---|---|
| | | One-time | Life-time |
| 01 | Scrap value | 94.53 | |
| 02 | Land utilisation | 17.27 | |
| 03 | Equipment (switchyard, substation) | 15.62 | |
| 04 | Remediation benefits | 26.41 | |
| 05 | Transmission and interconnection evacuation | 30.4 | |
| **Direct (plant-specifc) benefits: Solar PV** | | **184.24** | |
| **Direct (plant-specifc) benefits: Solar PV+BESS** | | **184.24** | |
| 06 | System balancing (reactive power) benefits (net) | 330 | 159.7 |
| **Direct (plant-specifc) benefits: Solar PV + BESS + SynCON** | | | **343.94** |

Moreover, as the state will need to retire old and inefficient plants over the coming decade, repurposing solar+BESS capacity will allow the state to acquire alternate generation capacity and meet its growing electricity demand in a cost-effective manner.

In 2019, MSEDCL suggested revisions to MERC's RPO target of 13.5% by FY 2024–25, stating that the state would need 12,500 MW of solar capacity to meet the target, up from 4,500 MW. Repurposing older power plants with solar will allow the utility to meet its RPO target and avoid penalty for non-compliance.

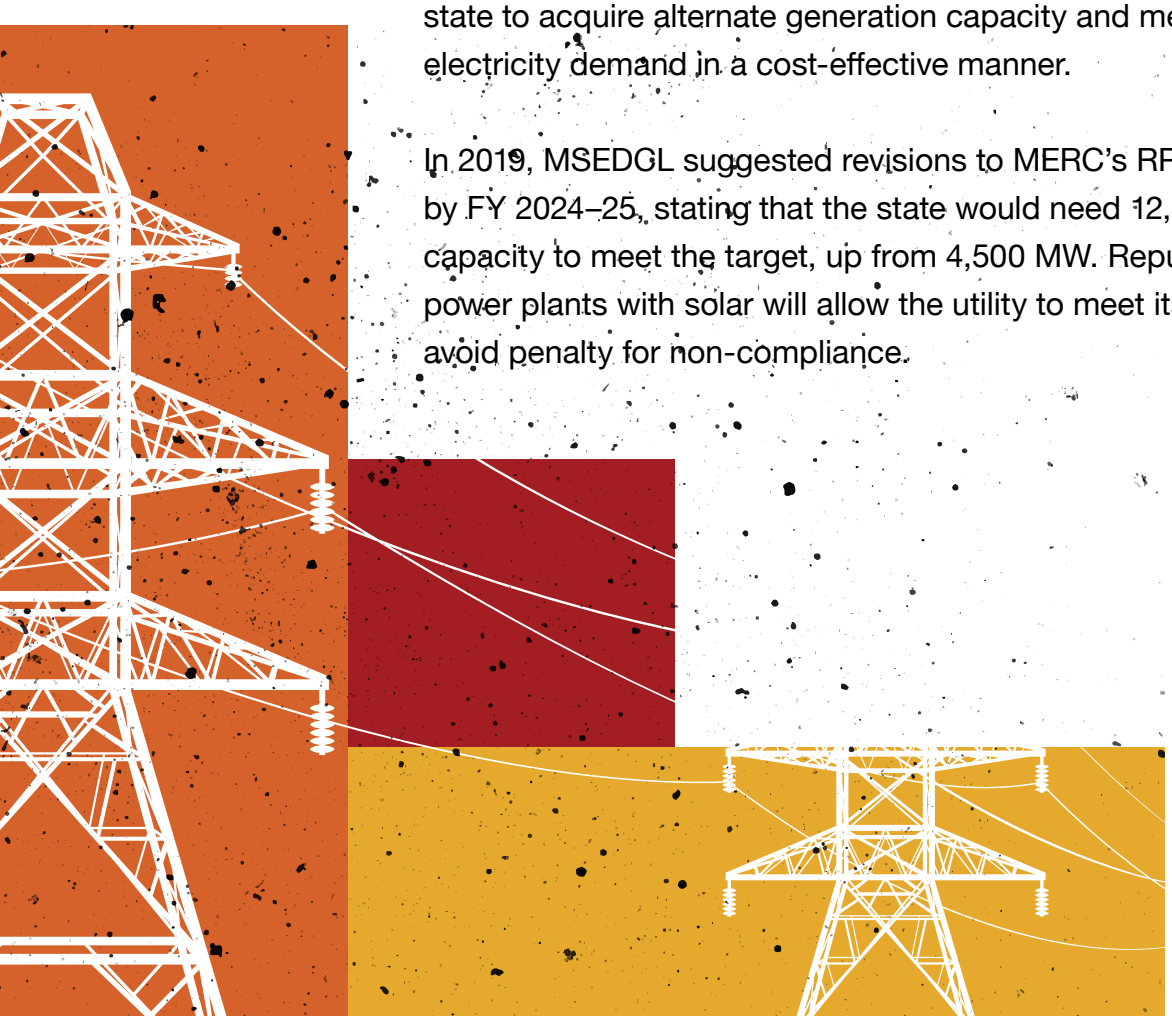


TABLE 12

## RE + storage capacity from repurposing old coal assets in Maharashtra

| Plant | Installed coal capacity | Capacity | |
|---|---|---|---|
| | | Solar PV | BESS |
| Bhusawal TPS unit 3 | 210 MW | 57 MW | 6 MW/24 MWh |
| Chandrapur TPS unit 3–7 | 1920 MW | 867 MW | 85 MW/340 MWh |
| Khaparkheda TPS units 1–4 | 840 MW | 112 MW | 10 MW/40 MWh |
| Koradi TPS units 6 and 7 | 420 MW | 51 MW | 5 MW/20 MWh |
| Nashik TPS units 3, 4 and 5 | 630 MW | 137 MW | 14 MW/56 MWh |

# conclusion

Without further capacity addition, Maharashtra's current surplus power capacity will likely be exhausted in the coming years. Ensuring that incremental future demand is met by the least-cost option will improve the financial performance of utilities, competitiveness of industries and reduce the government's subsidy burden, in turn benefitting the state's economy and electricity consumers.

