Doing More with Less Coal

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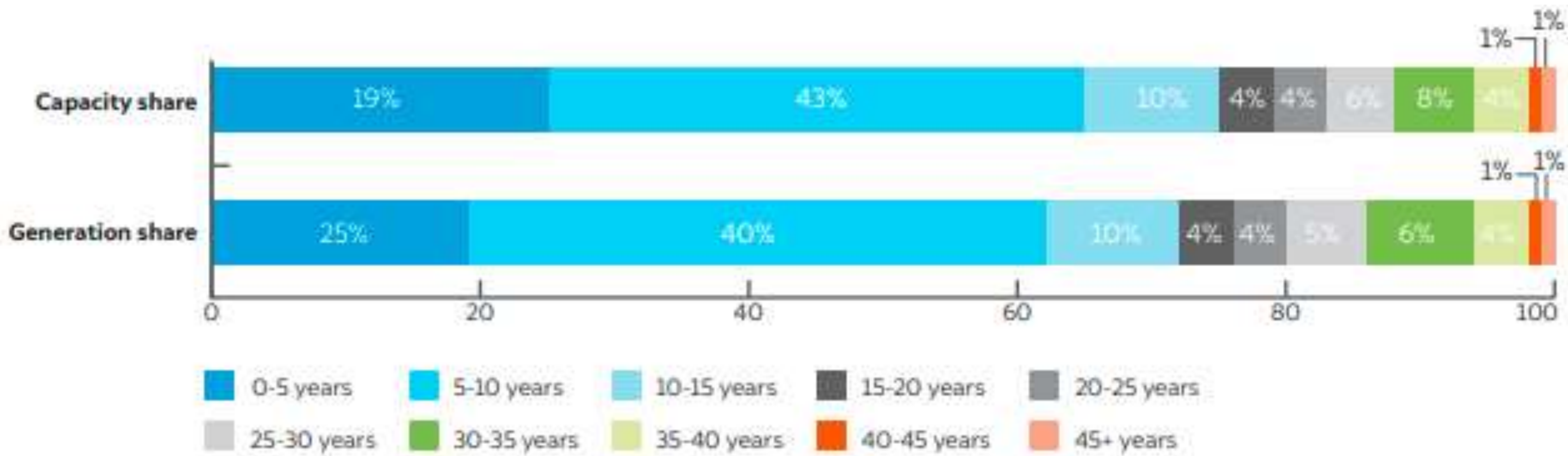
Objectives

