iFOREST | INTERNATIONAL FORUM FOR ENVIRONMENT, SUSTAINABILITY & TECHNOLOGY

TOOLKIT

REPURPOSING RETIRED THERMAL POWER PLANTS IN INDIA

TOOLKIT

REPURPOSING RETIRED THERMAL POWER PLANTS IN INDIA

iFOREST

INTERNATIONAL FORUM FOR ENVIRONMENT, SUSTAINABILITY & TECHNOLOGY

Research Direction: Chandra Bhushan

Research and Writing: Mandvi Singh and Srestha Banerjee

Research Support: Devrupa Paul

Design and Layout: Raj Kumar Singh

iFOREST | INTERNATIONAL FORUM FOR ENVIRONMENT, SUSTAINABILITY & TECHNOLOGY

June 2025

Contents

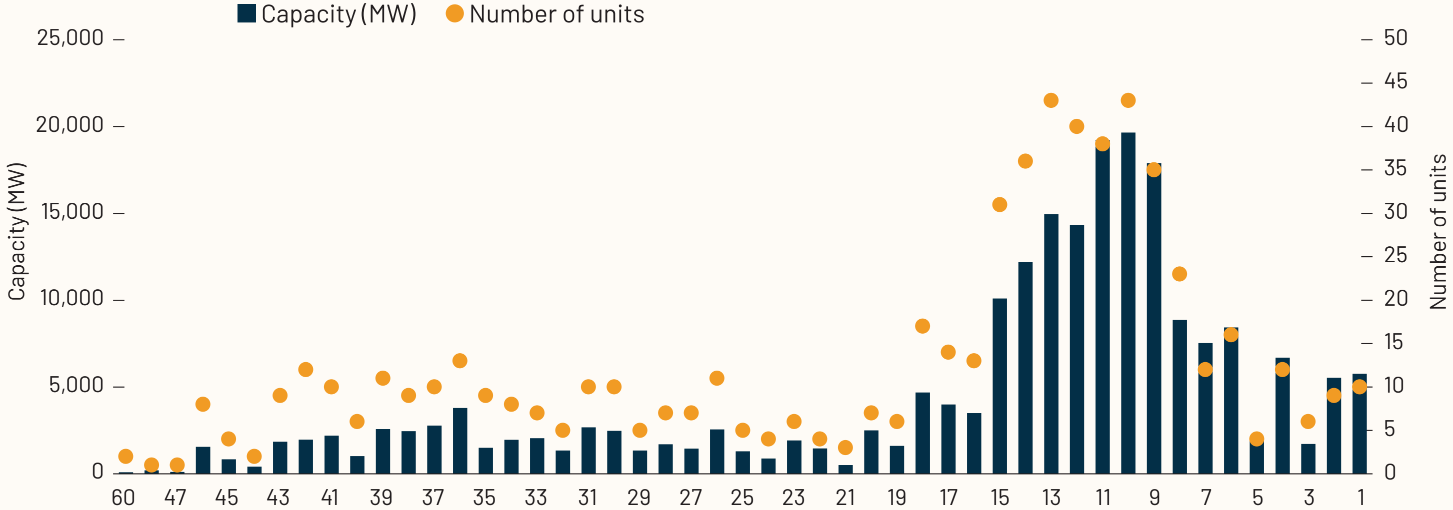
List of Abbreviations

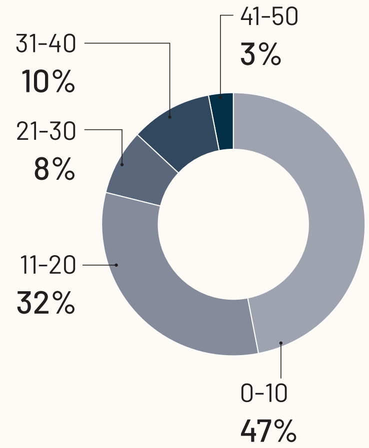
ACEN	ACEN Corporation
ADB	Asian Development Bank
ARO	Asset Retirement Obligation
BESS	Battery Energy Storage System
CAPEX	Capital Expenditure
CTE	Consent to Establish (from pollution control board)
C&D	Construction and Demolition (Waste)
CEA	Central Electricity Authority
CERC	Central Electricity Regulatory Commission
CPCB	Central Pollution Control Board
CTO	Consent to Operate (from pollution control board)
DPR	Detailed Project Report
Discom	Distribution Company (Electricity)
ETS	Emission Trading Scheme
EPF	Employees' Provident Fund
ETM	Energy Transition Mechanism
ESMP	Environmental and Social Management Plan
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
ESG	Environmental, Social, and Governance
FGD	Flue-gas desulfurization
GHI	Global Horizontal Irradiance
GHM	Green Hydrogen Model
GDP / GVA	Gross Domestic Product / Gross Value Added
HWM	Hazardous Waste Management
ID Act	Industrial Disputes Act
IR Code	Industrial Relations Code
ISTS	Inter-State Transmission System
LCOE	Levelized Cost of Energy
LCA	Life Cycle Assessment
MRV	Measurement, Reporting, and Verification
MW	Megawatt
MoEFCC	Ministry of Environment, Forest and Climate Change
MNRE	Ministry of New and Renewable Energy
NCEUS	National Commission for Enterprises in the Unorganised Sector
NPV	Net Present Value
NPCIL	Nuclear Power Corporation of India Limited
OHS Code	Occupational Safety, Health and Working Conditions Code
O&M	Operation & Maintenance
OPEX	Operational Expenditure
OEM	Original Equipment Manufacturer
PLF	Plant Load Factor
PPA	Power Purchase Agreement
RE	Renewable Energy
RTC-RE	Round-the-Clock Renewable Energy
SEBI	Securities and Exchange Board of India
SMP	Social Management Plan
Solar PV	Solar Photovoltaic
SERC	State Electricity Regulatory Commission
SPCB	State Pollution Control Board
TPPs	Thermal Power Plants
TPS	Thermal Power Station
VGF	Viability Gap Funding

