Executive summary

It was a 'lost-decade' (2010–2020) for coal-based power generation in India. There was much promise at the beginning of the decade and generation capacity was added at a breakneck pace. Eventually, low economic growth and poor growth in power demand ended up bankrupting the sector that was already teetering on the brink. Today, non-performing assets (NPAs) abound in the sector and recovery of dues is a challenge throughout the value chain. We are at crossroad, where at the global stage, India is contemplating its net-zero emissions timelines, while the only strategy presented thus far has been increasing the installed capacity base of renewable energy (RE).

Older plants outcompete younger ones in fixed and variable costs

What about our thermal fleet then? The timelines for compliance with pollution norms have been repeatedly stretched, with plants now being asked to present affidavits of retirement deadlines, if they have any, and benefit from a more lenient treatment. While air pollution legislation has been given prominence, soil and water pollution emanating from millions of tons of ash pile up still goes unnoticed. The COVID-19 pandemic has also dented demand growth and many assets, which are in advanced stages on construction, are in a grip of uncertainty. Alongside, a new market-based economic dispatch (MBED) mechanism for procuring bulk power has been proposed to begin in April 2022. By dispatching power through a central clearing mechanism, MBED aims to reduce power procurement costs by INR 12,000 crore (MoP, 2021). All these developments point to an undercurrent of a storm brewing in the sector, and it is at this moment we ask the question—Can India rethink how it manages its coal-based power generation fleet from here on?

Reviewing the thermal setup

We began this study with an examination of the performance—thermal, financial, and operational—of nearly 194 GW of coal-based generation capacity over the course of 30 months leading up to the start of the COVID-19 pandemic in India. We explored how assets are being utilised and segment them by vintage and ownership. We observed that older plants are generating a disproportionate share of electricity and, unsurprisingly, private sector plants bear the brunt of under-utilisation challenge the sector is facing. When exploring the cost distribution of plants, we find that not only do older plants have low fixed costs but they also have low variable costs and outcompete younger plants in the merit order stack. Even in cases where plants incurring low variable costs are available, plants with higher variable costs are dispatched as they are contracted and preferred by utilities, given their lock-in clause in the contracts. The net impact of the current strategy of utilisation of assets is that the thermal efficiency of the generation fleet in India is an abysmal 29.7 per cent, which in turn points to regulators being lax about such poor technical performance.

Given the inefficient operations of the thermal fleet, we wanted to assess what exactly determines power plant efficiency and the variable costs of generation. Towards this end, we carried out a parametric regression assessment of these two metrics. We find that age, plant load factor (PLF), and the average size of units in a plant play an important role in determining how efficient a plant is. In the case of variable costs, we find that it is largely driven by the cost of delivered coal and to a lesser extent by operational characteristics of a plant such as station heat rate (SHR) and auxiliary consumption. These reinforce the theory that newer vintage plants, if operated more consistently, would yield better outcomes to achieve system efficiency and possibly also lower variable costs. This in turn implies better environmental outcomes—lower greenhouse gas (GHG) emissions, reduced output of criteria pollutants, or lesser quantity of ash generated. But the financial implications of this proposition remain to be seen.

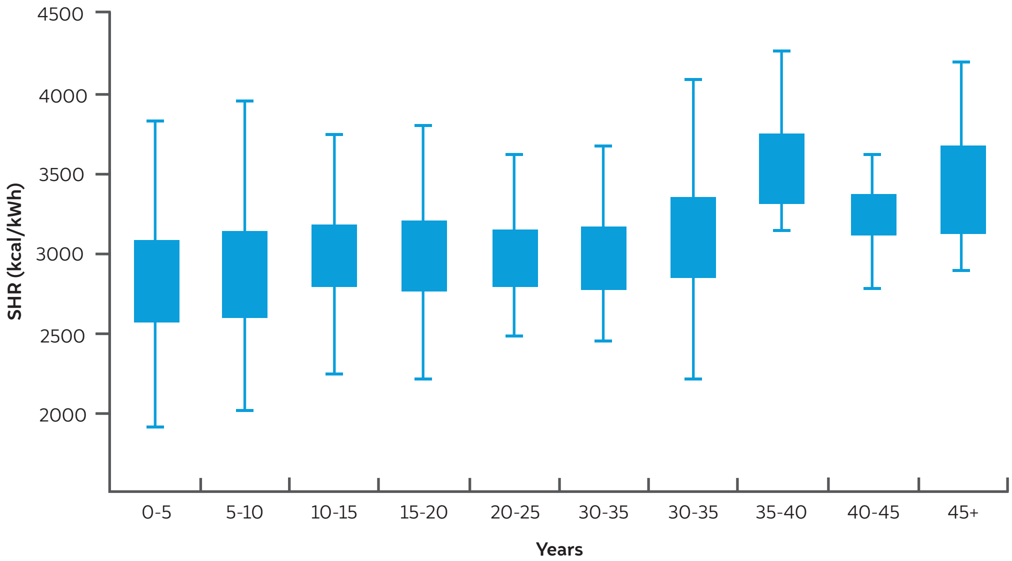

Figure ES1
Younger plants use lesser thermal energy to generate electricity

Source: Authors' analysis based on CEA monthly coal statements, monthly generation reports and coal grades data from SEVA

