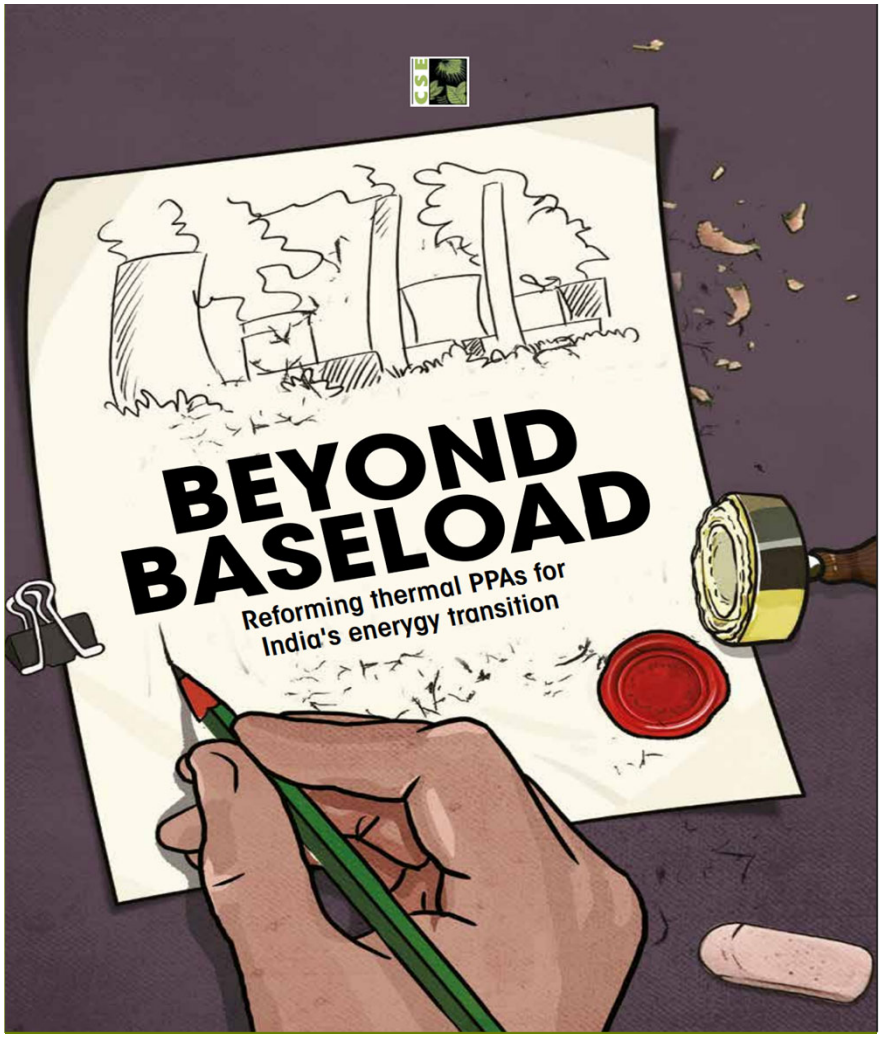


- **Kushagra Goyal,** Sustainable Industrialisation unit**,** CSE

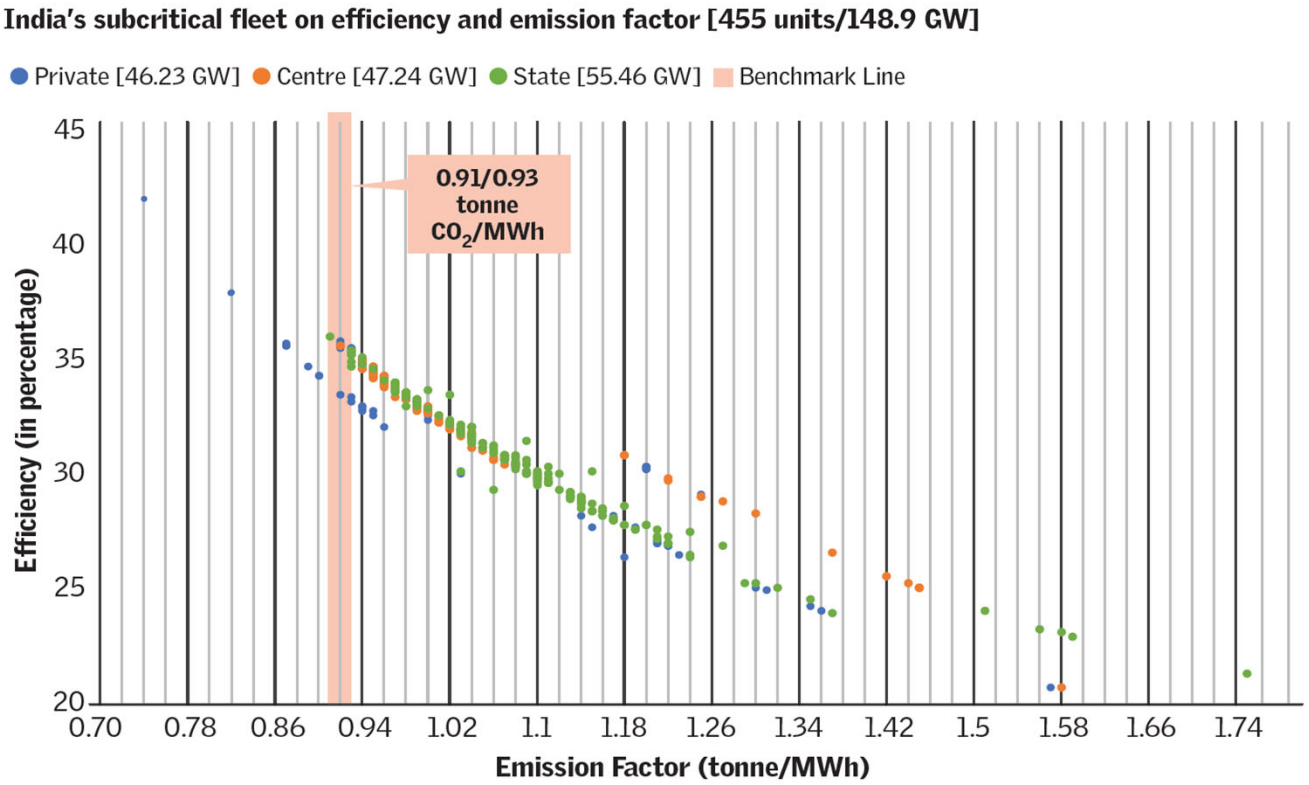
Role of coal power is permanently altered

- **In FY 2019-20,** for every one unit of solar energy consumed, 19 units of coal power was consumed.
- **By FY 2025-26,** for every one unit of solar energy consumed, 7 units of coal power is consumed in India.