01 Context and Purpose

1.1 India's ageing thermal power fleet

Vintage profile of operational coal-based TPP units

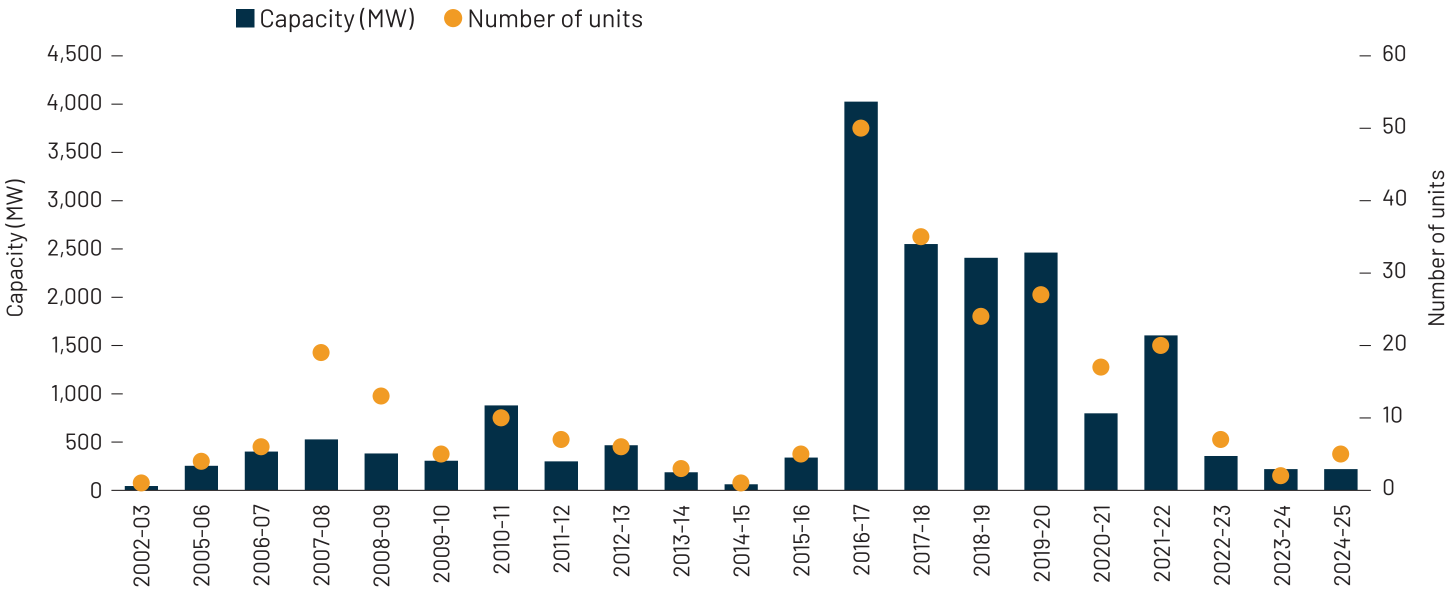




Source: Global Energy Monitor, January 2025

- 218 GW of coal-based capacity is operational in India as of January 2025, of which 28,697 MW (127 units) was installed over 30 years ago. This includes 7,020 MW (39 units) that is over 40 years old.[1]
- If CEA's 2020 advisory to retire coal-based units older than 25 years were to be implemented, 38,342 MW of capacity (166 units) or about one-fifth of total installed coal-based capacity would be eligible for decommissioning.[2]
- At present a 2023 CEA advisory has paused the retirement of coal plants of >200 MW capacity until 2030 to meet rising demand, though smaller units continue to close.[3]
- Further, CEA's National Electricity Plan 2023 considers 2,121.5 MW of capacity for retirement by 2032.[4]
- Power plant units are routinely retired at end-of-life due to techno-economic factors. As of November 2024, 18,802 MW across 267 units have been retired in India — 88% coal, 6% gas, 4% lignite, 3% diesel.[5]
- Going forward, TPPs are less likely to operate for 40–50 years, as cleaner alternatives grow and environmental, economic, and climate pressures increase.

Year-wise retired thermal capacity



Source: CEA, as of November 2024

Factors contributing to the deteriorating techno-economic position of existing coal-based units

High generation cost: TPPs now have higher variable costs than new RE, making them less competitive.

Low PLFs: Reduced utilisation due to surplus capacity and rising RE reduce PLF, increasing per-unit costs.

Costly compliance: Meeting new emission and water norms requires expensive retrofits, often unviable for older plants.

Payment delays: Discoms' long payment cycles strain working capital and financial stability.

Inflexibility: Most TPPs can't operate flexibly, limiting their role in RE-dominated grids.

Stranding risk: Ageing units face early closure due to expired PPAs, low merit order, and poor economics.

Socio-environmental pressure: Public opposition over pollution and health impacts affects operations.

Policy uncertainty: Shifting energy and climate policies create long-term investment and operational risks.

1.2 Strategic role of repurposing TPP units

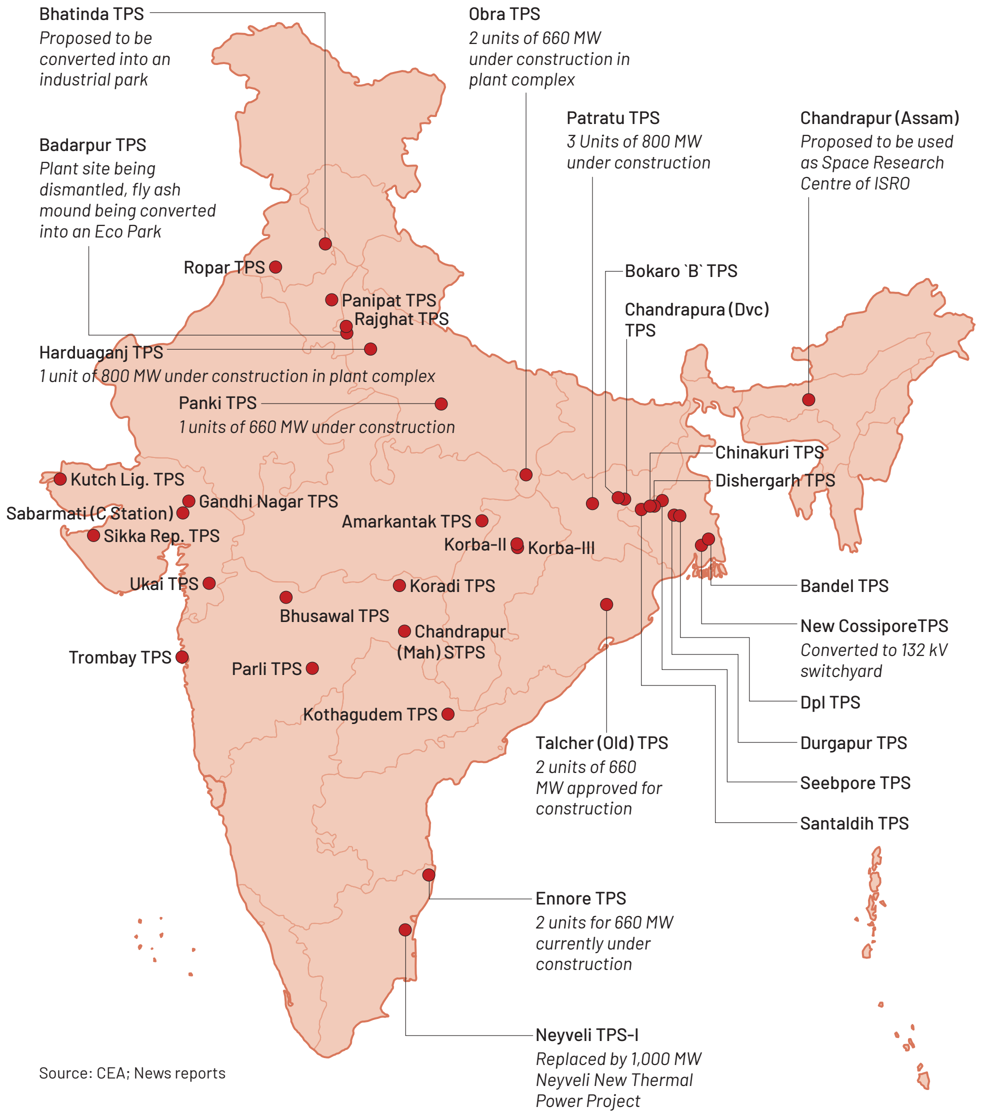
- Closure of power plant units involves three stages: retirement (shutdown), decommissioning (dismantling and remediation), or abandonment (no action), followed by repurposing (reuse of site).[6]

- Many retired unit sites in India have strong potential for repurposing for clean energy—solar, biomass, storage, or hydrogen—given the existing infrastructure at these sites.

- In India, repurposing remains limited. Most retired TPP units are planned for replacement with supercritical units, though this is becoming less viable.