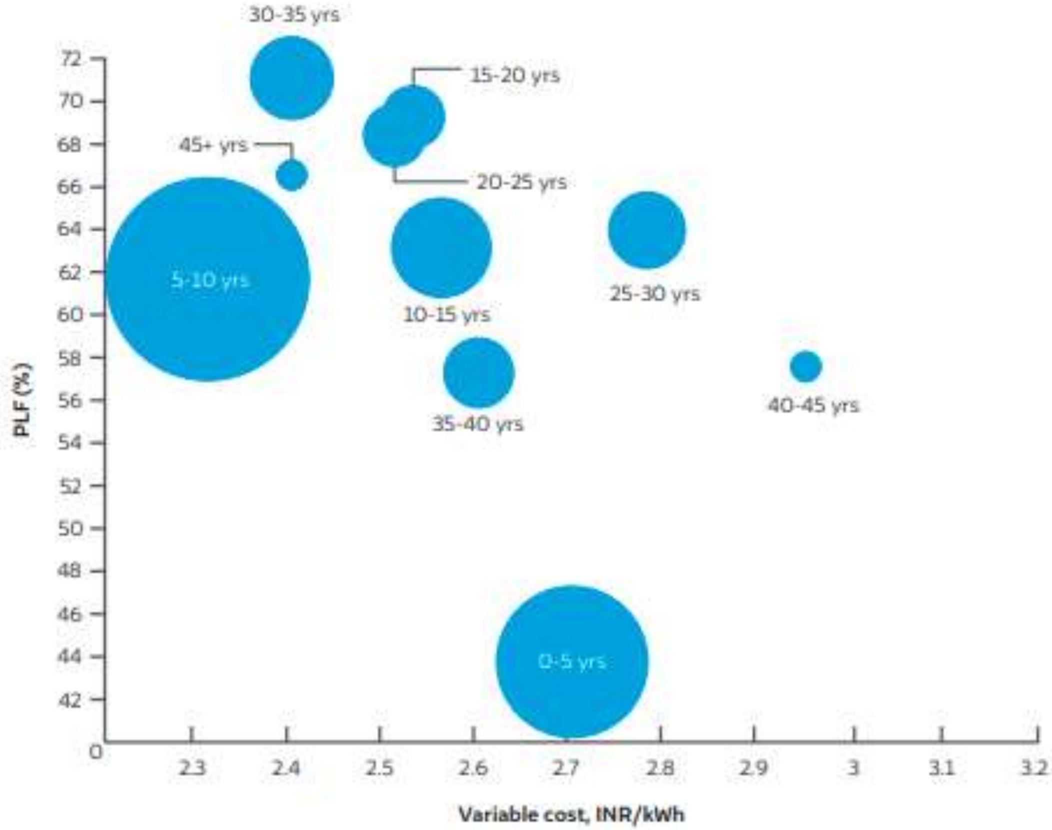
- How are thermal power plants utilised and what are the different ways of characterising their utilisation?
- How efficient is the generation fleet and what are the drivers of efficiency and of variable costs of generation?
- What opportunities exist for improving the efficiency of the thermal fleet?
- Is an efficient fleet cost-effective and what implications does it have for phase-out (moth-balling or decommissioning) of thermal assets?

Newer plants punching well below their weight



Source: Authors' analysis from CEA daily generation reports

Despite having low variable cost, the PLF of 5-10 year group is low



Source: Authors' adaptation from CEA daily generation reports and MERIT state-wise daily summary data

Note: The bubble size represents the capacity share

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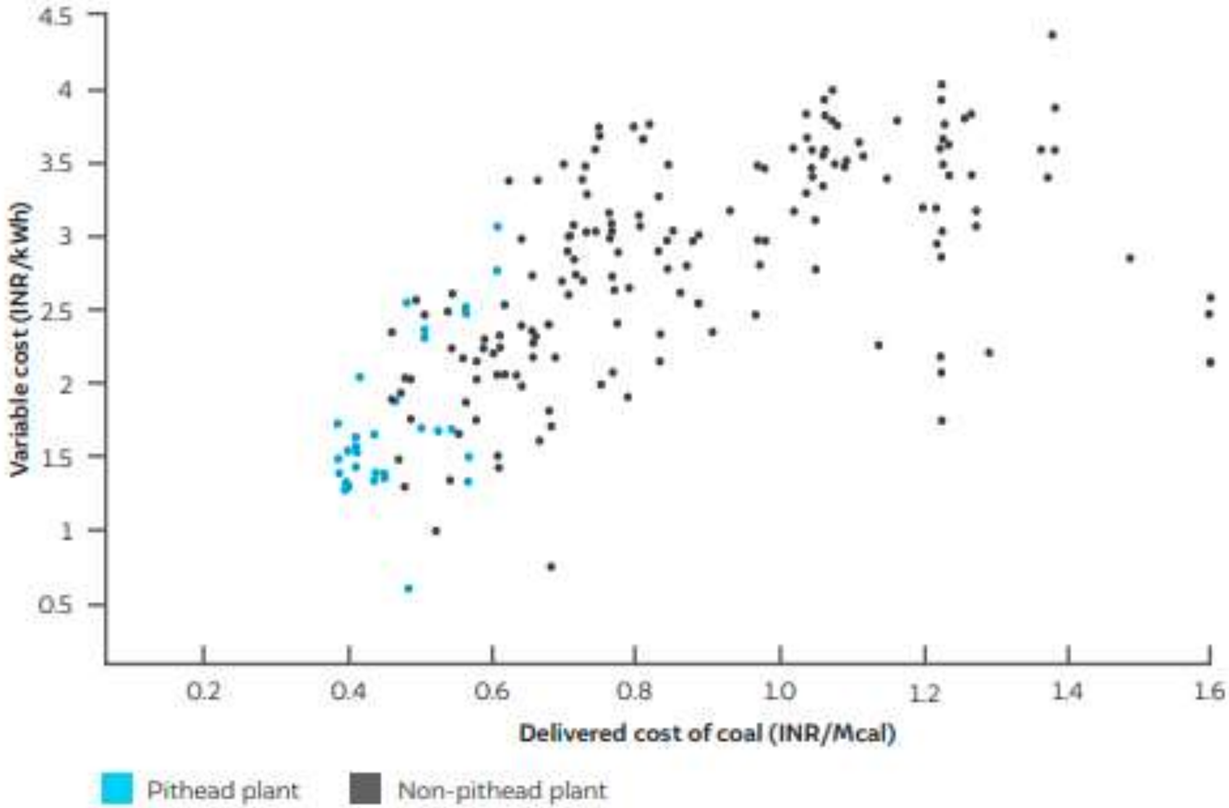
Coal costs are largely determined by coal transportation distances