- The contractual structure paying coal-based thermal power plant for a uniform availability factor over 24 hours makes little financial sense.

Source: CSE analysis based on hypothetical utililisation scenario of a 660 MW unit over an year

In 2025, CSE marked the performance of TPPs based on efficiency and emission factor

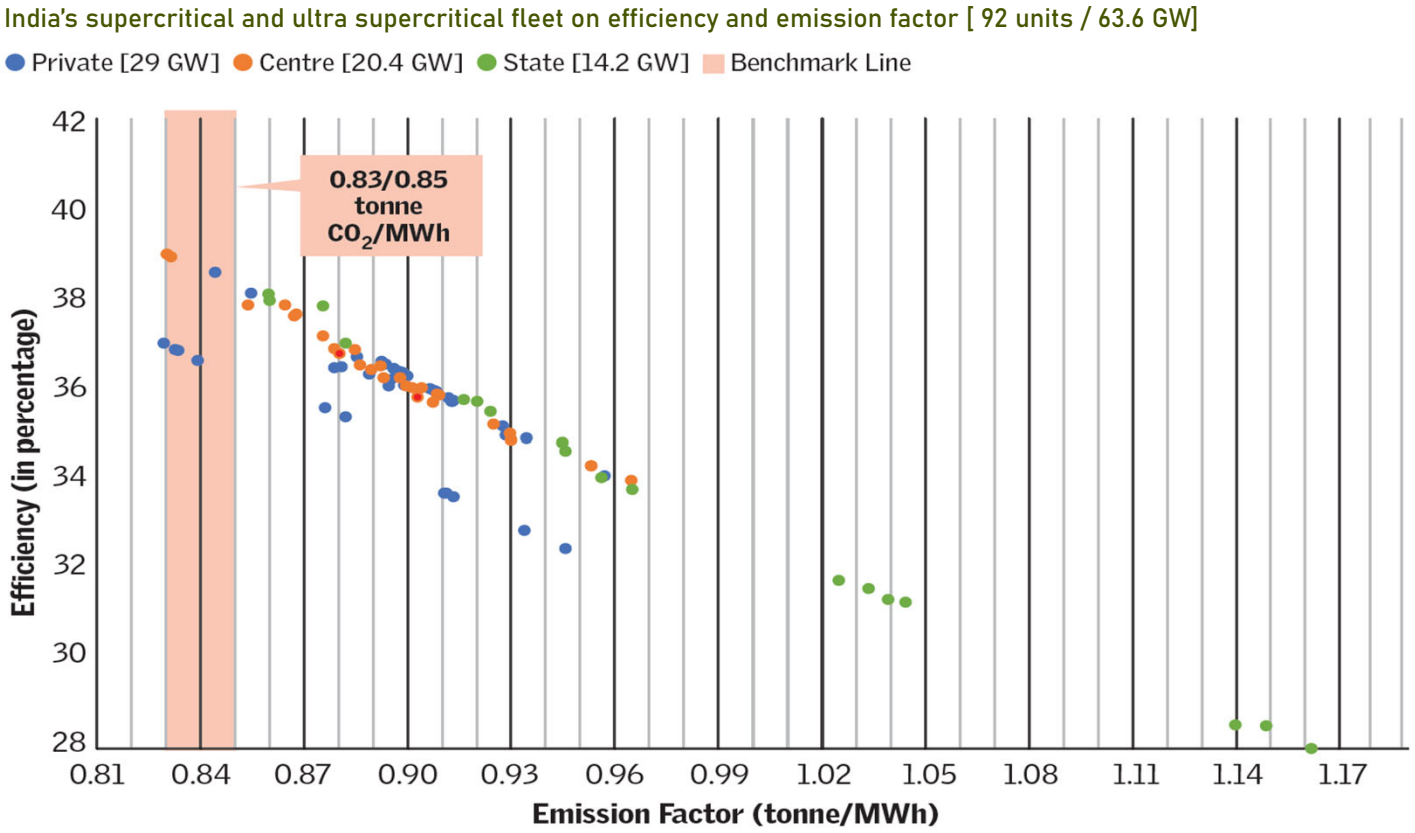
- Operational variance across units can be observed.
- The technology of operation being similar, yet the variation.



