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PLAYBOOK FOR DEVELOPING PRE-FEASIBILITY STUDIES FOR GRID-CONNECTED COAL-FIRED POWER PLANT (CFPP) REPURPOSING

Green Grids Rising
ASEAN-UK Green Transition Fund

ECA Economic Consulting Associates

castlerock consulting

KPMG

Forewords

On behalf of the UK, I am pleased to welcome the publication of the *Coal-Fired Power Plant (CFPP) Repurposing Playbook*. We are proud to partner with ASEAN in advancing practical solutions that support emissions reductions, and this Playbook provides practical guidance for repurposing coal-fired power plants as part of a secure, just, and sustainable energy transition.

As ASEAN works towards its energy transition ambitions, repurposing existing coal assets is a practical way forward to reduce emissions urgently while maintaining power system reliability and energy security. The UK's own transition offers a useful example: in September 2024, we became the first G7 country to phase out coal-fired electricity generation, demonstrating that ambitious decarbonisation can be achieved while maintaining a secure and reliable power system. Drawing on international experience, regional perspectives, and robust assessment frameworks, this Playbook helps energy sector stakeholders to make informed decisions on repurposing.

The UK recognises the leadership of the ASEAN Secretariat, the ASEAN Centre for Energy, and the Heads of ASEAN Power Utilities/Authorities, whose collective efforts have been instrumental in bringing this important work to fruition. I would also like to thank Economic Consulting Associates, KPMG Malaysia, Castlerock Consulting, and Palladium for their expertise and contributions to the development of this Playbook. Their commitment underscores the value of regional cooperation in addressing shared energy and climate challenges.

The UK is proud to have supported this initiative and looks forward to continuing our partnership with ASEAN to accelerate clean energy transitions and achieve climate objectives through practical, evidence-based approaches.

Helen Fazey
UK Ambassador to the Association of Southeast Asian Nations (ASEAN)

Acknowledgements

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The programme forms part of approved ASEAN-UK Cooperation, The support of the ASEAN Secretariat to the programme and the wider GTF Clean and Just Energy Transition Pillar is gratefully acknowledged.

The Green Grids Rising team express their sincere appreciation to the ASEAN Centre for Energy (ACE) for its close collaboration, technical guidance and coordination throughout the development of this playbook, helping to ensure that the work reflects ASEAN's regional energy priorities and context.

The Playbook has benefited immensely from the contributions of representatives of the Heads of ASEAN Power Utilities/Authorities (HAPUA) who provided technical insights through workshops and consultations undertaken as part of the Green Grids Rising programme. These contributions have been invaluable in grounding the playbook in the diverse circumstances, opportunities and challenges faced by power systems across the region.

The contributions of technical experts, regional and international partners, and other stakeholders who shared their knowledge and perspectives throughout the development of the playbook are also gratefully acknowledged.

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Abbreviations and acronyms

AGC	Association of Power Generators (Chile)
ALMP	Active labour market programmes
AMS	ASEAN Member State(s)
APAEC	ASEAN Plan of Action for Energy Cooperation
APG	ASEAN Power Grid
BESS	Battery energy storage system
CCGT	Combined cycle gas turbine
CCS	Carbon capture and storage
CCTR	Clean Coal Transformation (APAEC programme area)
CFPP	Coal-fired power plant(s)
CTC	Coal Transition Commission
ECA	Economic Consulting Associates
EGAT	Electricity Generating Authority of Thailand
ESIA	Environmental and Social Impact Assessment
ESMAP	Energy Sector Management Assistance Program
ETM	Energy Transition Mechanism
GEDSI	Gender Equality, Disability and Social Inclusion
GEM	Global Energy Monitor
GTF	Green Transition Fund
IAEA	International Atomic Energy Agency
IPP	Independent Power Producer(s)
JETP	Just Energy Transition Partnership
NDC	Nationally Determined Contributions
NEVA	National Employment Vulnerability Assessment
O&M	Operation and Maintenance
PDP	Power development plan
PLN	Perusahaan Listrik Negara
PPA	Power purchase agreement
PPP	Public-private partnership
RE	Renewable energy

SJRP	Sector job resilience plans
SMEC	San Miguel Electric Cooperative
SMR	Small Modular Reactors
SVC	Static var compensator
TOR	Terms of reference
TRL	Technology Readiness Level
VRE	Variable renewable energy
WtE	Waste-to-energy



Executive summary

Purpose of the playbook

This playbook supports ASEAN policymakers and utilities in assessing options for repurposing grid-connected coal-fired power plants (CFPPs). Coal repurposing can help balance decarbonisation with system reliability, regulatory requirements, and social and environmental impacts.

For the purpose of this playbook, coal repurposing is defined broadly, though with a primary focus on the reuse of the site for alternative roles in the power system. It is not a single solution, but a set of transition options that can support either continued operation until planned retirement or earlier retirement and replacement.