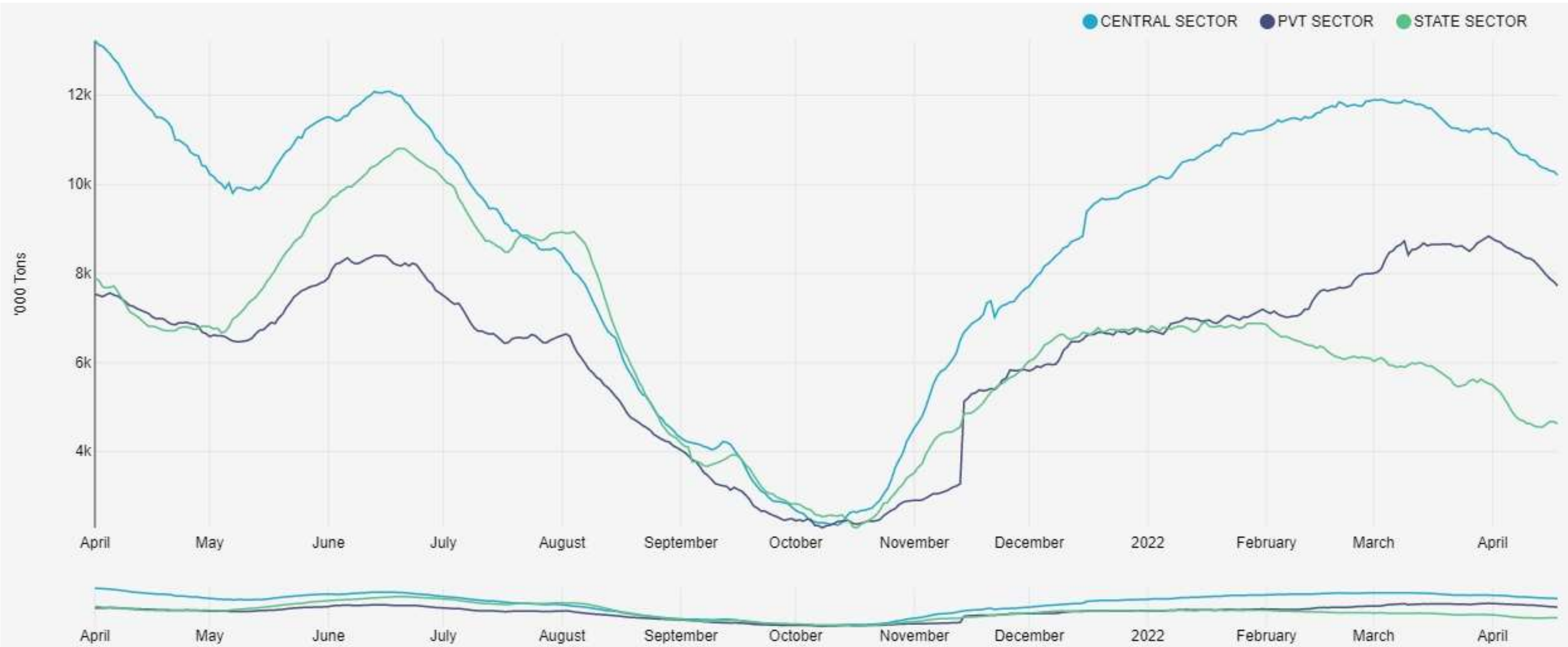
- Variable costs are distorted by fuel costs, supply contracts, transport costs, etc.,