Our approach to determining the criteria for dispatch

In a bid to conceive of a system where efficiency is rewarded, we demonstrate an approach to dispatch power, based on an efficiency merit order and not the one based on stated variable costs. We chose efficiency as the criterion for dispatch because variable costs are distorted by fuel costs and fuel supply contracts, among others. The order based on variable costs does not mirror efficiency, as evident in our descriptive assessment of the system. As a first step in our approach, we assign higher PLFs to newer vintages, which is inherently a logical step—from operational and financial standpoints of the system. We order plants in an increasing order of estimated SHR, based on the parametric function we established in the first step. Generation schedules are assigned to plants at a daily resolution level, without factoring in spatial and temporal constraints in the movement of power but only providing for the energy demanded in a day. This is a significant limitation, but it is important to understand the nature of unconstrained opportunities existing in the Indian thermal fleet. If the proposed efficiency-based dispatch is employed, the Indian coal fleet would be able to cater to the average energy demanded from it (over the assessment period) at an improved thermal efficiency of 6 per cent over the baseline (the current scenario in action). This implies that the generation efficiency goes up to 31.6 per cent. As a corollary, we find that the reassignment results in an annual saving of nearly 42 MT of coal and a concomitant reduction in GHG and criteria pollutant emissions. The overall fleet also operates at a higher overall PLF of 78 per cent, with significant room for providing more generation should the system require it.

Outcome of our assessment: a more efficient and lower cost generation mix

We have structured an efficient generation mix, but does it financially make sense? The drivers of overall variable costs are delivered cost of coal, SHR, auxiliary consumption, unit size and age. In our assessment, we find that the delivered cost of coal in the reassigned scenario increases the overall cost of generation, as 20 per cent of the pit-head plants do not generate in the reassigned scenario. However, plants consume less energy, operate at a higher load factor, and as a result there are significant savings on variable costs of generation. The total savings on variable costs in this reassigned scenario amounts to INR 8,944 crore. Against the overall cost of power procurement by discoms, this is a small fraction, though significant enough to give much needed breathing room for their finances.

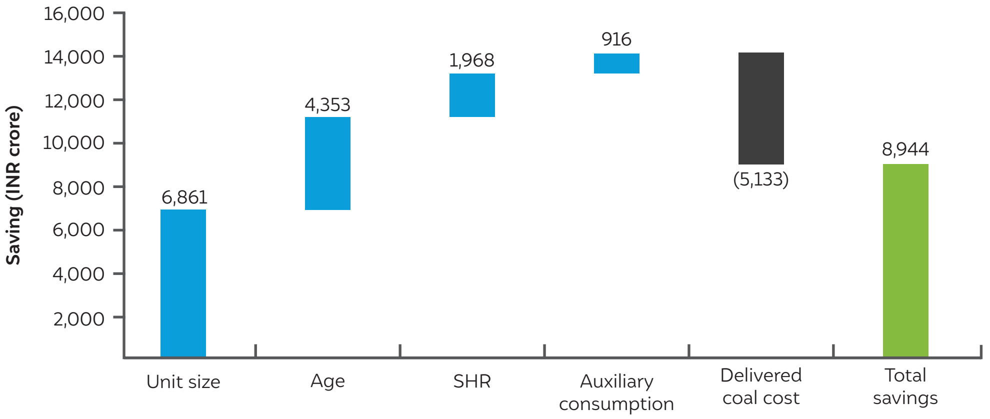

Figure ES2
Most of the savings in the reassigned scenario is attributable to improved efficiency

Source: Authors' analysis

As a key outcome, we find that nearly 50 GW of capacity could be deemed as surplus to the requirements of the system, for the energy demand it caters to. Even when considering power delivered, the retained generation capacity could provide for the quantum of peak power required (143 GW in the analysis period) from the thermal fleet. We propose that 30 GW of the surplus capacity, which represents the older and some of the least efficient assets, be taken up for accelerated decommissioning as these have been identified in the *National Electricity Plan* (2018) for decommissioning during the course of this decade (2021-2030). Each passing year of delay increases the burden on us with a higher electricity bill and more air, water, and soil pollution to manage. It also results in a one-time saving of INR 10,200 crore in avoided pollution-control retrofits, which would otherwise be needed should some of these plants continue to operate. Nearly 20 GW of capacity can be considered for moth-balling and based on a more rigorous assessment, it can be decided where they would be called upon to generate if contingencies are likely to arise. We also observe that the system has significant slack, outside of this assessed stock of plants, to manage contingencies and demand growth over the course of this decade. With nearly 36 GW of thermal power in various stages of construction, we find that meeting the electricity and power demand in later years of this decade should not be a matter for concern. Given some key limitations in terms of the spatial and temporal resolution in our study, there is a need to carry out a more rigorous assessment of the opportunities identified in this study. Equally, there is a need to assess electricity demand over the course of this decade and the prospects of RE materialising to the extent that it is currently anticipated in existing studies, in order to conclusively decide on decommissioning and its benefits.