- iFOREST finds that of 12 GW retired between 2016-21, only 2.7 GW is being replaced, and just 1.4 GW repurposed. Most sites remain abandoned.[7]

Decommissioned and repurposed coal-based TPP units during 2016-2021



Source: CEA; News reports

Advantages of decommissioning and repurposing retired TPP units

Site-level

- Optimal use of existing infrastructure (land, transmission, water access, civil infrastructure & ancillary assets), reducing cost for new energy projects.
- Reduced environmental risks by remediating legacy contamination or hazards.
- Improved land use by transitioning under-utilized or derelict sites into active, revenue-generating assets.

Enterprise-level

- Avoidance of stranded assets by leveraging the site for new energy or commercial uses.
- Diversification opportunities into clean energy or industrial activities.
- Improved ESG performance and brand value through visible commitments to sustainability and transition.
- Opportunity to access incentives or support from national/global transition programmes.

Nation-level

- Supports national clean energy targets.
- Reduces pressure on greenfield land by prioritizing brownfield redevelopment.
- Enhances grid reliability by reusing grid infrastructure at strategic locations.
- Enables a just transition by phasing down thermal power generation while creating future-ready energy assets.

Community-level

- Opportunities for skill development and reemployment of former plant workers.
- New livelihood opportunities in redevelopment project.
- Reduction in local pollution and health risks through proper decommissioning and site remediation.

1.3 Integrating repurposing with India's energy transition agenda

- Repurposing of retired TPPs is especially crucial as India's coal-based power sector is deeply intertwined with the socio-economic fabric of several coal regions of India.
- Coal-heavy states like Jharkhand, Chhattisgarh, Odisha, Maharashtra, and West Bengal host 35% of India's coal capacity. By 2030, up to 21% of this coal fleet will be over 25 years old, including 39% and 32% for states like West Bengal and Odisha, respectively. Most of these are pithead TPPs in regions with limited economic alternatives, occupying ~20,800 acres of land and employing ~59,800 workers.
- Unplanned closures risk severe social and economic disruption, while a planned transition—paired with investments in green energy and industry—can unlock significant economic benefits and also support the country's green energy transition and net zero goals.

Vintage profile of installed coal-based TPP capacity in coal states

State	Existing units		Units >25 years of age in January 2025		Units >25 years of age in December 2030			
	Installed capacity (MW)	No of units	Installed capacity (MW)	No of units	Installed capacity (MW)	No of units	Estimated land area (acres)	Estimated workforce employed
Jharkhand	6,993	16	420	2	420	2	546	1,571
Chhattisgarh	22,683	60	2,940	10	2995	11	3,894	11,201
West Bengal	12,515	49	3,755	20	4845	25	6,299	18,120
Odisha	9,120	24	1,420	4	2920	7	3,796	10,921
Maharashtra	24,366	71	4,390	15	4810	17	6,253	17,989
Total	75,677	220	12,925	51	15990	62	20,787	59,803

Source: Global Energy Monitor, January 2025; iFOREST estimated

02 Planning for Decommissioning

2.1 Post-closure stages – from retirement to repurposing

Stage 1
Retirement

- Generation is delicensed under Section 7 of the Electricity Act, 2003. Thus, retirement decisions rest with the generating company.
- Only a board approval is required, followed by intimation to the CEA. If grid security is unaffected, closure proceeds.
- CEA updates the All India Installed Capacity Database accordingly.[8]

Stage 2
Decommissioning

- Decommissioning involves technical, environmental, social, and economic actions to remediate sites and manage community/workforce impacts.
- Activities are shaped by the site's reuse plan.
- No legal mandate exists in India for decommissioning retired TPPs—units can remain "as is."
- If a plant owner decides to decommission a retired unit, multiple environmental and labour laws apply.

Stage 3
Repurposing or redevelopment

- Repurposing creates new economic opportunities for enterprises, workers, and communities at retired plant sites.
- May involve full/partial dismantling, remediation, or adapting existing infrastructure for new uses.
- New environmental and labour laws apply, based on the sector of redevelopment.

2.2 Identifying candidate plants for decommissioning

A decision-support framework—based on a unit's operational status and its potential to support a just transition—can help identify and prioritise candidates, especially in the context of India's clean energy and just transition goals.

A. Based on the operational status of units

1. **Abandoned Units:** Fast-track decommissioning for non-operational units left neglected.
2. **Units Nearing Closure:** Prioritise based on key indicators:
   - **Age:** Over or nearing 30–45 years, especially smaller units (>200 MW).
   - **Environmental Non-compliance:** Unable to meet new norms (e.g., FGD), especially in sensitive zones.
   - **Economic Stress:** High O&M or compliance costs make operations unviable.
   - **Grid Redundancy:** Low capacity use or non-critical for grid stability.
3. **Inefficient Units:** Not immediate priority but may be phased out under long-term transition plans.

B. Based on just transition potential of units

1. **Coal-Dependent Regions:** Prioritise closures where coal drives local economies. These sites offer scope for:
   - Green redevelopment through clean industry repurposing.
   - Socio-economic transition via early planning for reskilling, social protection, and community support.
2. **Non-Coal Regions:** Though impacts are smaller, assess local job dependence and plan with stakeholders to ensure economic continuity and minimise disruption.

Priority matrix for decommissioning TPP units

Operational status of units	Location	
	In coal regions	In non-coal regions
Retired	Highest priority	High priority
Primed for closure	High priority	Low priority
Operating efficiently	Not an immediate candidate	Not an immediate candidate

2.3 Regulatory readiness for decommissioning and repurposing

Environmental regulations for decommissioning[9]

- **Decommissioning (partial or full) must safeguard local health, environment, and future repurposing.**
- **CPCB's 2021 draft guidelines outline legal obligations under existing environmental laws—but are yet to be notified.**

Draft Environmental Guidelines for Decommissioning Coal/Lignite-Fired Power Plants (July 2021)

Issued by MoEFCC and CPCB, the draft guidelines set a regulatory framework for full or phased closure of utility and captive coal/lignite plants. Operators must ensure compliance, while SPCBs oversee enforcement through regular inspections. Key provisions:

i. **Recommended planning phase process:**

- Future land use should be identified early to guide cleanup and redevelopment.
- Environmental assessments (EIA & EMP) must be prepared and approved by regulators.

ii. **Recommended compliance during demolition/dismantling and remediation:**

Environmental laws and regulations:

- The Water (Prevention and Control of Pollution) Act, 1974
- The Air (Prevention and Control of Pollution) Act, 1981
- Fly Ash Utilisation Notification
- The Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016
- The Construction and Demolition Waste Management Rules, 2016
- The E-Waste (Management) Rules, 2016
- The Fly Ash Utilisation Notification, 1999 (and amendments)
- The Regulation of Polychlorinated Biphenyls Order, 2016
- Local/state-level regulations as applicable

Occupational health and safety laws:

- The Building and Other Construction Workers (Regulation of Employment & Conditions of Service) Act, 1996
- The Factories Act, 1948