Delivered cost of coal = Coal price/ Gross calorific value of coal

Source: Authors' analysis based on compilations from various generation tariff orders

On coal stock – state and private plants significantly disadvantaged



Cheaper plants run as base load, but younger plants ramping

	Baseload		Ramping	
Age grouping	Contracted capacity	Wtd VC	Contracted capacity	Wtd VC
0-5 years	3421	1.98	4060	2.78
5-10 years	10940	1.55	9430	2.87
10-15 years	3955	1.60	5480	2.79
15-20 years	4905	1.85	210	2.94
20-25 years	2000	2.22	420	2.95
25-30 years	1000	1.92	1680	2.77
30-35 years	4360	2.01	2802	2.80
35-40 years	4350	1.53	576	2.79
Total	34931		24658	

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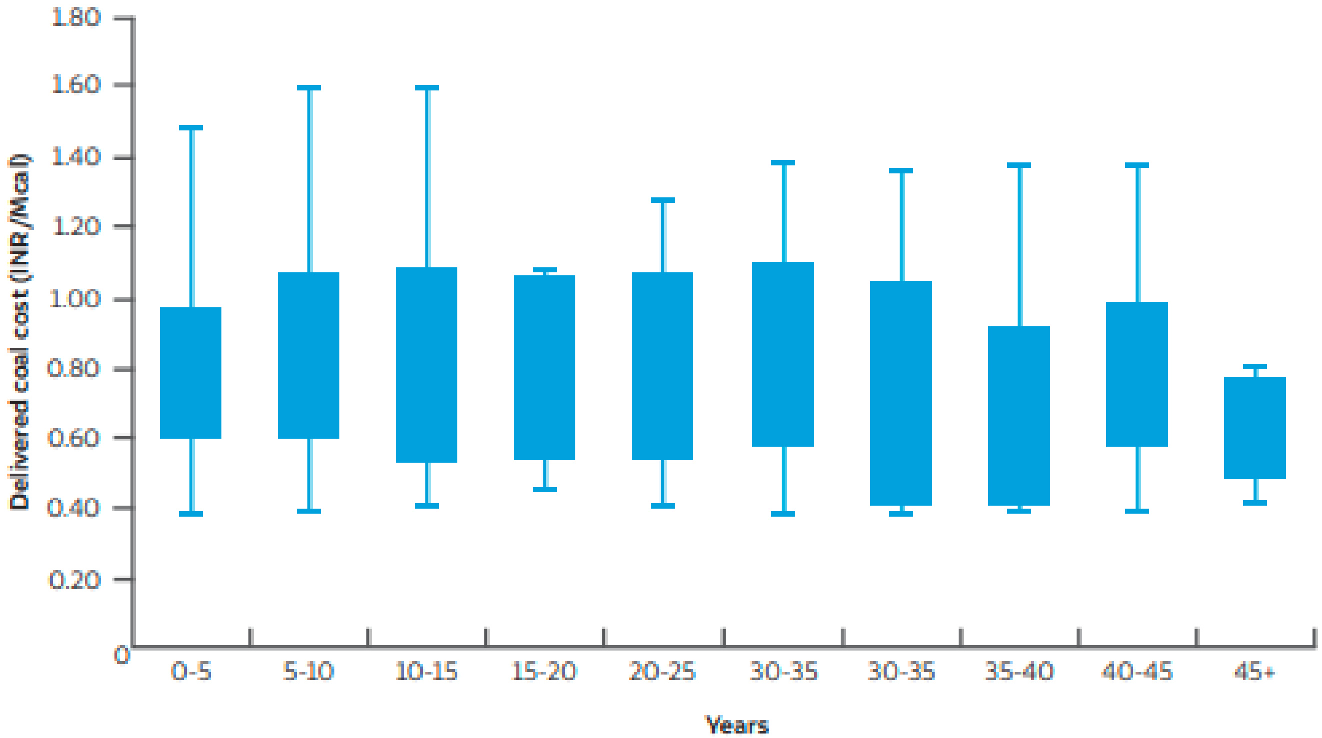
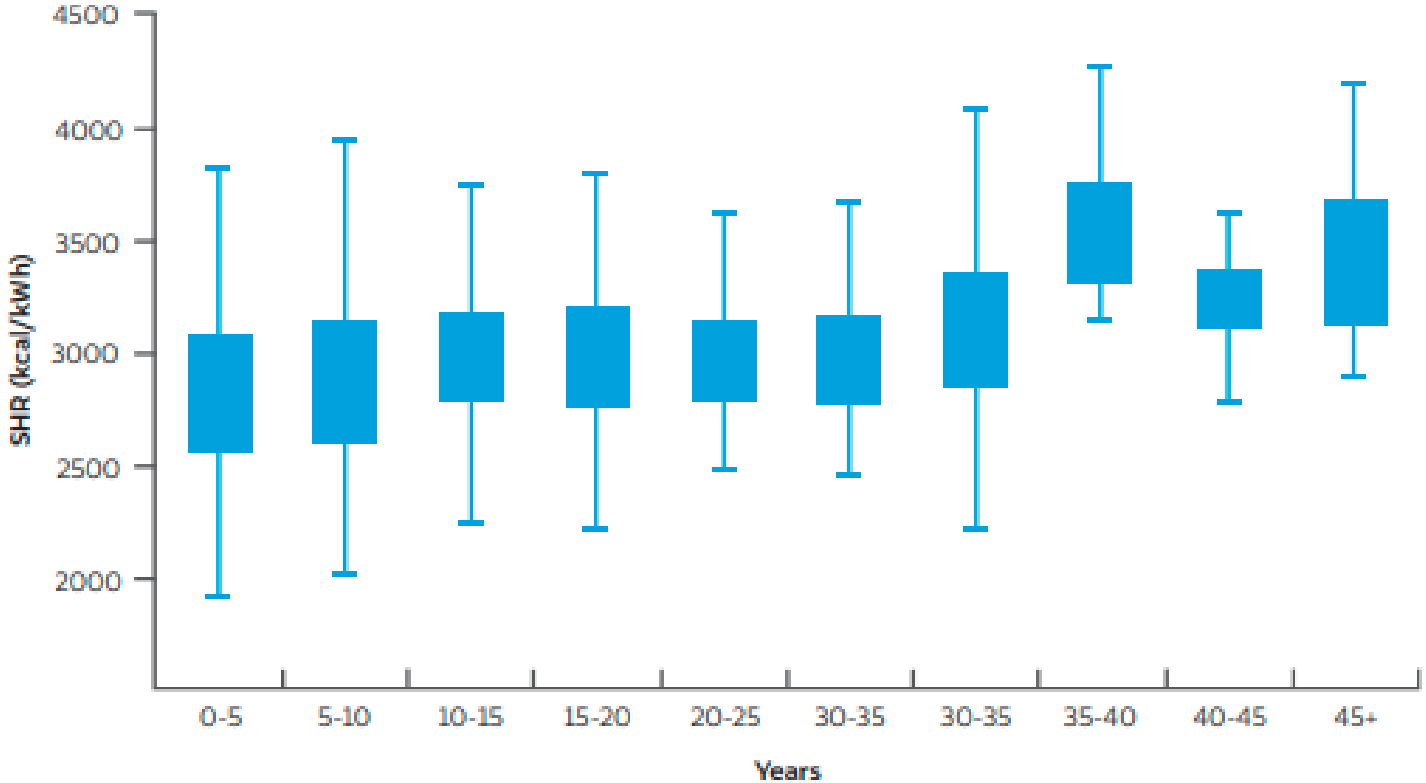
Delivered coal cost of older plants makes them competitive