Source: CSE analysis based on CEA's CO_2 database, Version 19

In 2025, CSE marked the performance of TPPs based on efficiency and emission factor

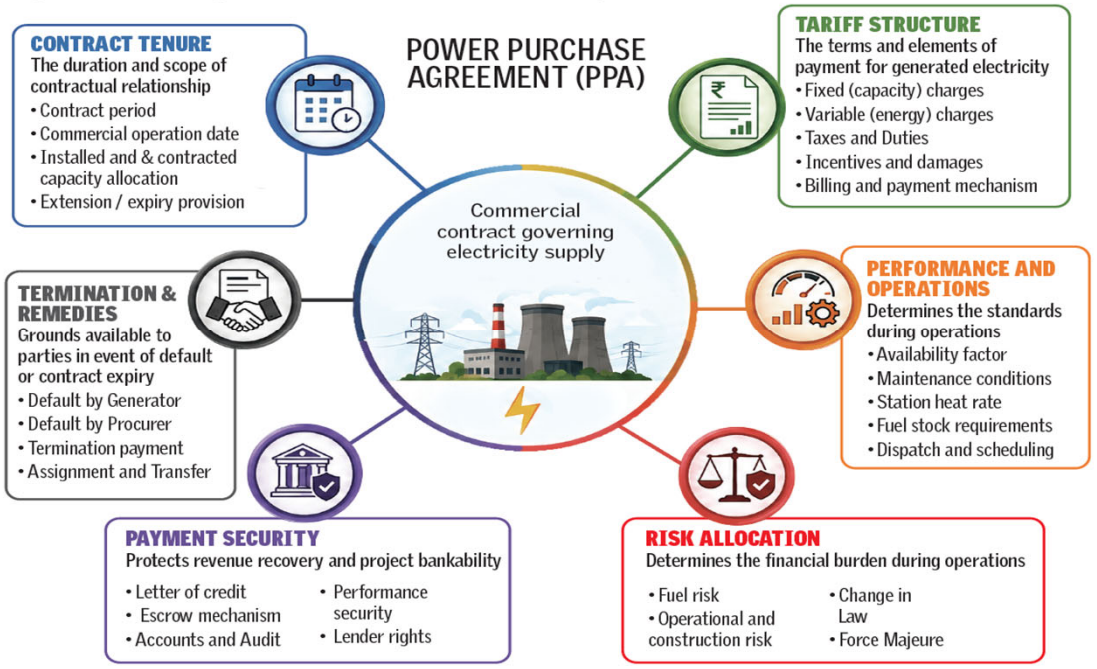
- The relatively new fleet of Ultra / Supercritical technology showcased similar variation in operational efficiency alongside emission profile.