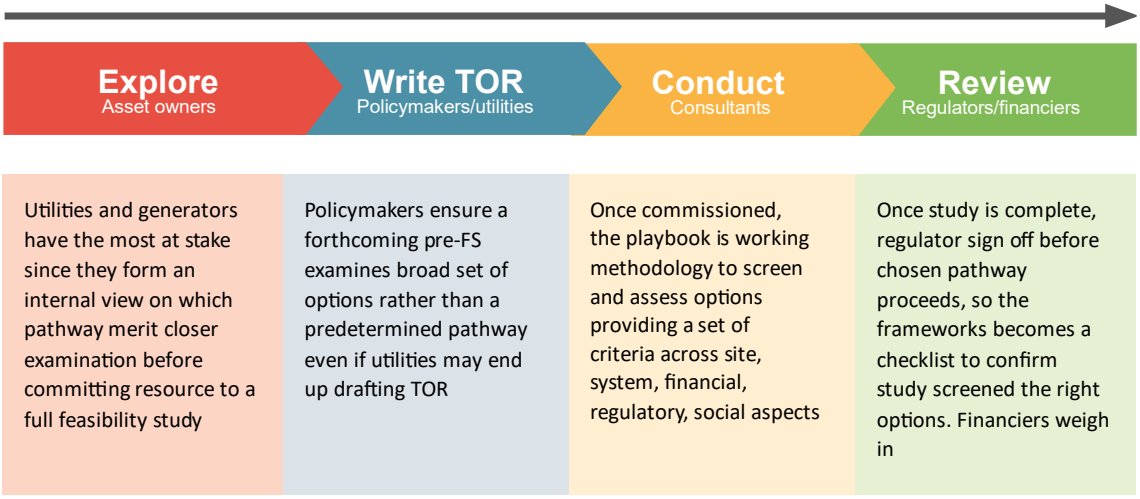
The playbook provides a structured framework for a rapid pre-feasibility study to screen and assess options before full feasibility studies and investment decisions. It does not rank options because suitability depends on national, local, site and plant-specific conditions. Instead, it helps stakeholders identify objectives, screen a broad range of options, and determine which are most appropriate for a specific CFPP.

How to use this playbook

This playbook is intended to support a broad range of stakeholders including asset owners, policymakers, utilities, regulators, financiers and consultants across the full spectrum of pre-feasibility planning for coal repurposing. It is best understood as a flexible decision-support tool that can be used throughout pre-feasibility planning. It can help stakeholders:

- Explore potential repurposing pathways and define the key questions for further study.
- Shape the terms of reference (TOR) for a pre-feasibility study.
- Provide a consistent methodology for technical teams or consultants assessing options.
- Review whether a completed pre-feasibility study is sufficiently comprehensive and site-specific.

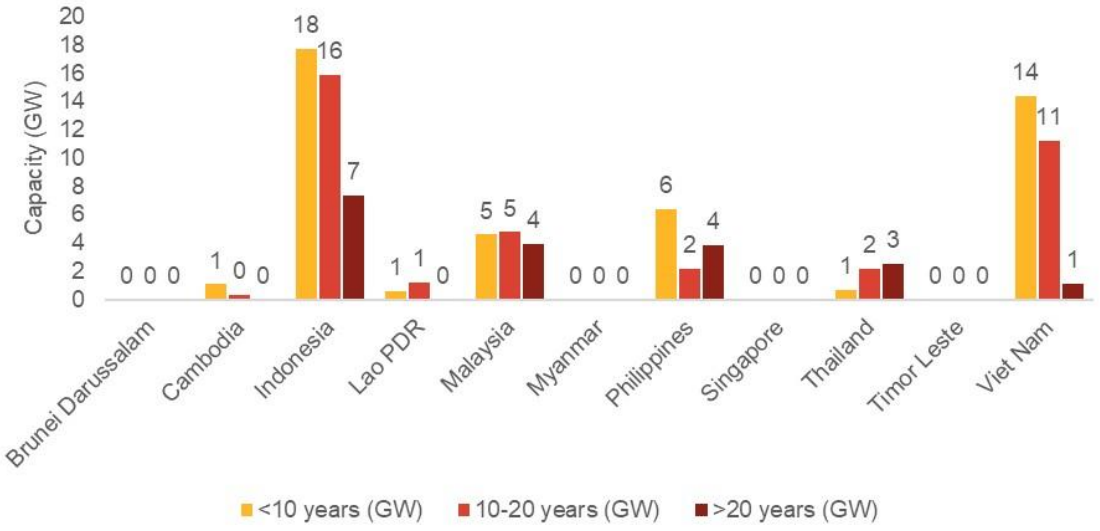
Overview of playbook use cases



Why this matters for ASEAN

ASEAN has more than 102 GW of installed grid-connected CFPP capacity, around one-third of total regional power capacity, and 45% of this capacity is less than 10 years old [1], with several ASEAN Member States (AMS) also retaining pipelines of new CFPPs.

Overview of playbook use cases



Note: All figures are based on generating units as reported by the GEM Global Coal Plant Tracker. A single power plant may contain multiple units. Excludes units marked as being primarily captive. Source: GEM January 2026, accessed May 2026.

[1] Based on data from the GEM Global Coal Plant Tracker, January 2026. Excludes capacity which is marked as being primarily captive. Across ASEAN, captive capacity is even younger than grid-connected capacity.

At the same time, power systems are changing rapidly due to rising demand, increasing renewable energy penetration and system modernisation, alongside commitments to transition away from coal. This creates a need to consider both transitional options that reduce emissions while plants remain operational and full phase-out options that replace coal generation and reuse sites or grid connections for clean energy, storage or other uses.

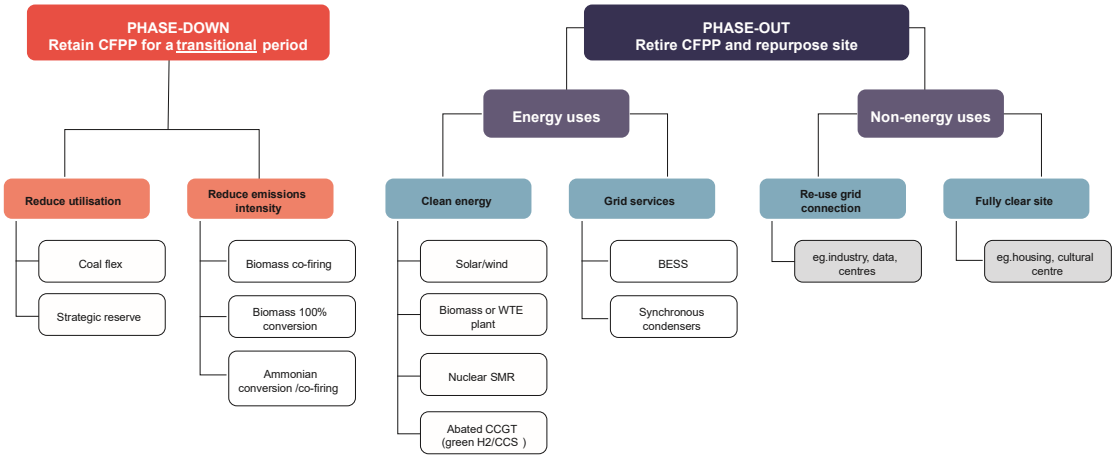
Options for coal repurposing

There is a wide range of CFPP repurposing options, depending on the extent of the transition away from coal and what role it continues to play in the power system or local economy:

- **Coal phase-DOWN:** Retain CFPPs temporarily to support system reliability or reduce emissions through measures such as flexibility retrofits or fuel substitution. These should be strictly transitional, time-bound, and linked to a funded decommissioning pathway without extending the plant's technical, operational or commercial life.[2]
- **Coal phase-OUT:** Retire CFPPs and repurpose sites for clean energy, storage, grid services, or non-energy uses, potentially retaining the grid connection.

The options need not be mutually exclusive. Indeed, there is value in considering phase approaches to CFPP repurposing, with an initial focus on phase-down before transitioning to a full phase-out.

Typology of repurposing options



BESS = Battery Energy Storage System | CCGT = Combined Cycle Gas Turbine | SMR = Small Modular Reactor | CCS = Carbon Capture and Storage | H2 = Hydrogen | Only CCGT abatement with 100% green hydrogen is supported under the UK Government's International Fossil Fuel Policy. Abated CCGT should be treated as an option of last resort, considered only in exceptional circumstances where a demonstrable system need exists, no viable renewable alternative is available, and the investment does not delay or undermine the transition to clean energy. Ammonia and biomass co-firing are not supported under the scope of the UK-funded programme. References to these options are included solely for analytical completeness and comparative assessment and do not constitute a recommendation for adoption or implementation.

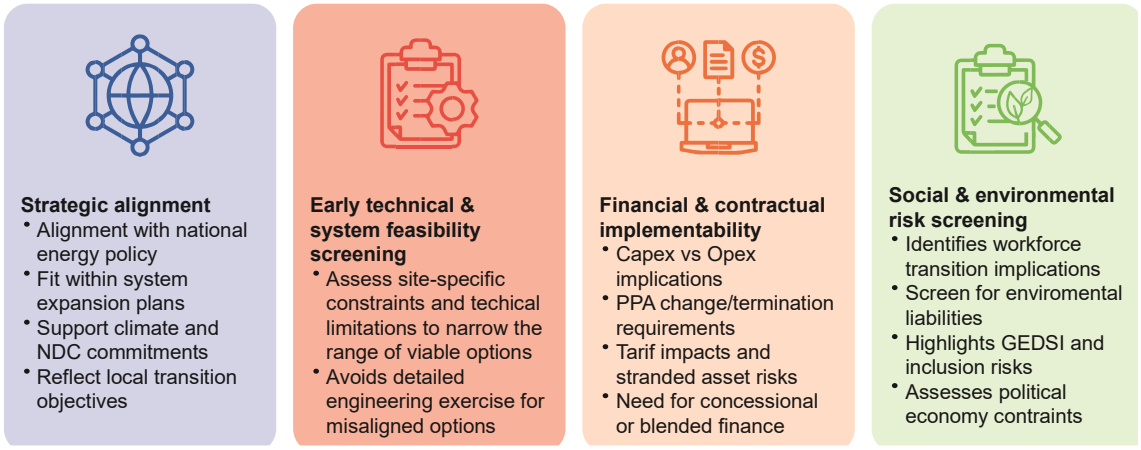
[2] Note that carbon capture and storage for CFPPs is not considered a repurposing option in this playbook, as it does not reduce coal consumption and risks locking in a country's dependency on coal.

Framework for repurposing

No repurposing pathway is universally suitable. Feasibility depends on national and local conditions, including grid needs, financing, policy and regulation, technology readiness, and site characteristics. A pre-feasibility study is therefore essential to identify the most appropriate options.

The figure below provides an overview of the potential objectives of a pre-feasibility study:

Purposes of a pre-feasibility study



The framework presented below, and elaborated on throughout the remainder of this playbook, provides a tiered, multi-step process to assessing the most suitable repurposing options for a specific CFPP. It is structured around five sequential steps:

- **Framing:** Define objectives, constraints and policy alignment.
- **Options:** Identify the full range of potentially relevant pathways.
- **Screening:** Narrow options based on technical feasibility, maturity and cost.
- **Assessment:** Conduct detailed analysis of site, system, financial, regulatory, environmental and social factors.
- **Implementation:** Identify risks, engage stakeholders and develop an initial implementation roadmap.

Key considerations – screening and assessment

Screening is critical for quickly eliminating options that are not commercially or technically mature, suitable for the timeframe, or affordable. It should also consider capex-opex trade-offs and potential financing sources.

Shortlisted options should then undergo a site-specific pre-feasibility assessment covering:

- **Site characteristics**: Location, layout and readiness.
- **System impacts**: Energy, capacity, flexibility and grid stability.

- **Costs and financing**: Capital and operating costs, financing structures, tariffs and access to climate or concessional finance.
- **Legal and regulatory frameworks**: Contracts, licences and institutional arrangements that may constrain repurposing.
- **Environmental impacts**: Greenhouse gas emissions, local pollution, health impacts and fuel supply chains.
- **Social impacts**: Effects on workers, communities and local supply chains.

A pre-feasibility study delivers a structured decision framework to enable policymakers and asset owners to decide whether and how to proceed with coal repurposing. It should also provide estimates of indicative costs and timelines to help identify financial risks and guide implementation, as well as help policymakers anticipate any sequencing challenges.