Giving life to an illusion: how do we realise this opportunity?

The key contribution of our assessment has been clearly defining the performance metrics of the current thermal fleet in India in terms of both technical and financial aspects. As the data was hitherto not available easily in the public domain, it was compiled patiently and put together diligently for the purposes of the analysis. With data at our disposal, we propose a simple yet powerful way of viewing an alternative dispatch system. Some may consider the assessment incomplete as a result of the limitations stated earlier. However, in the planning horizon, the right set of policies and incentives can very much bring the outcomes envisaged in this study to life.

Despite the simplicity of our conclusions, the proposed reassignment of generation in favour of more efficient plants is far less likely to be operationalised. The Indian power system is mired in a rigid set of bilateral contracts for supply and taking away one to replace with another cannot be easily done. Our approach would leave the states with far lesser control on their sources of power, as many state-owned power generation stations are candidates for decommissioning. Given the challenges of payments for power procured and the broader political economy wielding 'power' over 'owned' generation assets, such a proposition is anathema to most actors. However, the future of the power system even as envisaged in recent white papers from the central regulator is moving towards a market-based system and does not bet on a bilateral scheduling between generators and discoms. Our proposed approach results in cost savings when viewed as a whole, but individual states are likely to see it only in terms of more costs and less flexibility for their operations.

Retiring inefficient assets will create headroom for new investment focusing on the long-term

We have two main recommendations for the Ministry of Power (MoP) and relevant actors as they look to establish the framework for MBED. First, we urge them to **establish a set of key performance indicators (KPIs) for the thermal generation fleet, among which environmental footprint associated (as represented by thermal efficiency) with thermal power generation should be accorded priority.** Individual legislations on water and criteria pollutants continue to languish, but bringing thermal efficiency to the centre of the debate could lower the costs. And second, we reiterate **the need for consensus-building among states, in dialogue with central actors, to embrace the notion of a unified market. That the proposed MBED (starting in April 2022) is being carried out in two phases (MoP, 2021) is an indicator of uncertainty in the process**. Beyond the implementation framework, we propose that **an entity such a National Electricity Council be set up to oversee the concerns of states and central entities and allow for a seamless transition to the concept of 'one nation, one market'.** The challenges of this transition go well beyond the technical domain and must address the needs of state electricity utilities and key entities like Coal India Limited and Indian Railways, and what the future holds for them.

As stated earlier, despite the financial savings being relatively small, our proposed approach to prioritise efficiency opens up a window of opportunity to de-stress generation assets in the sector. By clearing out the stock of inefficient assets, we create fresh breathing room and make a case for more investment in the sector—in RE, energy storage, system upgrades, among others. With the sword of surplus not hanging over the sector anymore, cash flows for stressed assets could improve and, as a result, financial institutions saddled with NPAs could be relieved of their burden. Having gone past this preliminary hurdle, the power sector needs to address some critical issues before it, as it prepares for the larger energy transition.

1. Introduction

Image: iStock

A country's economic development is synonymous with its growth in power demand. The projection of a USD 5 trillion gross domestic product (GDP) by 2024 (PTI, 2019a) has also set the expectation that India's power demand is set to escalate multifold in the next decade. The last decade (2010–2020) generated much hype but did not live up to that promise. Electricity consumption across the economy increased by a mere 55 per cent between FY 2010 and FY 2020 (MoP, 2020). The Central Electricity Authority (CEA), starting with the 13th Electric Power Survey, has consistently overestimated the peak power demand and overall electricity demand in the economy (Josey, Mandal, & Dixit, 2017). The supposedly prudent and shrewd private sector in India did itself no favours by buying into that narrative, without any checks of its own. The surplus generation capacity that the power sector achieved has been well documented (Josey, Mandal, & Dixit, 2017; Parray & Tongia, 2019; Josey, Dixit, Chitnis, & Gambhir, 2018; IEA, 2020). This resulted in the creation of a large number of generation assets, largely coal-based and more efficient, in many cases being available on call, but not being requisitioned. Equally, the supply of coal to some of the newly built plants was also in doubt, because development of new coal mining areas did not keep pace with the increased demand.