The pivot towards the operational obligations

Power Purchase Agreements [PPA] is a supply contract between generator and purchaser (usually a DISCOM / state Power Corporation)

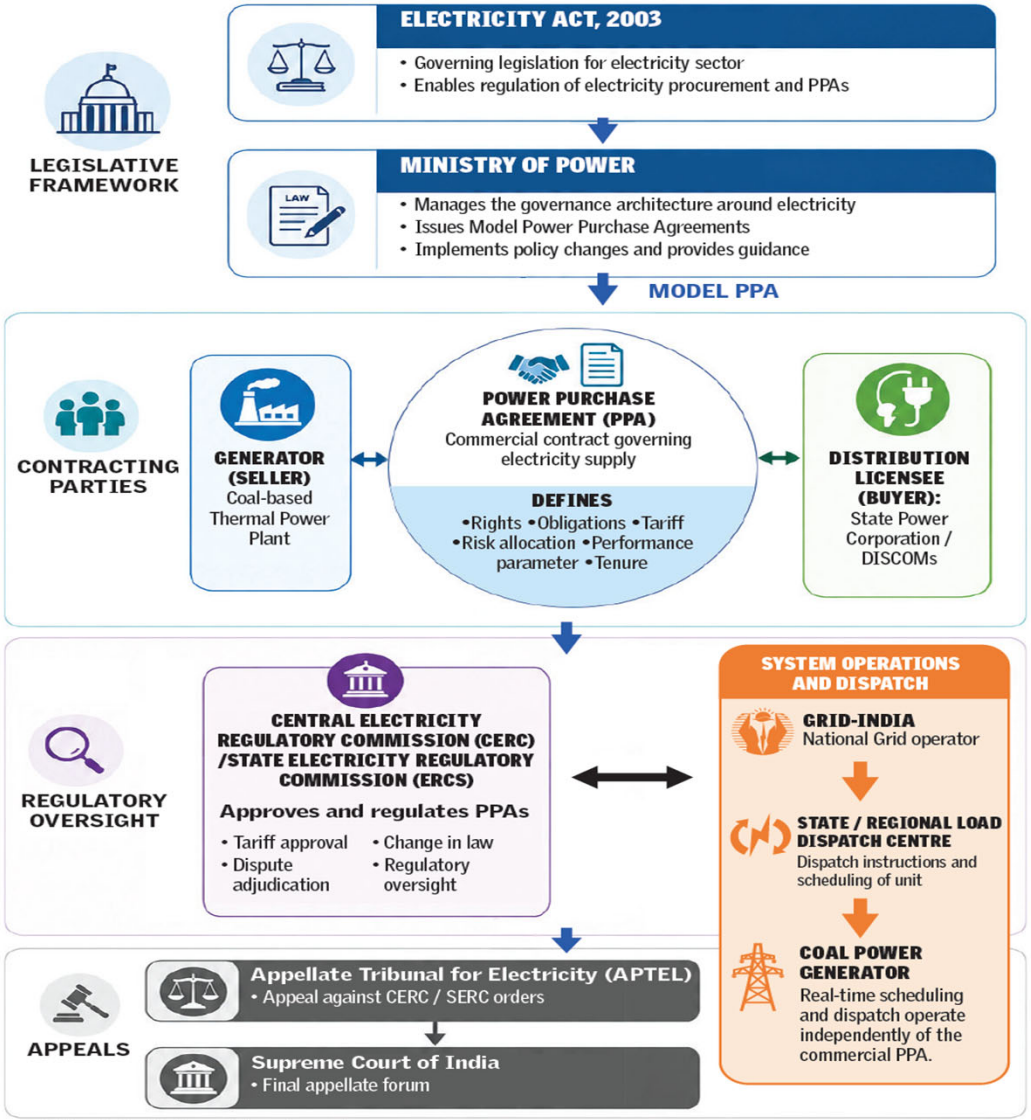
Figure 4: Anatomy of a thermal PPA — core components



Source: CSE analysis of PPAs accessed via RTIs

Table 1: Risk distribution under thermal PPAs

Risk	Typical allocation
Construction risk	Generator
Operational performance	Generator
Fuel procurement	Generator (subject to contractual provisions)
Fuel price variation	Depends on tariff structure
Dispatch risk	Procurer/System Operator
Market / offtake risk	Freedom determined by PPA with benefits usually shared equally
Payment risk	Procurer (mitigated through payment security mechanisms)
Regulatory change	Shared through Change in Law provisions
Extraordinary events	Governed through *Force Majeure* provisions