1. Introduction

1.1. About the ASEAN-UK Green Transition Fund

The ASEAN-UK Green Transition Fund (GTF) is the UK's flagship programme to accelerate ASEAN's transition to a clean and climate-resilient economy by reducing emissions in key sectors, supporting green economic growth, and improving the livelihoods of vulnerable people. The GTF is structured around five pillars, spanning climate policy, green finance, energy, sustainable cities and transportation, and nature-based solutions, with the objective of delivering technical assistance through capacity-building, knowledge-sharing and peer-to-peer learning. It also pilots transformational technologies and facilitates evidence-based climate mitigation actions and policies, with climate adaptation as a co-benefit.

As part of the GTF clean and just energy transition pillar, the Green Grids Rising initiative aims to strengthen the flexibility and resilience of ASEAN's energy infrastructure and regulatory frameworks. It aims to facilitate a transition away from coal dominated grids and support the integration of variable renewable energy (VRE). The initiative aims to achieve this by enhancing the capacity of regional and national stakeholders to implement policies and market mechanisms which will address current barriers to the energy transition. It is closely aligned with the ASEAN Plan of Action for Energy Cooperation (APAEC) 2026-2030.

1.2. Introduction to this playbook

The repurposing of CFPPs is a useful tool to help countries strike a balance between decarbonisation and other considerations, including system reliability, social and environmental impacts, regulatory frameworks, the affordability of electricity. It is particularly relevant to ASEAN as countries strive to decarbonise their energy systems – supporting national and regional climate ambitions – while aiming to increase system resilience and energy security.

For the purpose of this playbook, coal repurposing is defined broadly, though with a primary focus on the reuse of the site for alternative roles in the power system. Critically, coal repurposing is not intended as a single solution but as a set of potential transition options that can help countries manage the evolution of CFPPs within evolving power systems.

This playbook is intended to act as a practical guide to support policymakers and utilities across the ASEAN Member States (AMS) to assess potential options and pathways for repurposing CFPPs. It provides a structured framework in which different options can be screened and assessed as part of a pre-feasibility study. The framework does not pre-empt a specific repurposing option and recognises the heterogeneity between countries and across different CFPPs . Instead, it encourages policymakers, utilities, generators, and regulators to consider the key objectives for the specific CFPP being examined and screen and assess a broad range of repurposing options to identify the most appropriate and promising options for the site in question.

The pre-feasibility framework considers aspects including the technical feasibility of different repurposing options, costs and financing considerations, broader impacts on the power system, regulatory and commercial considerations, and environmental and social impacts, including GEDSI (Gender Equality, Disability and Social Inclusion) considerations. It does not replace detailed engineering or grid modelling studies, which would need to be completed as part of a full feasibility study.

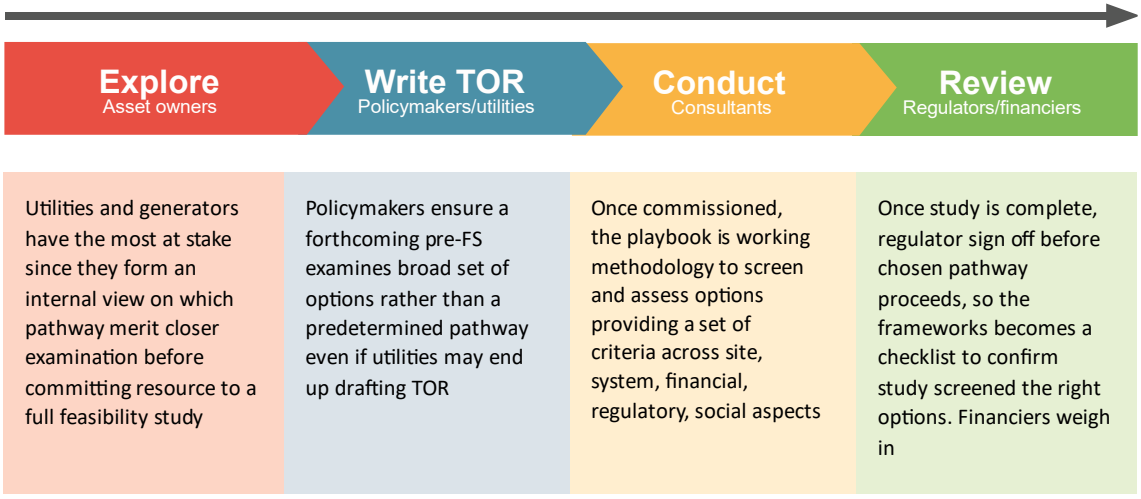
It is important to stress that CFPP repurposing should not be seen as a measure to extend the technical or commercial lifetime of a plant. Where phase-down measures are considered, they should be explicitly time-bound, linked to a defined retirement schedule, and assessed against a credible plan for replacement capacity and grid reinforcement.

Note that this playbook focuses on grid-connected CFPPs. Captive CFPPs, which are not connected to the grid and serve to power industrial plants and sites, make up a material share of CFPP capacity in several AMS, and repurposing options should be considered as part of green industrialisation efforts. Although the overall approach for developing a pre-feasibility study, and the principles presented in this playbook also apply to captive CFPPs, there are some differences in the relevant considerations, reflecting captive CFPPs not being grid-connected and having a different commercial structure.

1.3. How to use this playbook

This playbook is intended to support a broad range of stakeholders including asset owners, policymakers, utilities, regulators, financiers and consultants across the full spectrum of pre-feasibility planning for coal repurposing. **It is best understood as a flexible decision-support tool rather than a single-use document**: useful for early-stage exploration, for shaping the scope of a pre-feasibility study commissioning process, for conducting the pre-feasibility study analysis itself, and for reviewing its outputs. The core function of the playbook is methodological as it provides an analytical framework for the actual screening and assessment of CFPP repurposing options. Nevertheless, it is also designed to support several other uses by specifying what questions need answering as described in Figure 1.