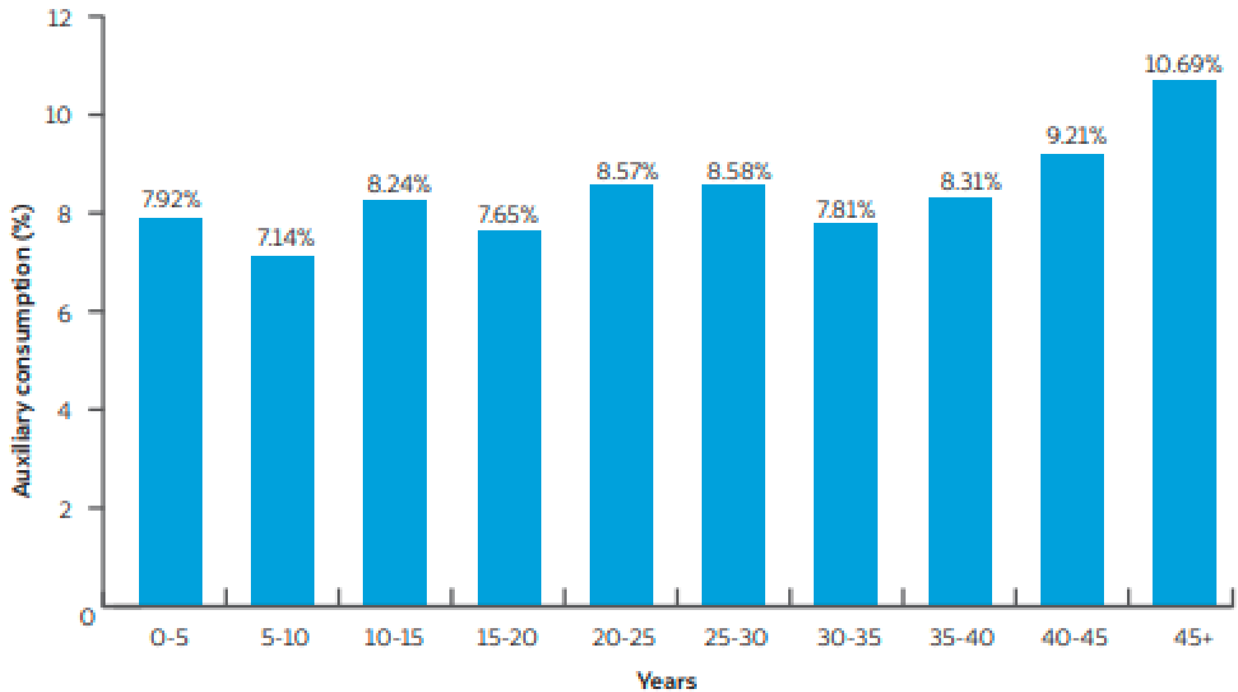
Source: Authors' analysis based on compilations from various generation tariff orders

Younger plants use lesser energy to generate electricity



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

Older plants have higher self-consumption and leave less to be sold



Source: Authors' analysis based on compilations from various generation tariff orders