Source: CSE analysis of Indian regulatory documents

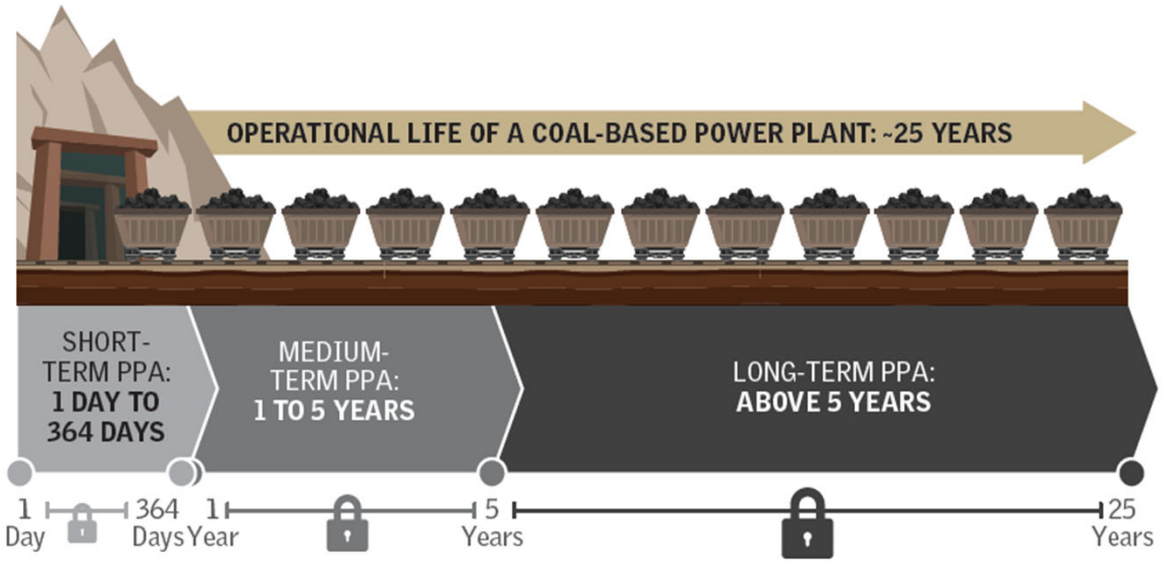
PPA Governance structure

- Despite the large regulatory structure, the PPA is a contract between two parties.

- Currently, with Public Private partnership (PPP) the key building method, the plant may be privately built yet ownership is shared.

PPA categorization issue

- The MoP guidelines classify every PPA above 5 years as long-term.
- The CERC / ERC guidelines require 80-85 per cent of power procured to be lock-in under long-term PPAs to ensure certainty in power supply.
- Historically, this has meant 25 years. The operation life of a coal unit became the default option.
- The textual obligations state long-term without specifying an year, yet the practice of 25 year as base continues.



Source: CSE analysis of Ministry of Power guidelines

Cost assessment of a greenfield PPA

- A coal plant follows a two-part tariff structure and the CAPEX is part of the fixed cost tariff payable on basis of availability to generate not actual generation.

Step 1: Capacity x PLF x Time = Generation [*100% nameplate possibility]
2400 MW x 1000kW/MW x (8,760 hours x 25 years) =
~ 525,600,000,000 kWh

Step 2: Generation x 80 % = billed generation [80% availability over 25 years]
~ 525,600,000,000 kWh x 0.80 = **~ 420,480,000,000 kWh**

Step 2: Generation x fixed cost tariff = absolute payout
~ 420,480,000,000 kWh x Rs. 4.165
= ~ Rs. 1,751,299,200,000/- / × **~1.75 lakh crore**

- These are nameplate valuations which do not address the risk incurred and interest payout.

- Bihar's 2,400-MW Pirpainti Thermal Power Station to be set up on a design, build, finance, own and operate (DBFOO) discovered tariff of Rs. 4.165/- / kWh in fixed cost.

Table 2: Cost of a new coal unit

Unit size with per MW cost	Equity component 30 % [in ₹ crore]	Debt component 70 % [in ₹ crore]	Total cost [in ₹ crore]
660 MW @ ₹11.5 crore/ MW	2,277	5,313	7,590
800 MW @ ₹11.5 crore/MW	2,760	6,440	9,200
660 MW @ ₹13 crore/MW	2,574	6,006	8,580
800 MW @ ₹13 crore/MW	3,120	7,280	10,400

Cost assessment of a greenfield PPA

- A coal-based thermal power plant only starts making a return from the commercial date of operation (COD), hence no cost recovery takes place from the date of LoA until CoD.
- Systemic costs of coal by being mindful of these numbers is key to understand the tariff burden over varying time period.

Table 5: Pay-out analysis based on PPA tenure

PPA tenure	Annual debt payment (₹ crore/ year)	Total debt paid (₹ crore)	Interest paid (₹ crore)	Annual equity payment (₹ crore/ year)	Total equity paid (₹ crore)	Equity return earned (₹ crore)	Total annual capacity payment (₹ crore/ year)	Total Consumer Payout (₹ Cr)
	A	B = A x debt repayment period	C = B - initial debt	D = Capacity charge attributable to equity	E = D x PPA tenure	F = E - Initial equity	G = A + D	H = B + E
6 Years	2,498.97	14,993.84	3,441.39	1,906.93	11,441.61	4,224.85	*4,405.91*	26,435.44
11 Years	1,618.22	17,800.47	6,248.02	1,378.90	15,167.89	7,951.13	*2,997.12*	32,968.36
15 Years	1,349.67	20,245.01	8,692.56	1,234.19	18,512.84	11,296.08	2,583.86	38,757.85
20 Years	1,176.64	23,532.85	11,980.40	1,152.96	23,059.20	15,842.44	*2,329.60*	46,592.05
25 Years	1,082.22	27,055.49	15,503.04	1,116.43	27,910.71	20,693.95	*2,198.65*	54,966.20

- Using the weighted average discovered tariff (2019-25) derived from 7 coal projects across 6 states, we see the overall payout rising as the repayment period rises.