Figure 1 Overview of playbook use cases



2. The need for CFPP repurposing framework in ASEAN

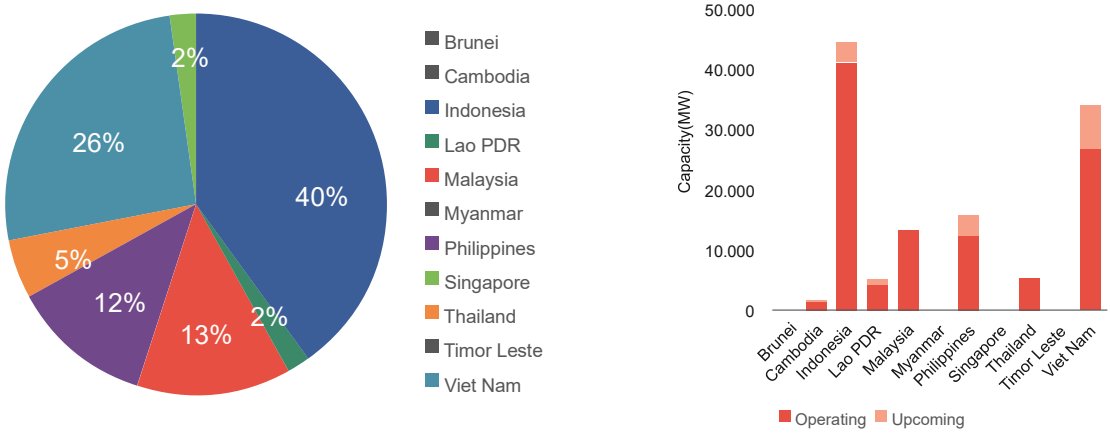
2.1. Coal-fired power generation in ASEAN

ASEAN's power generation landscape is marked by diversity in both fuel sources and system configurations. As of 2024, however, coal remains the largest contributor to installed capacity across the region, accounting for 38.9% of ASEAN's total installed power-generation capacity[3].

Installed and planned coal capacity

The installed grid-connected coal power fleet across ASEAN exceeds 102 GW[4]. Indonesia dominates with 40% of the region's total capacity (40.9 GW across 145 units). Viet Nam follows with 26% (26.7 GW, 66 units), while Malaysia (13%, 13.3 GW, 25 units) and the Philippines (12%, 12.4 GW, 59 units) also maintain sizeable CFPP fleets. Together, these four countries account for over 90% of the installed coal capacity.

Figure 2 Share of grid-connected coal power capacity in ASEAN by 2025 (left), Installed grid-connected capacity, MW (right)



Note: All figures are based on generating units as reported by the Global Energy Monitor (GEM) Global Coal Plant Tracker. A single power plant may contain multiple units. Excludes units marked as being primarily captive.
Source: GEM January 2026, accessed May 2026.

[3] ASEAN Centre for Energy (ACE). August 2026. ASEAN Energy Statistica Yearbook (AESY).

[4] All data provided in this section is based on the Global Energy Monitor (GEM) Global Coal Plant Tracker, accessed May 2026.

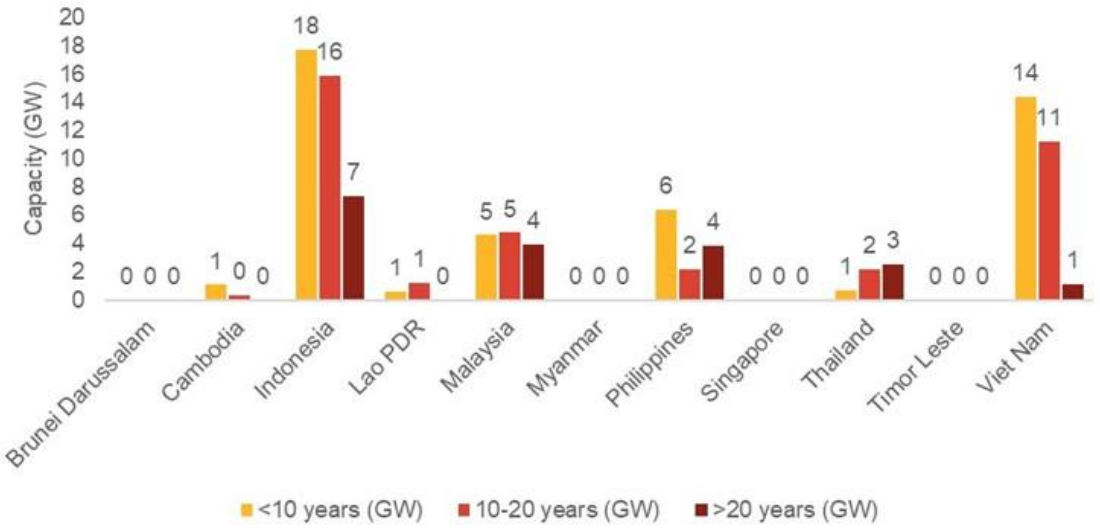
Despite international momentum for decarbonisation, several AMS continue to maintain substantial coal pipelines. Viet Nam leads with 7.2 GW of planned capacity, while Indonesia, Lao PDR, and Philippines all have over 3 GW of planned new capacity.

Note that these figures exclude captive CFPP capacity. Across ASEAN a further 21.9 GW of coal capacity is recorded as being operational as captive plants, with 19.9 GW of this being in Indonesia. A further 10.7 GW of captive coal CFPP capacity is in the pipeline in Indonesia.

Age profile of capacity

The concentration of young units suggests that more than half of ASEAN's coal capacity has long remaining technical lifetimes, strengthening the case for considering repurposing pathways. Indonesia and Viet Nam hold the largest share of younger facilities, pointing to opportunities for blended repurposing pathways that can support a phased transition away from coal. In Malaysia and the Philippines, a higher proportion of older units opens space for early phase-out and conversion projects. These variations underline that each country brings a different starting point, and this diversity can support a range of repurposing pathways tailored to national circumstances.