Environmental compliance requirements for decommissioning

Environmental parameter	Regulation	Compliance requirement	Concerned authority
Air pollution	Air (Prevention and Control of Pollution) Act, 1981 (Air Act)	During dismantling, the CTO to be revised or reissued for demolition, as the process can generate emissions and disturb soil.	SPCB
Water pollution	Water (Prevention and Control of Pollution) Act, 1974 (Water Act)	During dismantling, the CTO to be updated or reissued to reflect reduced wastewater discharge and changes in stormwater flow.	SPCB
Hazardous waste management	Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016	• Plant owner to manage and safely dispose of all hazardous materials used, generated, or stored, in line with the HWM Rules, 2016. • A hazardous waste management plan—covering prevention, reuse, recycling, and disposal—to be prepared and submitted to obtain a CTO.	SPCB
E-waste	E-Waste (Management) Rules, 2016, under the EP Act, 1986	E-waste to be disposed of/recycled as per the rules, including taking authorisation from the concerned authorities.	SPCB
Construction and Demolition (C&D) waste	Construction and Demolition (C&D) Waste Management Rules, 2016	All C&D waste to be managed as per the Rules, which entails: • Prepare and submit a comprehensive waste management plan to the local authority for approval. • Collect, segregate and store materials like concrete, soil, steel, wood etc. as per the notification of the local authority. • Regularly clean up the area, at a frequency decided in consultation with the local authority. • Partner with authorised agencies for waste removal. • Dispose of waste at approved collection centre/processing facility. • Pay applicable fees for collection, transport, and disposal.	Local administration and SPCB
Fly ash utilisation and management	MoEFCC notification for fly ash utilisation	• Management, use and disposal of fly ash, boiler ash, and boiler slag generated during TPP operations is as per various MoEFCC notifications. The first notification on fly ash utilisation was issued in 1999, and amended subsequently in 2003, 2009, 2016, 2021, and 2022. • The latest notification of 2021 (as amended in December 2022), mandates 100% use of fly ash and bottom ash generated in a given year of plant operations, over a three-year cycle. For legacy ash, the notifications specify progressive usage within 10 years starting April 1, 2022. It also identifies several eco-friendly ways of using fly ash, and the penalty for non-compliance.	SPCB

Environmental parameter	Regulation	Compliance requirement	Concerned authority
Ash pond management	Guidelines on Design, Construction, O&M and Annual Certification of Ash Ponds, 2023	Fly ash, boiler ash, and slag from TPPs to be managed as per MoEFCC notifications, with the latest (2021, amended 2022) mandating 100% ash utilization over a three-year cycle. Legacy ash is be progressively used within 10 years from April 1, 2022. In context of decommissioning, ash pond & dyke reclamation should include: • Obtaining statutory permission from SPCBs before abandoning ash ponds. • Preventing pollution through suitable reclamation methods. • Complete dewatering, site preparation, and 300mm earth cover placement, ensuring the final level is below the dyke top for proper drainage. • Vegetation to prevent erosion, or repurposing for solar/wind installations—subject to feasibility studies, clearances, and pollution control measures. • Annual certification of reclaimed ash ponds/dykes, with reports submitted to authorities.	SPCB

Environmental regulations for repurposing

- **Clean energy projects are exempt from environmental clearance under the EIA Notification, 2006.[10]**
- **For green hydrogen, MoEFCC (June 2023) requires consents under the Air and Water Acts; LCA may be done separately under MNRE guidance.[11]**
- **Non-energy projects must follow full environmental clearance process—screening to appraisal.**

Environmental compliance requirements for repurposing

Environmental parameter	Green Hydrogen Plant	Solar PV – Ground mounted	Solar PV - Rooftop	BESS	Law under which permit to be obtained	Concerned authority
Air Pollution	CTE and CTO	None	None	None	Air Act, 1981	SPCB
Water Pollution	CTE and CTO	None	None	None	Water Act, 1974	SPCB
Hazardous waste management	Authorisation to handle hazardous waste generated, aligned to the CTO	None	None	None	HWM Rules, 2016	SPCB
C&D waste management	Plan for handling C&D waste generated at the site, aligned with the CTE	None	None	None	C&D Waste Management Rules, 2016	SPCB
E-waste management	Authorisation to handle E-waste generated, along with plan for its disposal	None	None	None	E-Waste Rules, 2016	SPCB

Note: As per CPCB classification, solar PV plant of less than 25MW capacity is classified in White category, & hence no consent required; End-of-life disposal of solar PV and batteries required to be done by industry through authorised recyclers.[12]

Regulatory framework for workforce management

- Social aspects are governed mainly by labour laws on closures and disputes.
- Social impact assessments are usually not required, as repurposing stays within the existing plant area.

Key Applicable Laws:

- Industrial Disputes (ID) Act, 1947 (subsumed in the Industrial Relations Code, 2020).
- Contract Labour (Regulation and Abolition) Act, 1970 (subsumed in the Occupational Safety, Health and Working Conditions Code, 2020).
- Social Security Code, 2020
- The Building & Other Construction Workers (Regulations of Employment and Conditions of Service) Act, 1996

Note: Labour Codes enacted in 2020 await state-level implementation through finalised rules.

Categories of TPP workers

Departmental

Under the Industry Employment (Standing Orders) Central Rules, 1946[13], a worker becomes permanent after an unlimited appointment or three months of continuous service as a probationer. Permanent employees in coal and power companies are eligible for benefits like pension, EPF, healthcare, and sometimes housing.

Contractual

The Contract Labour Act (1970)[14] defines contract workers as those hired via contractors, often without the principal employer's direct knowledge. In the coal sector, they hold fixed-term jobs with EPF and pension entitlements. The OSH Code (2020) expands this definition to include regularly employed workers with pay and social security benefits, but applies only to contractors with 50+ workers, excluding smaller setups.

Informal

According to National Commission for Enterprises in the Unorganised Sector (NCEUS) and the Labour Bureau[15], informal workers lack employment and social security and are generally outside formal employer-employee relationships. In the coal and coal-based power sectors, they are mostly daily-wagers and gig workers.

Legal provisions related to workers

Law	Provisions
Industrial Disputes Act, 1947[16]	• Applicable to industrial units with over 100 workers (300 under the new, yet-to-be-notified IR Code). Retrenchment requires a 3-month notice and prior government approval. If no decision is made within 60 days, approval is deemed granted. • Compensation: 15 days' average pay per completed year (or part over 6 months). In closures beyond employer's control, capped at 3 months' pay. • State Variation – Jharkhand (2016): Applies to establishments with 50+ workers. Requires 45 days' notice and 45 days' pay per completed year. • IR Code: Raises threshold to 300 workers. Introduces a Worker Reskilling Fund, with 15 days' wages per retrenched worker to be paid within 45 days, funded by employer and other government sources.
Contract Labour (Regulation and Abolition) Act, 1970[17]	• Regulates the rights, benefits, and working conditions of contract labourers. • Applies to establishments or contractors with 20+ contract workers in the past 12 months. • Key Stakeholders: Establishments (public/private), contractors/sub-contractors, and workmen (manual, technical, clerical, etc.). • OSH Code: Raises threshold to 50+ workers and includes inter-state migrant contract workers with equal entitlements.
Social Security Code, 2020[18]	• Consolidates 9 laws to extend social security to all workers—organised, unorganised, gig, platform, and migrant. • Key Provisions: Welfare schemes by Centre (e.g., health, pensions) and States (e.g., PF, housing); funded via a Social Security Fund. • Institutions: Social Security Boards (national/state) and Career Centres to manage and support implementation. • Eligibility: Workers aged 16+ must register to access benefits
The Building & Other Construction Workers (Regulations of Employment and Conditions of Service) Act, 1996[19]	• Regulates employment conditions, safety, and welfare of building and construction workers. • Applicability: Covers workers on sites like buildings, roads, bridges, tunnels, dams, and pipelines. • Key Provisions: Ensures demolition safety, controls hazardous exposure, mandates fair wages, working hours, and basic amenities like canteens, creches, water, and toilets.
The Factories Act, 1948[20]	• Ensures health, safety, and welfare of factory workers. • Applicability: Applies to premises with 10+ workers (with power) or 20+ (without power) engaged in manufacturing. • Key Provisions: Requires safe working conditions, sanitation, ventilation, dust/fume control, safe machinery use, and employer-led health & safety policies with active implementation.