Cost assessment of a greenfield PPA

- Table 6 of the report showcases the nameplate cost calculation vis-à-vis weighted average tariff over different year of repayment.
- Table 7 translates the payout on consumer tariff (excluding OPEX and system cost), showcasing that in a tariff cost saving of 114 paise / kWh, the overall consumer payout doubles.

Table 6: Comparison of Minimum Capital Recovery and Marked-up Fixed Cost Payment

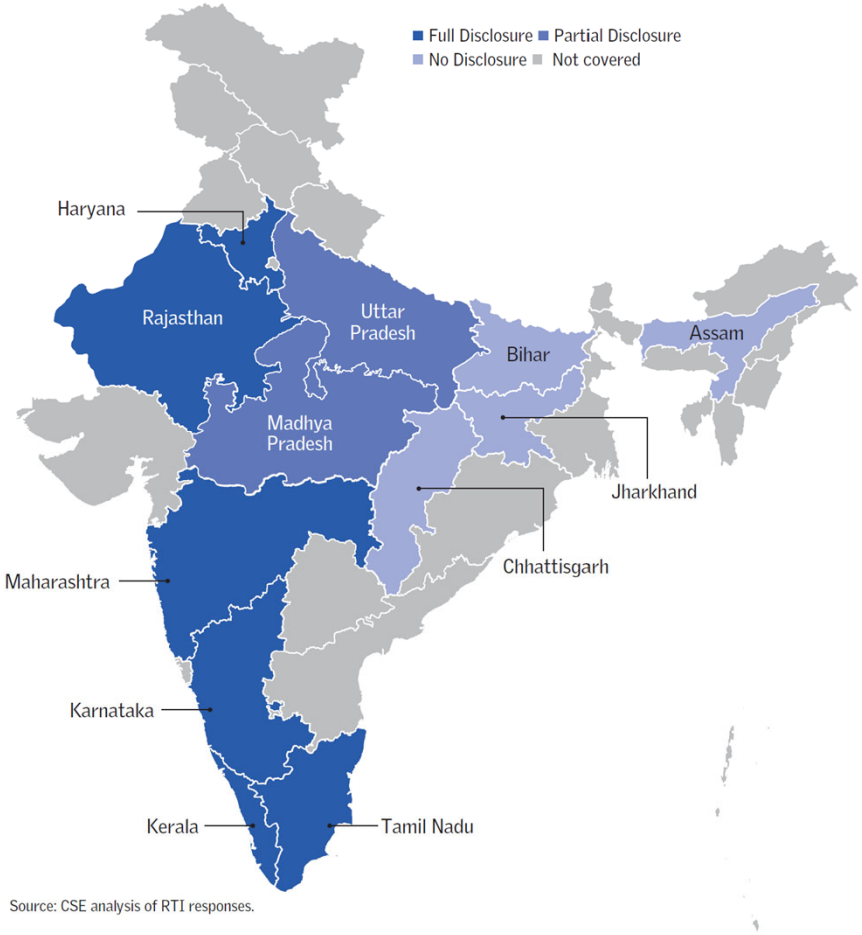
PPA tenure	Minimum Annual Capacity Payment (₹ crore/year)	Minimum Consumer Payout (₹ crore)	Weighted Average Fixed-Cost Recovery (₹ crore/year)	Total Consumer Payout at Weighted Tariff (₹ crore)
6 years	4,405.91	26,435.44	2,700	16,200
11 years	2,997.12	32,968.36	2,700	29,700
15 years	2,583.86	38,757.85	2,700	40,500
20 years	2,329.60	46,592.05	2,700	54,000
25 years	2,198.65	54,966.20	2,700	67,500

Table 7: Capacity tariff comparison under different PPA tenures

PPA tenure	Minimum Annual Capacity Payment (₹ crore/year)	Minimum Capacity Tariff (₹/kWh)	Weighted Average Fixed-Cost Recovery (₹ crore/year)	Weighted Average Capacity Tariff (₹/kWh)
6 Years	4,405.91	6.29	2,700	3.85
11 Years	2,997.12	4.28	2,700	3.85
15 Years	2,583.86	3.69	2,700	3.85
20 Years	2,329.60	3.32	2,700	3.85
25 Years	2,198.65	3.14	2,700	3.85

- The analysis showcases that length of the PPA determines the overall systemic costs paid by the DISCOMs / Power Corporations.