Figure 2 Grid-connected CFPP age profile by capacity in GW



Note: All figures are based on generating units reported by the GEM Global Coal Plant Tracker. A single power plant may contain multiple units. Excludes units marked as being primarily captive. Source: GEM January 2026, accessed May 2026.

The relatively young age profile of coal plants in Southeast Asia – particularly in Indonesia, Viet Nam and the Philippines – creates a set of interrelated challenges for repurposing:

- **Stranded asset risk and outstanding debt** – Younger CFPPs typically have significant unrecovered capital costs, often financed through long-term debt structures. Early retirement can create stranded asset risks, where plant owners are unable to recover their investments, and may require compensation mechanisms, debt restructuring or alternative revenue streams to recover these costs.

- **Long-term contractual commitments** – Many CFPPs in the region operate under long-term PPAs often spanning 20-30 years. These contracts typically guarantee capacity payments and cost-recovery, regardless of plant utilisation. As a result, early retirement or significant changes in plant operation may require complex renegotiation of contractual terms, which can be legally and politically challenging, as discussed later in the playbook.

- **Residual life and asset value** – From a technical perspective, young CFPPs have decades of remaining operational life. Early retirement may be inefficient if the plant remains functional, creating tensions between asset utilisation and transition objectives. At the same time, young CFPPs often occupy strategically valuable locations (grid connections, proximity to demand centres), making the underlying assets highly valuable. Here the challenge is not only how to phase-out coal but also how to maximise the value of existing assets.

Emissions from coal power

Across ASEAN, grid-connected coal plants emit an estimated 561 million tonnes of CO_2 ($MtCO_2$) each year and carry a lifetime emissions potential of 17.5 billion tonnes of CO_2 ($GtCO_2$). Indonesia is the most significant contributor, with approximately 50% of annual emissions (228 $MtCO_2$) and over 50% of lifetime emissions (9.35 $GtCO_2$) of ASEAN CFPPs. This is followed by Viet Nam with 140 Mt CO_2 of annual emissions, the Philippines with 81 Mt CO_2 of annual emissions, and Malaysia with 61 Mt CO_2 .

2.2. ASEAN climate commitments

Many ASEAN countries have committed to a transition away from coal dominated power systems, either directly or indirectly through broader national climate commitments. The table below provides an overview of key initiatives and commitments by AMS to support the transition away from coal. While some countries explicitly reference coal in their Nationally Determined Contributions (NDCs), others address it through specific policies such as moratoriums on the development of new coal. Others only address the transition indirectly through renewable energy targets or broader sectoral policies. No NDCs explicitly refer to coal plant conversion or repurposing, indicating that key elements of coal transition planning are not yet systematically integrated into climate pledges. However, several AMS have begun to move from pledges to concrete initiatives.

Table 1 Current initiatives and measures to support CFPP retirement/conversion across AMS

Country	Current initiatives	Indirect measures
Brunei	*No domestic grid-connected coal capacity (captive only)*	NDC target to increase the renewable energy share in the electricity mix
Cambodia	Coal moratorium on new plants issued in 2021	Target to achieve 70% renewables by 2030

Country	Current initiatives	Indirect measures
Indonesia	Presidential regulation No. 11 of 2022 sets out objective for coal phase-out Ministry regulation No. 10/2025 establishes a framework for the early retirement of CFPPs	18.6 GW of RE capacity by 2030 under 2025-2034 power development plan (RUPTL)
Lao PDR	No coal retirement initiatives identified	Plans to increase hydropower and renewable generation share and expand exports to neighbouring countries
Malaysia	National Energy Transition Roadmap (2023) targets full coal phase-out by 2044 No new coal capacity to be approved, and half of the existing coal capacity to be retired by 2035	Renewable share target 40% by 2040 and 70% by 2050
Myanmar	*No domestic grid-connected coal capacity (captive only)*	NDC targets RE expansion
Philippines	Government introduced a moratorium on the approval of new greenfield CFPPs in 2020. Pilot projects for the early retirement of two CFPPs under Energy Transition Mechanism (ETM) programmes	35% RE target in power mix by 2030 and 50% by 2040
Singapore	*No domestic coal capacity* Transition Credits Coalition (2023) for regional coal retirement finance	NDC target to increase solar deployment; regional VRE support; carbon tax on power generation in place
Thailand	2024 PDP envisages no new coal capacity, with gradual phase-out of existing CFPP capacity	National RE target 51% by 2037
Viet Nam	Revised PDP8 limits new coal which is not yet under construction and mandates that no new coal-fired power plants will be built after 2030. Older plants must explore conversion to clean fuels or retirement by 2050.	Target RE share 40-47% by 2030; significant wind/solar rollout
Timor-Leste	*No domestic coal capacity*	National RE target of 50% by 2030

Source: Review of national NDCs, power development plans (or equivalents), and policy documents or statements.

3. Overview of CFPP repurposing options

It is important to stress that CFPP repurposing should not be seen as a measure to extend the technical or commercial lifetime of a plant. Where phase-down measures are considered, they should be explicitly time-bound, linked to a defined retirement schedule, and assessed against a credible plan for replacement capacity and grid reinforcement.

CFPP repurposing options can be broadly grouped into the following categories, depending on the extent of the transition away from coal and what role it continues to play in the power system or local economy.

- **Coal phase-DOWN** is used to refer to options that retain CFPPs for a transitional period to support system reliability under higher VRE penetration. These can be split into options that aim at:
    - Reducing **coal utilisation,** such as coal flexibility retrofits and strategic contingency.
    - **Reducing emissions intensity** through partial fuel substitutions, as in the case of introducing co-firing of biomass – subject to it being sustainably sourced – or ammonia.