03 Evaluating Repurposing Opportunities and Feasibility

3.1 Plant site assessment

Key Assessment Areas:

Land availability

Equipment condition & reusability

Local industrial activity

Supporting infrastructure & resources

Five-step approach:

Preliminary site inspection

Assessment of land availability for repurposing

Evaluation of infrastructure and equipment

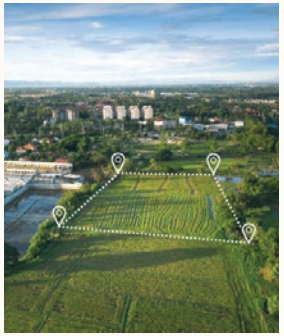
Evaluation of energy demand and energy infrastructure in the study area

Evaluation of repurposing options

Plant Assessment Details

Preliminary site inspection

- Collect baseline information
- Assess existing conditions of plant
  - » Field visits
  - » Consultations with plant authorities
  - » Visual assessment of the infrastructure and buildings
  - » Review of the status of retired units
  - » Understand current plans for repurposing



Assessment of land availability for repurposing

- Evaluation of the plant layout
- Current land use assessment to identify
  - » Suitability for integrating renewable technologies (e.g. solar PV, BESS, & green hydrogen production)
- Land availability analysis considering land types for repurposing
  - » Unused land
  - » Land freed after dismantling retired units
  - » Old ash dumps & coal stockpiles

Evaluation of infrastructure and equipment

- Infrastructure Assessment
  - » Components with sufficient residual life can be integrated into new facilities e.g. green hydrogen plants etc.
- Mechanical Equipment Assessment
  - » Turbines, generators, auxiliaries, switchyard, turbine house, coal handling systems, & water treatment facilities

Evaluation of energy demand and energy infrastructure in the study area

- Energy demand assessment for past 5 years
- Energy consumption projection
- Existing transmission network and connectivity assessment

Evaluation of repurposing options

- Option A: Green Electricity Model (GEM)
  - » Solar Photovoltaic (PV)
  - » Battery Energy Storage Systems (BESS)
  - » Biomass-based plant
- Option B: Green Hydrogen Model (GHM)

3.2 Techno-economic feasibility assessment

Techno-economic feasibility evaluation dimensions	Economic feasibility parameters	Long-term viability considerations
• Technological readiness • Resource availability • Scalability • Environmental & social benefits	• CAPEX (Capital Expenditure) • OPEX (Operational Expenditure) • Potential Returns • Net Present Value (NPV)	• Regulatory evolution (policies, incentives) • Renewable energy market trends • Technological advancements (e.g., electrolysers, storage, smart grids)

Model case 1: Solar plant evaluation criteria

Assessment Parameters	Data Sources/Tools
Site and Resource Assessment	Field Survey
Satellite Imagery	Google Earth
Solar Radiation Data	NASA/POWER Source Native Resolution Hourly Data
Technology Specifications	OEM Data Sheets

Capacity analysis of Solar PV plant considering excess area available and the area's global horizontal irradiance (GHI)

Assessment of the plant capacity

Assessment of the plant locations

Technology review

- Technology commercially mature and widely deployed
- Components readily available with robust supply ecosystem
- Long-term technology viability
- High energy yield

Economic analysis

Ability to deliver a competitive Levelized Cost of Electricity (LCOE) benchmarked against prevailing grid tariffs

Suggest operational parameters

- Capacity Utilization Factor
- Availability Factor
- Plant Life
- Auxiliary Power consumption
- Yearly net loss of generation

Model case 2: Green hydrogen (GH) evaluation criteria

GH production facility criteria:

- Round-the-clock eenewable energy (RTC-RE) via the Inter-State Transmission System (ISTS) for electrolytic hydrogen production
- Targeting industrial off-takers in nearby locations.

Local demand and size assessment

Assessment of the plant location

Layout plan development

Technology review

- Proven operational performance and lower levelized costs
- Ease of deployment, operation, and maintenance
- Scalability to meet future hydrogen demand

Economic analysis

Ability to deliver a competitive Levelized Cost of Electricity (LCOE) benchmarked against prevailing grid tariffs

Suggest general plant parameters

- Electrolyser Systm (Alkaline)
- Renewable Energy Supply
- Water Supply and Purification

04 Assessing Impacts

4.1 Environmental and Social Impact Assessment (ESIA)

ESIA enables:

- Project proponents and stakeholders to identify, evaluate, and manage potential risks and opportunities.
- Supports informed decision-making and promotes long-term sustainability.

ESIA process involves:

- A structured evaluation of how the decommissioning of a TPP and its proposed repurposing may affect the surrounding environmental and socio-economic context.

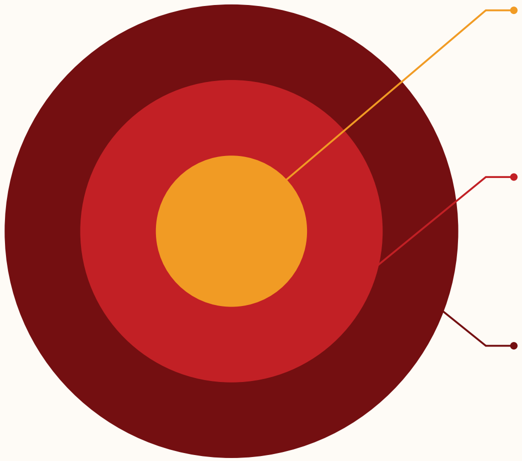
ESIA Steps

1. Preliminary area visit and understanding the scope of study
2. Delineation of the study area
3. Baseline assessment of environmental and socio-economic parameters
4. Development of the impact assessment framework
5. Assessment of prospective environmental and social impacts:
   - Closure & dismantling of the plant
   - Proposed repurposing project(s)
6. Determining overall environmental and social impacts and development of the comprehensive ESIA report

ESIA Step 1: Preliminary area visit

Site Evaluation	Evaluate potential impact areas based on plant location
Environmental Concerns	Identify contamination hotspots, waste stockpiles, and ecologically degraded zones
Social Context Mapping	Assess social features – worker dependence, infrastructure like housing, healthcare, education, etc.
Stakeholder Engagement	Initiate dialogue with plant management and local communities to refine study scope
Checklist Usage	Use a standardized site visit checklist for infrastructure, environmental observations, and stakeholder mapping

ESIA Step 2: Delineation of study area



Immediate Impact Area:
Area directly adjacent to the plant site with direct physical and social impacts (e.g., emissions, noise, employment loss)

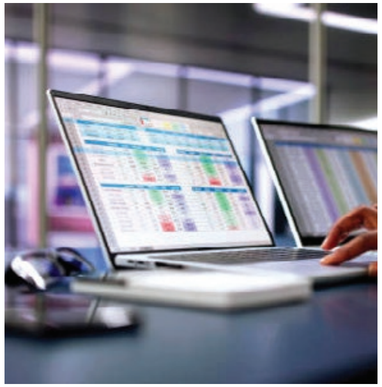
Primary Impact Area:
Area influenced by environmental dispersion (e.g., air/water pollution) and indirect socio-economic impacts

Secondary Impact Area:
Broader area affected by macro-level consequences like regional employment, economic changes, infrastructure dependency or businesses and supply chain

ESIA Step 3: Baseline assessment

Primary Data Assessment

- Household surveys
- Focused group discussions
- Stakeholder interviews



Secondary Data Assessment

- Govt records
- Pollution Control Board data
- Past EIAs/ESIAs

Environmental Parameters

Geographic

- Land use and land cover
- Topography
- Geology

Ecological

- Biodiversity
- Flora
- Fauna
- Endangered species

Pollution parameters

- Ambient air quality
- Water quality for groundwater & surface water
- Water stress
- Soil
- Noise