Data

Analysis period: September 2017 – February 2020 (30 months)

- Daily generation from plants over analysis period (194 GW)
- Reported variable cost from plants in MERIT over analysis period (180 GW)
- Monthly coal consumption from CEA over analysis period (184 GW)
- Monthly grade of coal supply from CIL SEVA over analysis period (184 GW)
- Unit ramping rates from the POSOCO report on ramping capabilities of coal-fired generation in India
- Future coal power demand from NEP 2018 and CEA Optimal generation mix by 2030

Source: Authors' compilation

Methodology

1
- Segmentation of units by age and ownership
- Assessment of plant capacities, generation and variable costs in each segment.

2
- Estimation of SHR using monthly coal consumption, generation and coal grades - 30 month panel data set
- Parametric representation of SHR using the panel dataset
- Calculation of SHR for all the units using the function derived from the parametric regression
- SHR = f{Age, unit size, PLF, import share}

3
- Estimation of delivered coal cost using coal grades data from coal grades and notified prices (CIL)
- Transportation charges were estimated using notified freight rates (IR). Plant-mine distances were calculated using location co-ordinates, and along rail network

4
- Variable costs aggregated to plant level (from MERIT)
- Parametric representation of variable cost for all the plants as VC = f{SHR, age, average unit size of plant, delivered coal price and auxiliary consumption}

5
- Generation reassignment based on an 'efficiency' merit order, with an implicit allocation of higher operational hours for efficient plants
- The reassignment process assumes other sources of generation contribute as much as they did in the actual scenario and that temporal variations are also managed with this reassigned fleet.

6
- SHR and variable cost is calculated in the reassigned scenario for each unit based on their respective parametric representations
- Cumulative variable costs, including auxiliary consumption, is calculated for the original and reassigned generation mix to determine total cost savings as a result of the reassignment

Source: Authors' compilation

Plant characteristics impact SHR and VC

- A 660 MW unit, in comparison to a 300 MW unit, will have a heat rate lower by 300 kcal/kWh
- A 10-year-old plant will have a heat rate that is 75 kcal/kWh lower than a 20-year-old plant
- An improvement in PLF by 20 per cent (in absolute terms) improves the heat rate by 65 kcal/kWh
- A 0.1 INR/Mcal decrease in coal price would reduce the variable cost by 0.19 INR/kWh
- A 1 per cent decrease in auxiliary consumption would lower the variable cost by 0.03 INR/kWh
- Replacing a 200 MW unit by 500 MW unit in the energy mix would cut down the variable cost by 0.12 INR/kWh

Source: Authors' analysis

Key Findings

- Receiving cheaper coal and existing PPAs give the older plants an edge over the new fleet under the existing merit order dispatch mechanism

“***Cheaper plants are not necessarily the efficient ones***”

- On reallocation, the overall PLF of the fleet increases to 78% from the baseline 59%

- In the reassigned scenario, around 50 GW coal capacity are identified as surplus to the system

- Out of the total surplus capacity, 30 GW could be decommissioned earlier than the CEA timelines as per *NEP 2018* and the rest could be mothballed and used in case need arises in future

Source: Authors’ analysis

Nearly 50 GW identified as surplus capacity to the system

Age group	Total capacity (MW)	Surplus capacity (MW)	% Rendered surplus
0–5 years	48,365	605	1%
5–10 years	76,983	5168	7%
10–15 years	18,475	8885	48%
15–20 years	7155	3155	44%
20–25 years	7860	5860	75%
25–30 years	10,646	7146	67%
30–35 years	12,561	7561	60%
35–40 years	8501	8501	100%
40–45 years	2335	2335	100%
45+ years	1142.5	1142.5	100%
Total	1,94,024	50,359 ([illegible])	26%