  Coal phase-down measures should be treated solely as low-carbon transition management tool and implemented only within a framework of clear safeguards designed to prevent the extension of a CFPP's technical, operational, or commercial lifespan. These measures must be time-bound, must not entail capital investments that prolong asset life, and must be directly linked to a defined and adequately funded decommissioning pathway

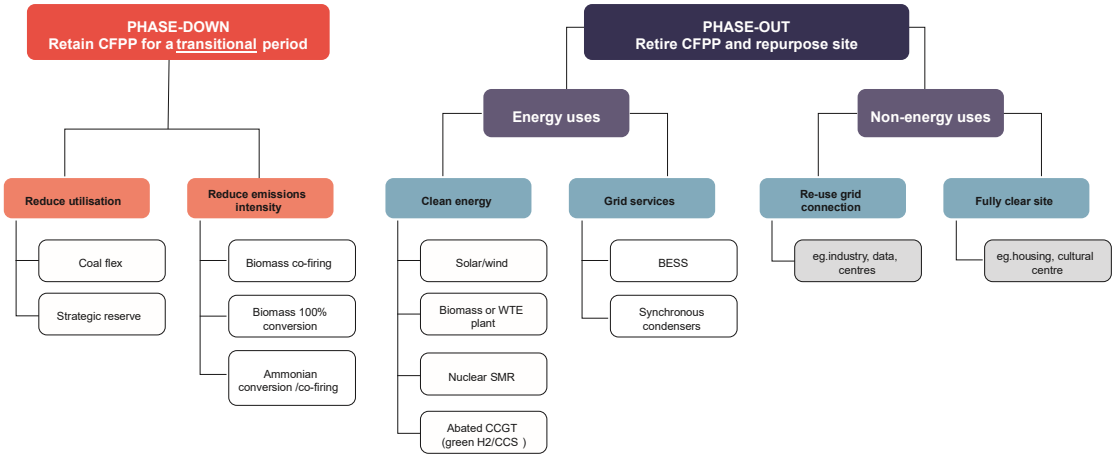
- **Coal phase-OUT** which refers to retiring the CFPP and repurposing the site for energy or non-energy uses:
    - **Energy uses** include clean energy alternatives replacing coal generation with low- or zero-emissions power generation (such as solar, wind or waste-to-energy) and grid service options using the grid connection for battery energy storage system (BESS) or synchronous condensers (SynCon) to achieve enhanced reliability. These options have the advantages of reusing valuable infrastructure, reducing clean-up costs, and supporting local economic recovery.
    - **Non-energy** uses include fully clearing the site or reusing the grid connection and repurposing the infrastructure for economic uses beyond electricity generation, such as industrial or commercial purposes like data centres.

A graphical representation of the typology of options is shown in Figure 5 below. The typology of options is not necessarily mutually exclusive. In fact, multiple options may often be

combined to complement one another, maximising benefits while minimising costs and socio-economic impacts.

Note that carbon capture for CFPPs is not considered a repurposing option. This approach does not reduce coal consumption and instead risks locking in a country's dependency on coal. It is also not a proven technology for CFPPs and is highly unlikely to be cost-effective at scale.

Figure 4 Typology of options



BESS = Battery Energy Storage System | CCGT = Combined Cycle Gas Turbine | SMR = Small Modular Reactor | CCS = Carbon Capture and Storage | H2 = Hydrogen

Only CCGT abatement with 100% green hydrogen is supported under the UK Government's International Fossil Fuel Policy. Abated CCGT should be treated as an option of last resort, considered only in exceptional circumstances where a demonstrable system need exists, no viable renewable alternative is available, and the investment does not delay or undermine the transition to clean energy. Ammonia and biomass co-firing are not supported under the scope of the UK-funded programme. References to these options are included solely for analytical completeness and comparative assessment and do not constitute a recommendation for adoption or implementation.

The following table provides an overview of the different reprising options within each of the typology options. A detailed overview of each of the options is provided in Annex A.

Typology option		Definition	Benefits	Challenges
Coal phase-down (as low carbon transition management tool)				
Reducing utilisation				
1	**Flexible coal refit**	Technical upgrades to maintain system security under higher VRE penetration, with CFPPs operating fewer hours when VRE output is low	• Enable more rapid VRE expansion by reducing coal power operating constraints • Reduces coal run-hours and emissions compared to baseload operation • Uses existing infrastructure	• Risk of locking in coal plants longer if guardrails are weak (ie, long PPAs, retirement signals) • Incremental emission reduction • Retrofit costs if retirement follows soon after

	Typology option	Definition	Benefits	Challenges
2	**Strategic contingency**	Hold coal generation capacity out of regular market dispatch and only make it available in extraordinary circumstances for system security	• Improves energy security during transition • Easier than immediate closure of CFPP and buys more time for renewables/storage • Limits operating hours compared to baseload coal	• Risk of coal lock-in if exit timelines are unclear • Ongoing fixed costs and emissions • Requires strong governance and transparent dispatch rules • Can undermine investment signals for clean capacity
Reducing emissions intensity[5]				
3	**Biomass co-firing** *Note that biomass co-firing is not supported under the scope of the UK-funded programme and would require separate assessment against sustainability criteria*	Partially replace coal with sustainably sourced biomass fuels. Internationally the co-firing share is typically in the range of 10 to 20%, within an existing coal-fired boiler, although this is also contingent on sufficient, sustainable biomass supplies.[6]	• Gradual emission reductions • Lower upfront capital costs compared to full conversion • Faster implementation timeline • Operational flexibility if biomass supply is disrupted	• Decarbonisation impact likely to be limited at 10-20% blending, though may even be lower, especially if biomass supply chains are limited • Fuel supply and sustainability risks given requirements for a reliable feedstock supply • Risk of coal lock-in without clear phase-out timelines
4	**Biomass conversion (50-100%)** *Note that biomass conversion is not supported under the scope of the UK-funded programme and would require separate assessment against sustainability criteria*	Retrofit a CFPP so that sustainably sourced biomass becomes the dominant or sole fuel (50-100% substitution)	• Substantial emissions reduction compared with coal • Retention of existing infrastructure • Dispatchable generation to support grid stability with high VRE	• Biomass sustainability constraints • Fuel price and supply risk, particularly in import-dependent countries • Lock-in risk if extending asset life

[5] For it to be a viable low carbon transition management tool, the CFPP repurposing project must able to demonstrate efficiency, health, safety, social and environmental improvements to existing fossil fuel assets, and to be done **only** where the investment does not increase the economic operational life of an asset that would otherwise be retired

[6] Experience in Indonesia has shown biomass input shares tend to average 1-5% of fuel energy, largely due to challenges associated with the biomass supply chain.