Maharashtra has one of the highest installed RE capacities in the country. Until a few years ago, renewable energy could not meet all of the incremental demand due to issues such as intermittency and peak availability. In the recent past, developers have successfully been able to provide RTC renewable energy at lower tariffs than coal plants by using hybrid projects, energy storage and pooling capacity from different locations.

Building the proposed 1320 MW (660x2) units at Koradi to meet peak electricity requirements will lead to the long-term lock-in of a generation source that has high fixed cost payments, runs on inflationary fuel, and is not compatible with the grid of the future.

Meeting the incremental demand in a cost-effective manner will require sustained renewable capacity addition, in addition to procuring RTC renewable power through competitive auctions and intermediaries like SECI. The state can derive significant economic benefit and reliable power supply by repurposing its old coal capacity due for retirement with a combination of solar, storage and synchronous condenser.

# endnotes

1. **MAHAGENCO**; https://www.mahagenco.in/projects/

2. **Pre-feasibility Report For MAHAGENCO**

3. **State government okays Rs.10,000 CR. outlay for Koradi TPS expansion**; https://www.nagpurtoday.in/state-govt-okays-rs-10625-cr-outlay-for-koradi-tps-expansion/10201222

4. **Powerline: REMCL awards 960 MW of round-the-clock renewable power projects**; https://powerline.net.in/2023/04/24/remcl-awards-960-mw-of-round-the-clock-renewable-power-projects/

5. **Dr. Gireesh Shrimali (2022). Financial benefits of repurposing Maharashtra's old coal plants**; Climate Risk Horizons. November 2022; https://climateriskhorizons.com/research/MH_Repurposing_web_final.pdf

# climate risk horizons

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