Climate

- Climatic conditions, including temperature and rainfall
- Wind speed & direction, major components affecting air pollution
- Desertification

ESIA Step 3: Baseline assessment

Social Parameters

Demographic profile

- Population distribution in study area
- Urban and rural
- Gender-wise distribution
- Share of the marginalised

Economic profile

- Key economic sectors
- District GDP and GVA
- Per capita income

Labour market and district workforce

- Distribution of worker and non-worker populations, including gender-wise assessment
- Labour force participation rate
- Unemployment rate

Workforce profile of the study area

- Worker and non-worker distribution
- Sector-wise worker distribution
- Assessment of induced dependence
- Terms of engagement and income levels

Workforce profile of TPP

- No. of workers impacted by the closure of TPP units
- No. of current workers & their distribution (departmental/ permanent, contractual, informal) engaged in operation units
- Education & skill assessment to evaluate ability for engagement in proposed repurposing projects and scope of mobility

Social infrastructure and services

- Health care
- Education

Physical infrastructure

- Road connectivity, including all-weather roads
- Electricity

ESIA Step 4: Development of the impact assessment framework

Environmental Parameters

- **Environment**
  - Air
  - Water
  - Climate
  - Soil
  - Noise
- **Social**
  - Economic
    - Employment and income
    - Changes in social businesses
    - Household spending
  - Social
    - Out migration
    - Access to social infrastructure and basic amenities
    - Social ills
    - Worker health and safety
    - Public Health
    - Roads, growth and value of property

Impact assessment matrix

Dimensions	Range/Extent categories
Nature	Positive
	Negative
	Neutral
Duration	< 2 years (very short)
	2–5 years (short-term)
	5–15 years (medium)
	>15 years (long)
	Permanent
Spatial extent	Limited to IIA
	Limited to PIA
	Spread over SIA
	Spread across neighbouring blocks
	Spread across the district
Magnitude	No impact
	Marginal (< 5%)
	Moderate (5-15%)
	High (15-25%)
	Very high (>25%)

Impact classification

IMPACT LEVEL

No Impact

The activities do not influence the stability of the component in any way and do not have any direct impact on future development decisions.

Minor Impact

The activities influence the stability of the component slightly but do not require major interventions or alterations.

Moderate Impact

The activities have a noticeable impact on the stability of the component and may necessitate minor modifications or adaptations.

Major Impact

The activities significantly affect the stability of the component, requiring substantial changes or careful planning to mitigate.

Critical Impact

The activities severely compromise the stability of the component, making immediate intervention essential to avoid failure or serious consequences.

ESIA Step 5: Assessment of prospective environmental and social impacts

2 Phase Impact Assessment Approach

Phase 1: Closure & Dismantling of TPP

- Short-to-medium-term environmental and social risks

Phase 2: Repurposing Activities

- Long-term impacts, mostly positive with manageable risks

Environmental Impacts of Closure

- Dust and air pollution during demolition
- Noise from heavy machinery
- Hazardous waste (asbestos, oils, chemicals)
- Soil and water contamination risks
- Temporary ecological disruptions

Social Impacts of Closure

- Job losses (contractual/ informal workers most affected)
- Loss of income for vendors, service providers
- Community dependency impacts (e.g., utilities)
- Psychological and social stress
- Risk of out-migration

Methodology for Closure ESIA

- Use of secondary data on site history and ecosystem
- Primary surveys in surrounding communities
- Risk matrix to categorize impacts (minor, moderate, major)

Env. Impacts – Repurposing Phase

- Net GHG emissions reduction
- Lower water usage than coal operations
- Minimal long-term solid waste
- Land use change risks (solar installation)
- Temporary dust and noise from construction

Social Impacts – Repurposing Phase

- Employment during construction & operations
- Skilling & inclusion opportunities (youth, women)
- Local economic revitalisation
- Risks of exclusion (former coal workers, vulnerable groups)
- Enhanced energy access and community resilience

Key Take Aways

- Closure phase has short term risks - must be mitigated
- Repurposing offers long term benefits - must be inclusive
- Just Transition strategies critical for affected communities
- Proactive planning - sustainable and equitable outcomes

ESIA Step 6: Determining overall environmental and social impacts and report preparation

Comprehensive ESIA evaluates both plant decommissioning and repurposing scenarios, and assesses environmental and socio-economic impacts

Compares baseline conditions with

- Projected impacts during closure and dismantling, and
- Impacts under two alternative repurposing options

Each impact is classified by

- Nature (positive/negative)
- Magnitude (minor to major)
- Duration (short-term, long-term)
- Overall significance

Results inform decision-making, mitigation planning, and stakeholder engagement

ESIA report preparation and regulatory submissions

4.2 Environmental and Social Management Plan (ESMP)

ESMP Framework

1. Identification of Environmental and Social Impacts

- **Nature** (positive, negative, or neutral)
- **Duration** (short-term, medium-term, long-term, or permanent)
- **Magnitude** (marginal, moderate, high, or very high)
- **Spatial extent** (of the impact assessment)

2. Regulatory and Standards Review

- National environmental legislation & clearance requirements
- Labour laws, occupational health & safety standards
- Local government rules & permits for demolition, waste handling, and construction
- International good practice guidelines (World Bank's Environmental and Social Framework and sector-specific IFC Performance Standards)

3. Determination of Mitigation Measures Avoid Minimise Mitigate Offset (AMMO) approach

- **Avoidance** Eliminate activities with high or irreversible impacts where alternatives exist
- **Minimisation** Modify project design or timing to reduce scale and intensity of impact
- **Mitigation** Apply technology or operational controls to reduce harm
- **Offset/Compensation** Restore ecosystems, fund community programs, compensate stakeholders

4. Formulation of Mitigation Action Plans

- Specific mitigation activities
- Timeline and phasing (aligned with project stages)
- Designated implementation agencies or contractors
- Resource and budget requirements

5. Monitoring, Evaluation, and Adaptive Management

- Monitoring indicators (e.g., ambient air quality, noise levels, employment statistics)
- Monitoring frequency and methodology
- Roles and responsibilities (e.g., site environmental officer, third-party auditor)
- Corrective actions for non-compliance
- Periodic review and adaptation of the ESMP based on monitoring outcomes

ESMP for Decommissioning and Repurposing Phases

ESMP Structure Across Project Phases

Two major project phases covered:

A. Decommissioning Phase (Closure & Dismantling of TPP)

B. Repurposing Phase (Three scenarios)
- Green Hydrogen Plant
- Solar Photovoltaic (PV) Project
- Battery Energy Storage System (BESS)

Separate Environmental Management Plans (EMP), and Social Management Plans (SMP) defined for each phase

Environmental Mgmt. Plan – Decommissioning Phase

Key Environmental Issues:

Air Quality: Dust & particulate emissions from dismantling

Water Resources: Risks of contamination from oils, chemicals

Soil: Leaching from material stockpiles

Noise: High levels from demolition machinery

Waste Management: Safe handling & disposal of hazardous and C&D waste

Mitigation Measures

Controlled demolition

Wetting of debris to suppress dust

Secure containment & segregation of waste

Continuous monitoring of pollution indicators

Social Mgmt. Plan – Decommissioning Phase

Key Social Risks:

Worker Transition: Job losses, particularly informal/ contractual workers

Local Economy: Disruption to plant-dependent vendors & services

Health & Safety: Occupational and community health risks

Vulnerable Groups: Elevated risk of marginalization

Response Measures:
- Livelihood support & skilling programs
- Economic support for small businesses
- Public health outreach & grievance redress
- Prioritised support for vulnerable groups

Environmental Management Plan (EMP) & Social Management Plan (SMP) for Decommissioning and Repurposing Phases

1 EMP – Repurposing Phase

Short-Term Risks:

- **Construction Phase:** Dust, noise, and site disturbance
- **Land Use:** Alterations, especially for solar installations
- **Operations Phase:** Risk from chemical handling (e.g., hydrogen)

Long-Term Benefits:

- Significantly reduced environmental footprint compared to coal-based operations

Mitigation Actions:

- Phased construction with pollution control
- Land use planning & ecological assessments
- Safety protocols for hydrogen or BESS handling

2 SMP – Repurposing Phase

Social Opportunities:

- **Employment:** Jobs in construction and operations
- **Skill Development:** Training for youth, women, local communities
- **Community Benefits:** Improved infrastructure and services
- **Equity & Access:** Ensure transition is inclusive for former TPP workers and vulnerable groups

Strategic Focus:

- Local hiring and gender inclusion
- Skills aligned with clean energy technologies
- Infrastructure investments to stimulate local economy
- Inclusive access to benefits across all social groups

3 Dynamic ESMP Updates

ESMP revised and detailed during the DPR stage

Updates will align with:

- Final selection of the repurposing option
- Detailed engineering and implementation plans
- Stakeholder inputs and evolving risk assessments

05 Financing Repurposing

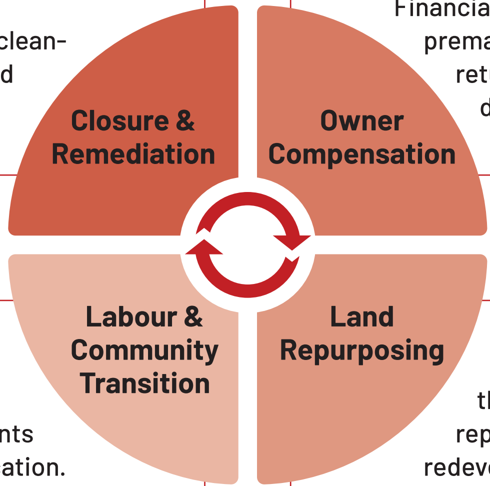
5.1 Understanding decommissioning costs

Decommissioning a coal TPP under a just transition requires addressing technical, environmental, economic, and social challenges to ensure remediation, fair compensation, and livelihood opportunities for affected workers and communities.

Decommissioning cost heads

Demolition of structures, salvage of equipment, and clean-up of contaminated coal and ash handling areas.

Financial payouts for premature closure covering lost returns, loan interest, and depreciation.



Support for displaced workers through compensation, skilling, re-employment, and investments in local economic diversification.

Preparing the site for new economic uses through infrastructure repowering, facility reuse, or redevelopment.

Stage-wise TPP decommissioning costs

Pre demolition phase

- O&M costs (continued employee costs & stations overheads)
- Worker compensation cost
- Cost of closure planning – ESIA & technical evaluations
- Cost of securing statutory clearances and permits
- Cost of tendering

Demolistion phase

- Cost of identification, removal & transport of salvageable material
- Cost of plant demolition works
- Cost of separation, recycling, & disposal of materials
- Cost of site clean up
- Monitoring & management costs

Pre-demolision phase

- Environmental remediation costs (for ground water and soil contamination)
- Contingency costs due to unplanned environmental damages
- Cost of monitoring/ manning the site, till repurposed.

- Decommissioning costs vary widely based on end-use plans—full demolition for redevelopment is more expensive than selective dismantling for repurposing.
- Global estimates for these costs range from $55,000–$170,000 per MW, influenced by plant size, environmental liabilities, and labour transition programs (e.g., in Germany, South Africa, US).
- In India, costs are emerging, with estimates varying between $37,000–$170,000 per MW; key drivers include site-specific factors and undepreciated assets from recent investments.

5.2 Existing provisions for cost recovery

Current tariff regulations lack explicit provisions for decommissioning cost recovery, relying on uncertain salvage value, with limited relief under 'change in law', highlighting the need for stronger legal and financial frameworks.

1. Salvage value of closed plant

CERC Tariff Regulations for TPPs assume a 10% salvage value and allow 90% depreciation, with the expectation that the salvage value will cover decommissioning costs.

Salvage value is uncertain and often insufficient, relying on volatile scrap prices and demand for used equipment, while decommissioning costs vary by site and future land use. Regulatory provisions fall short when closure costs exceed salvage returns due to low scrap value or high expenses.

2. Impairment loss of assets

Decommissioning costs are treated as asset impairments when an asset's book value exceeds its recoverable amount, with the loss recognized in profit and loss, subject to disclosure and possible reversal.

Tariff regulations lack a mechanism for recovering impairment losses. This is especially challenging once a plant ceases generation and the power purchase agreement (PPA) ends, leaving no payment obligation. While state-owned utilities may absorb such losses in their annual revenue requirements, independent power producers often cannot.

3. Change in law provision

Tariff regulations allow recovery of capital costs due to a 'change in law' during an active PPA, covering legal changes, reinterpretations, or global agreements.

The regulations currently limit 'change in law' relief to additional capital expenditures, excluding decommissioning costs or impairment loss recovery.

5.3 Best practices in managing end-of-life costs of energy assets

A range of financing mechanisms—drawing on Indian regulations and global best practices—can support TPP decommissioning through advanced cost planning and accrual. These include escrow or levy-based models (as used for Indian coal and nuclear plants), tariff-based recovery or asset retirement obligations (as in the U.S.), and emerging pooled public-private funds to ease financial burdens.

Funding for coal mine closure in India
Funded via a mandatory escrow account with annual deposits based on fixed per-hectare rates, used for progressive and final closure, though standardized rates may not fully cover site-specific costs.

U.S. decommissioning frameworks
Include trust funds, surety bonds, and corporate guarantees under EPA rules, with some states (Montana, Illinois) using dedicated environmental funds, and others (Virginia, Nevada) allowing cost recovery via tariffs; Washington enables regulatory liability transfers into retirement accounts for decommissioning.

Funding for nuclear power plant closure in India
funded through a 2 paise/unit levy on power consumers, maintained in a dedicated NPCIL-managed fund, though audits have flagged concerns over its adequacy and lack of a clear cost formula.

Funding to support early closures
- Debt management tools being used for coal transition include refinancing, securitisation, blended finance, insurance, and trust banking services.
- Flagship models like ADB's ETM and ACEN's Managed Transition Vehicle use pooled public-private finance to retire coal assets early and fund clean energy.

5.4 Proposed financial mechanisms for decommissioning cost recovery

Financing mechanisms for TPP decommissioning can draw from national and global practices to ensure financial adequacy and avoid fiscal stress or abrupt closures.

- **Regulation-driven financial assurance mechanisms**
- **Market and fiscal instruments**
- **Institutional and multilateral finance-based tools**

1. Regulation-driven financial assurance mechanisms

Tool	Structure	Purpose	Anchor
Decommissioning Surcharge/ Levy in Tariffs	Introduce a fixed surcharge in electricity tariffs to accumulate a decommissioning corpus over time.	Allows cost recovery from consumers in a gradual, predictable manner.	To be mandated by CERC/ SERCs under tariff regulations
Setting up dedicated decommissioning fund as an escrow/trust account	TPP operators to set aside funds annually into a ring-fenced, third-party managed escrow or trust fund during the operational life of the plant.	To cover technical costs - dismantling, site remediation, post-closure monitoring etc.	To be mandated by CERC/ SERCs
Asset Retirement Obligation (ARO) Disclosure	Mandate utilities to estimate and disclose ARO liabilities on their balance sheets.	Improves transparency and prompts pre-emptive financial planning.	To be enforced by SEBI for listed utilities or via the the Companies Act.