Many of the new assets were created primarily because power distribution companies (public and private discoms) indiscriminately signed power purchase agreements (PPA) based on a projected power demand that was not assessed well (Josey, Mandal, & Dixit, 2017). Signing PPAs implies that discoms are saddled with contracts that require them to honour the fixed cost payments due to the plants, irrespective of them supplying power, as dictated by the two-part tariff regime, which has been practiced in India since the 1980s. The indiscriminate signing of PPAs thus pushed up the overall cost of power purchase for discoms in recent years. In FY19, the total value of power sold to discoms was to the tune of INR 5,62,000 crore (USD 76.54 billion). In the same year, the total revenues that discoms managed to recover from their consumers was INR 4,87,000 crore (USD 66.33 billion) (PFC, 2020). The biggest challenge for the power sector is its revenues not covering even the cost of electricity procured. If the operating expenses of discoms (salaries, pensions, maintaining

Continuous overestimation of power demand in the past has led to surplus coal generation capacity distribution assets, financing costs, and so forth) of INR 1,60,000 crore (USD 21.79 billion) are considered, we see the wide gap between revenues from the sale of electricity and the costs of providing electricity (PFC, 2020).

Financial solvency remains the holy grail for the power sector and is key to the country's economic prospects

Only a financially solvent utility would be able to address the energy needs of the poor and the aspiring class with rising incomes, as well as competitively supply electricity to Indian industry. Despite generous public support—through grants and interest rate subventions—discoms were staring at annual losses to the tune of INR 27,000 crore in FY 2019 (PTI, 2019b), depriving them of their ability to cater to any of these segments effectively. As a result of their poor financial health, discoms remain as debtors to generation companies. The total dues owed by discoms to power producers stands at INR 90,026 crore at the end of February 2021 (PRAAPTI, n.d.) and, by some accounts, this figure could be even higher (Rajasekhar & Tongia, 2020).

In literature documenting the policy failures leading to the financial woes of discoms, the most frequently discussed issues pertain to the cross-subsidized tariff structure for domestic and agriculture consumers, poor metering, billing and collection inefficiencies, and high aggregate technical and commercial (AT&C) losses in the operations of utilities (Dubash & Rajan, 2001; Tongia, 2003; Das et al. 2019; Aggarwal et al. 2020; Rajasekhar & Tongia, 2020). However, there is one other factor that often flies under the radar, that is, power purchase cost. Studies acknowledge that power purchase costs account for about 75–80 per cent of total cost of power supply incurred by a discom (Bharadwaj, Ganesan, & Kuldeep, 2017; Josey et al. 2018; Aggarwal et al. 2020). However, power purchase cost is often treated as a rigid variable in the assessment of discom operations, because oftentimes discoms purchase power through long-term contracts that have to be honoured. An important option for discoms to reduce their power purchase cost is in the margin—through better management of variable costs. This, in turn, depends on how well the merit order dispatch (MoD) principles are followed. Discoms failing to rigorously follow MoD principles is the primary reason for them incurring a high-power purchasing cost. An assessment in the case of Uttar Pradesh finds that that low-cost generation stations are not utilised to their fullest potential. The reasons cited for this range from transmission constraints to coal availability, to plant availability, and even system requirements such as maintaining voltage in the sub-transmission system (Aggarwal et al. 2020).

While coal-based technologies for power plants have evolved with time, the adoption of efficient technologies in the Indian power system has certainly been lagging. The importance of efficiency in driving down costs has been completely ignored in the operation of coal-based power systems in India. The sub-critical pulverised coal technology has been the workhorse of the power system with significant domestic supply capability (Chikkatur & Sagar, 2007). The first super-critical plant in India was commissioned only in 2012 and the first (and possibly the only) ultrasuper critical power plant was commissioned in 2019 (ETEnergyWorld, 2019). Out of 205 GW capacity of coal/lignite plants in India, 93 GW has been added since April 2012 (CEA, 2020a; CEA, 2015). A bulk of this capacity uses sub-critical technology (CEA, 2018). Furthermore, there have been only a few critical assessments of the efficiency of coal-based generation assets in the Indian system (Chitnis, et al., 2018) and their effectiveness has been limited, as evident from the current state of the system. Barring the documentation of thermal performance, which has also been sporadic and which presents aggregated views on thermal efficiency of stations, a transparent depiction of factors driving the efficiency is not available.

As the debate around net-zero emissions and India's commitment to reducing overall greenhouse gas (GHG) emissions from energy use intensifies, the development of power sector in the next two decades would play a critical role in determining the pace of the country's progress. Coal used in the power sector contributes nearly 40 per cent of the GHG emissions arising from the use of fossil fuels in the Indian economy (MoEFCC, 2018; GHG