Map 1: RTI response status of state DISCOMs and power corporations

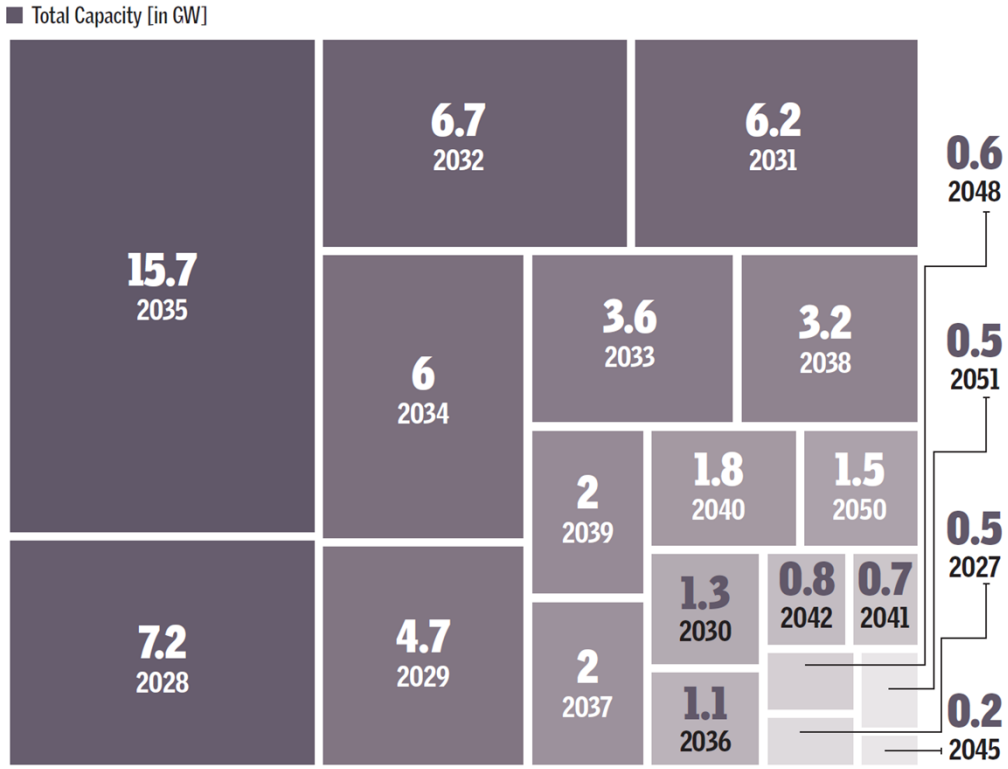


Source: CSE analysis of RTI responses.

State of PPA lock-in?

- We sent out RTIs to 12 states to enquire about the total PPA contracted capacity and the year of expiry of each PPA to identify the scale of PPA induced systemic lock-in.

Graph 9: India — select DISCOM's PPA lock-in | 67.1 GW



Source: CSE analysis of RTI responses from public sector DISCOMs

State of PPA lock-in?

- Survey across 8 states showcases that bulk of the contracted capacity is locked in rigid, long-term (25-year) contracts with **67.1 GW** of coal capacity assessed.

- **BEST (Mumbai)** stands out as the ***sole entity*** among the surveyed DISCOMs for utilizing five-year thermal PPAs for their electricity supply.

Estimating the scale of underutilisation

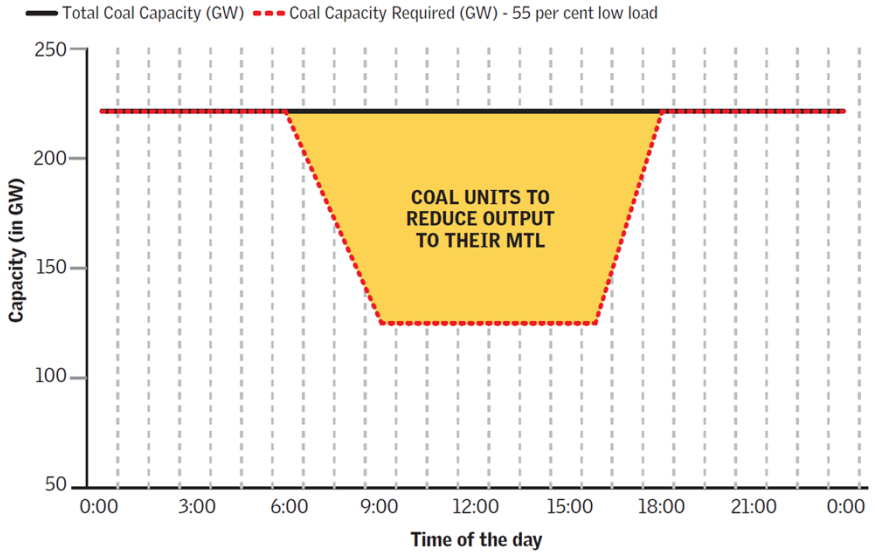
- As solar energy becomes a permanent feature for our electricity system, during day-time a signification portion of coal power fleet is unused.