Source: Authors' analysis

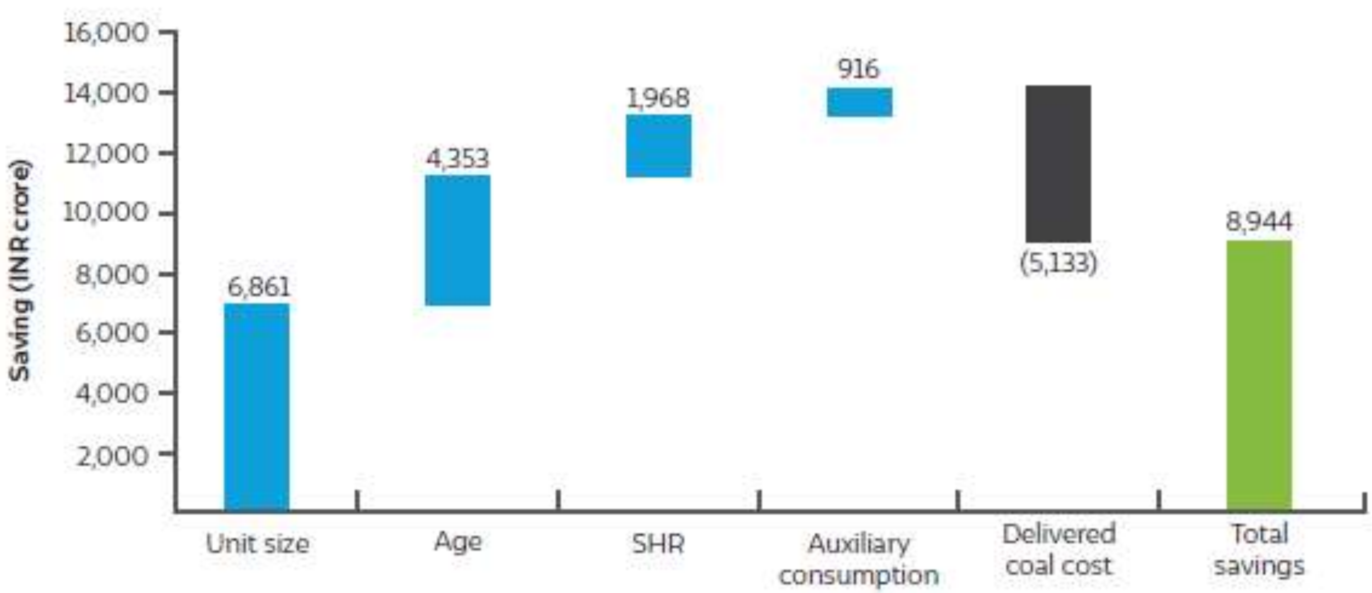
Implications for efficiency and coal consumption

- On reassignment, the overall efficiency of the coal fleet improved around 6% from 29.7% to 31.6%.
- The corresponding SHR improvement was to 2898 kcal/kWh from 2719 kcal/kWh
- This improvement directly translates to a 6% reduction in total coal consumption from the baseline amounting to 42 MT.

Source: Authors' analysis

Cost savings

- The total variable cost savings amount to around INR 8,944 crore annually along with a one-time saving of INR 10,250 crore by avoiding pollution control retrofits to the surplus capacity
- SHR and its determinants - age and unit size contributes to the majority of the savings.
- The delivered coal price of the reassigned fleet is higher than the base case, as the coal transportation distance increases.



Source: Authors' analysis

Implications of the reassigned scenario

- The regional generation variation is within 10%, while the grid has balanced larger deviations in the past. At an aggregate level transmission is not a bottleneck
- Barring WB, OD, KA and HR, all other states would see a generation variation within 20%
- A dip in the ramping capabilities of the system around 26% was observed, but the last year saw only 5% of the total ramping capacity being used
- The remaining coal generation capacity after decommissioning 30 GW, could cater to 108% and 77% of the average supply expected from coal in 2022 and 2030 respectively

Source: Authors' analysis

Thank you

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