For India, a scenario-based mechanism may be appropriate, considering the wide age range of existing plants

Scenario 1: Plants with >5 years of life

Decommissioning tariff component to be introduced as a part of the tariff. The amount to be put in a 'state decommissioning fund' and reimbursed to the plant based on decommissioning progress.

Scenario 2: Plants with <5 years of life

One-time settlement to be introduced between plants and discoms. Money deposited in a 'state decommissioning fund' and reimbursed to plants based on decommissioning progress.

Scenario 3: Plants closing prematurely

1. Private deals by plant owners to recover outstanding liabilities and costs.
2. A corpus fund to be set up to support premature decommissioning.

2. Market and fiscal instruments

Tool	Structure	Purpose	Anchor
Green/Just transition bonds	Issue sovereign, state, or utility-level bonds earmarked for the cost of decommissioning and transition activities.	Front-loads capital needs while spreading costs over time.	Requires strong credit backing and robust use-of-proceeds frameworks.
Carbon market revenues	Allocate a portion of carbon pricing revenues (e.g., through future ETS) for decommissioning and site rehabilitation.	Ensures polluter-pays principle and aligns incentives.	Linked to national carbon market development.

3. Institutional and multilateral financing

Tool	Structure	Purpose	Anchor
Multilateral financing via climate or transition facilities	Use concessional loans, grants, or guarantees from institutions like ADB, World Bank, or bilateral funds for early retirement and decommissioning.	Reduces fiscal burden and accelerates closure of old, inefficient units.	Requires state/central government partnerships, strong MRV, and just transition plans.
Viability gap funding (VGF) for decommissioning-linked repurposing	Central/state VGF schemes that support the repurposing of retired TPP sites (e.g., to solar parks or industrial zones), linked to successful decommissioning.	Creates post-closure economic value and incentivizes compliance.	Ministry of Power/MNRE in partnership with state governments and PSUs.

References

1. Global Energy Monitor, (2025), Global Coal Plant Tracker: Coal plants in India (MW). Energy infrastructure database. https://globalenergymonitor.org/projects/global-coal-plant-tracker/
2. Central Electricity Authority (CEA), (2020), Replacement/Renewal of Old Thermal Units [PDF]. https://cea.nic.in/wp-content/uploads/2020/04/repl_thermal_units.pdf
3. Central Electricity Authority (CEA), (2023), Letter from CEA (RM) to Utilities [PDF]. https://cea.nic.in/wp-content/uploads/tprm/2023/02/RM_CEA_letter_to_utilities_.pdf
4. Central Electricity Authority (CEA), (n.d.), Power Survey & Load Forecasting Division. https://cea.nic.in/power-survey-load-forecasting-division/?lang=en
5. Central Electricity Authority (CEA), (2023), National Electricity Policy 2022 [PDF]. https://cea.nic.in/wp-content/uploads/irp/2023/05/NEP_2022_32_FINAL_GAZETTE-1.pdf
6. Bhushan, C., Singh, M., and Khanna Utreja, S. (2023). Financing the Decommissioning of Thermal Power Plants in India. Pg 7. International Forum for Environment, Sustainability and Technology. https://iforest.global/research/financing-the-decommissioning-of-thermal-power-plants-in-india/
7. Bhushan, C., Singh, M., and Khanna Utreja, S. (2023). Financing the Decommissioning of Thermal Power Plants in India. Pg 23. International Forum for Environment, Sustainability and Technology. https://iforest.global/research/financing-the-decommissioning-of-thermal-power-plants-in-india/
8. Central Electricity Regulatory Commission. (2020). Petition under Section 79(1)(a) and Section 79(1)(f) of the Electricity Act, 2003 read with the Central Electricity Regulatory Commission (Terms and Conditions of Tariff) Regulations, 2014 for relief on account of a Change in law affecting Stage-II of Badarpur Thermal Power Station. Pg 6. New Delhi. https://cercind.gov. in/2020/orders/119-MP-2019.pdf
9. Bhushan, C., Singh, M., and Khanna Utreja, S. (2023). Financing the Decommissioning of Thermal Power Plants in India. Pg 10. International Forum for Environment, Sustainability and Technology. https://iforest.global/research/financing-the-decommissioning-of-thermal-power-plants-in-india/
10. Central Pollution Control Board. (2016). Final Document on Revised Classification of Industrial Sectors Under Red, Orange, Green and White Categories. Pg. 5, 12, 18
11. Ministry of Environment, Forest and Climate Change. (2025, February 7). Environment Ministry issues Guidelines for obtaining consent to establish and operate to control environmental pollution; introduction of common consent under Air and Water Act. Retrieved from https://lexplosion.in/environment-ministry-issues-guidelines-for-obtaining-consent-to-establish-and-operate-to-control-environmental-pollution-introduction-of-common-consent-under-air-and-water-act/
12. Central Pollution Control Board. (2016, March 7). Modified directions to SPCBS/PCCs on Revised Classification of Industrial Sectors Under Red, Orange, Green and White Categories. Retrieved from https://cpcb.nic.in/categorization-of-industrial-sectors-2016/
13. Ministry of Labour and Employment. (1946). The Industrial Employment (Standing Orders) Central Rules, 1946. Schedule I: Model Standing Orders for Industrial Establishments Not Being Industrial Establishments in Coal Mines. Rule 2, Clauses (a) & (b).
14. Ministry of Labour and Employment. (1970). The Contract Labour (Regulation and Abolition) Act, 1970. Section 2(1)(b) & 2(1)(c)
15. National Commission for Enterprises in the Unorganised Sector (NCEUS). (2007). Condition of Workers in the Unorganised Sector. Pg 3, Section 1.14. Ministry of Micro, Small and Medium Enterprises, Government of India. https://dcmsme.gov.in/Condition_of_workers_sep_2007.pdf
16. Government of India. (1947). The Industrial Disputes Act, 1947. Sections 25-F, 25-FFA, 25-FFF, and 25-O. Ministry of Law and Justice. https://www.indiacode.nic.in/bitstream/123456789/11102/1/industrial-disputes-act-1947.pdf
17. Government of India. (1970). The Contract Labour (Regulation and Abolition) Act, 1970. Sections 1(4)(a–b), 16–21. Ministry of Labour and Employment. https://www.indiacode.nic.in/handle/123456789/1467?view_type=search
18. Government of India. (2020). Occupational Safety, Health and Working Conditions Code, 2020. Sections 45(1)(i–ii) (p. 40) and Sections 59–61 (pp. 43–44). Ministry of Labour & Employment. https://labour.gov.in/sites/default/files/osh_gazette.pdf
19. Ministry of Labour and Employment. (1996). The Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996. Sections 1, 37, and 40. Government of India. https://www.indiacode.nic.in/bitstream/123456789/7682/1/building-and-other-construction-workers-act-1996.pdf
20. Ministry of Labour and Employment. (1948). The Factories Act, 1948. Sections 2(m), 7(a), 11–12, 21, and 45. Government of India. https://labour.gov.in/sites/default/files/factories_act_1948.pdf

iFOREST

INTERNATIONAL FORUM FOR ENVIRONMENT, SUSTAINABILITY & TECHNOLOGY

http://iforest.global/