- Under assumptions that 10 per cent of the installed capacity is consumed as auxiliary power and 15 per cent of the fleet remains unavailable due to planned outages and maintenance, the estimated daytime surplus remains substantial

Table 10: Net daytime solar power surplus

Scenario	Installed capacity (GW)	Gross surplus (GW)	Deduction: Auxiliary (10%) + outage (15%) (GW)	Net surplus (GW)
55% technical minimum load	228.6	102.87	57.15	45.72 GW
40% technical minimum load	228.6	137.16	57.15	80.01 GW

Graph 13: Illustrative operation of coal fleet at 55 per cent MTL



Other themes explored in the policy study

- In 2026, Torrent Power acquired from Larson & Toubro (L&T) its only operational power plant subsidiary, Nabha Power Ltd, for an enterprise value deal of Rs 6,889 crore. The valuation includes an equity in cash payment of Rs. 3,661 crore with 13 years remaining on the PPA.

- To examine whether the contractual rigidity is necessarily permanent, the case of Tata Mundra UMPP is discussed to analyse the concept of PPA renegotiation. The case study shows when the scale of balance shifts towards DISCOMs from the power generators.

- The embedded cost of Fuel Supply Agreement (FSA), a necessary condition for bidding, is discussed in light of Germany's payout mechanism for early closure / lower utilisation of coal mines. The country in a negotiated settlement will be paying €4.35 billion in targeted payouts (€2.6 billion to RWE and €1.75 billion to LEAG) for 43.9GW capacity by 2038.

- **Ramp rate**: The rate of change of output power, expressed in percentage of maximum continuous power rating, per minute, as declared by the unit or prescribed under the applicable grid regulations, whichever is higher.

- **Solar hours**: The period of the day, as notified by the system operator or prescribed under the applicable regulations, during which solar energy generation is expected to be available and contribute to meeting grid power demand.

Suggestive clauses to be included

- **Seller's obligations**:
  - operate unit in line with the declared efficiency of the unit relying on best available operation and maintenance practices to maximise fuel savings
  - declare emission intensity of generated electricity on a quarterly basis to the buyer
- **Buyer's obligations**:
  - Provide optimum schedule for maintenance of unit to maintain consistent efficiency and emission intensity of generated electricity
  - Maintain record of efficiency and emission intensity of generated electricity on a quarterly basis
- **Energy charge**:
  - Subject to regulatory foresight the parties may agree to a differentiated charge for solar and non-solar hour of operations with provision for seller to sell excess power in open market during solar hours without sharing sale profits with the buyer
  - Subject to regulatory approval, the parties may agree to a variation in energy charge during low load operations to account of SHR loss during lower PLF conditions
  - Subject to regulatory approval the parties may mutually agree to an emission factor range for electricity generated with incentive payout on tariff accrued to seller if generated electricity is aligned to the agreed upon range

A modernised PPA

- CSE has provided model clauses for aligning PPAs for RE integration and efficiency operations for ERCs and Procurers to reduce system costs in the long run.
- It includes new definitions, model clauses and a concept of scheduled exit / release clause

Select policy recommendations

- **Update the model PPA:** Revise the Model Thermal Power PPA to reflect the evolving role of coal, including provisions for operational efficiency, emission intensity, flexible operation, differentiated solar and non-solar hour requirements, and other model clauses suggested in the report.
- **Differentiate availability factor for solar and non-solar hours:** Review the uniform annual availability factor to reflect different system requirements during solar and non-solar hours, aligning thermal capacity payments more closely with actual system needs.
- **Make periodical PPA portfolio review mandatory:** Require DISCOMs and Power Corporations to periodically assess existing thermal PPA liabilities against evolving system requirements, including the options of renegotiation, tenure revision and negotiated exit.
- **Incentivise efficient, low-carbon thermal generation:** Establish measurable efficiency and emission-intensity benchmarks and incentivise better-performing thermal units through Merit Order Dispatch preference or performance-linked mechanisms to reduce fuel consumption and CO_2 emissions.
- **Establish a framework for PPA renegotiation and exit:** Develop standard principles for voluntary renegotiation, tariff adjustment and negotiated exit, with compensation limited to genuine unrecovered costs and appropriate treatment of existing financial obligations.

Thank you

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