	Typology option	Definition	Benefits	Challenges
5	**Ammonia conversion/co-firing** *Note that this option is not supported under the UK Government's International Fossil Fuel Policy*	Blend green ammonia (up to 20% by energy content) with coal in existing plants to reduce the amount of coal to operate the plant	• Interim solution to slightly reduce carbon emissions • Supports energy security with existing assets and contributes to grid stability	• Sourcing green ammonia is expensive and poses risks for energy security • Highly toxic and safety risks
Coal phase-out				
Energy uses				
Clean energy				
6	**Wind / solar (+ BESS)**	Switch to wind turbines and solar PV, often paired with battery energy storage	• Existing transmission, substations, and land access • Integration of BESS provides firm capacity and grid stability • Zero fuel cost and very low operating emissions	• Variable output needs integration and market design considerations • Higher capital costs (particularly with BESS) • Demolition of CFPP equipment is challenging and costly
7	**Biomass power** *Note that biomass power is not supported under the scope of the UK-funded programme and would require separate assessment against sustainability criteria*	Develop a new and purpose-built biomass power plant generating power from biomass fuels	• Dispatchable, low-carbon generation • Maintains energy infrastructure use and possibly local jobs	• Biomass feedstock supply and sustainability risks • Higher generation cost than wind/solar in most markets
8	**Waste-to-energy**	Convert waste into heat or electricity via combustion, gasification, or anaerobic digestion	• Reduces landfill waste and produces energy • Can provide stable baseload output	• Air quality concerns and permits can be complex • Feedstock availability and competition with recycling markets
9	**Nuclear SMR**	Repurpose coal plant sites with smaller nuclear reactors (< 300–400 MW) designed for modular	• Zero-carbon baseload electricity from nuclear fuel without direct emissions • Preserves jobs and energy security	• Lack of nuclear capabilities and project development support • Public concerns over nuclear safety and environmental risks

	Typology option	Definition	Benefits	Challenges
		fabrication and replication	• High output density to minimise footprint requirement	• High carbon emissions potential from fuel mining and processing • Long permit / regulatory lead times
10	**Abated CCGT with CCS or green hydrogen** *Note that under the UK Government's International Fossil Fuel Policy, abated CCGT with less than 100% green hydrogen blending is not supported. Even further, this is permitted only in exceptional circumstances and subject to strict conditions. These include alignment with national decarbonisation pathways, demonstrable lack of viable renewable energy alternatives, and assurance that the proposed measures neither delay nor detract from the transition*	Decommission and replace CFPP with natural gas CCGTs with CCS to capture and store CO_2 emissions or combust hydrogen produced via low-carbon pathways (electrolysis)	• Natural gas power generation provides dispatchable power and firm capacity • Significant emissions reduction if capture rates are high or if 100% green hydrogen is used	• Requires access to CO_2 transport and storage infrastructure • Substantial new components are needed (carbon capture units, CO_2 compressors and storage locations) • Requires geological storage access and strong policy/market incentives • Hydrogen production costs remain high without strong policy support • Storage and transport infrastructure requirements
Grid services				
11	**Standalone BESS**	Decommission CFPP and use the grid connection for a standalone BESS storing and discharging electricity while providing stability to the grid	• Fast deployment and no fuel supply risks • Facilitates renewable expansion • Minimal environmental impact • Compatible with early retirement and just transition strategies	• Regulatory frameworks for storage are still evolving in many ASEAN countries • Requires careful market and tariff design • Battery production and disposal need careful management • Local expertise may be limited
12	**Synchronous condensers**	Convert existing coal generators into large rotating machines that primarily control	• Provides essential grid services • Long technical lifetime	• High capital costs for installation and maintenance

Typology option		Definition	Benefits	Challenges
		reactive power flow, supporting grid stability	• Can reuse existing generators and grid infrastructure • Low operational emissions	• Requires technical expertise in integration with existing grids • Competition from alternative reactive power solutions like BESS
Non-energy uses				
13	**Reuse the grid connection**	Repurpose former CFPPs for industry/agro-industry or commercial purposes (e.g., data centres)	• Aligns with long-term decarbonisation pathways • Creates new industrial value chains, job creation and demand growth • Efficient reuse of land and grid infrastructure • Attract private capital quickly	• High electricity demand • Risk of locking in fossil-heavy grids if not paired with renewables • Not suitable for remote coal sites • May require strong regional planning and policy support • May need remediation and face longer development timelines
14	**Fully clear site**	Decommission CFPP and sell or transfer land for alternative uses (residential, commercial, mixed)	• Clear coal exit for transition • No long-term environmental liabilities • Unlocks land value • Simple governance/regulation	• High remediation costs to address contamination • Loss of energy sector employment • Requires strong land-use planning

Source: ECA under the Green Grid Rising Workstream I, ASEAN-UK Green Transition Fund – Clean and Just Energy Transition

In practice, coal repurposing is rarely a single-step process. Instead, **most transitions involve sequenced and hybrid approaches while ensuring decarbonisation direction,** in which different options are deployed over time to balance reliability, cost, and decarbonisation objectives.

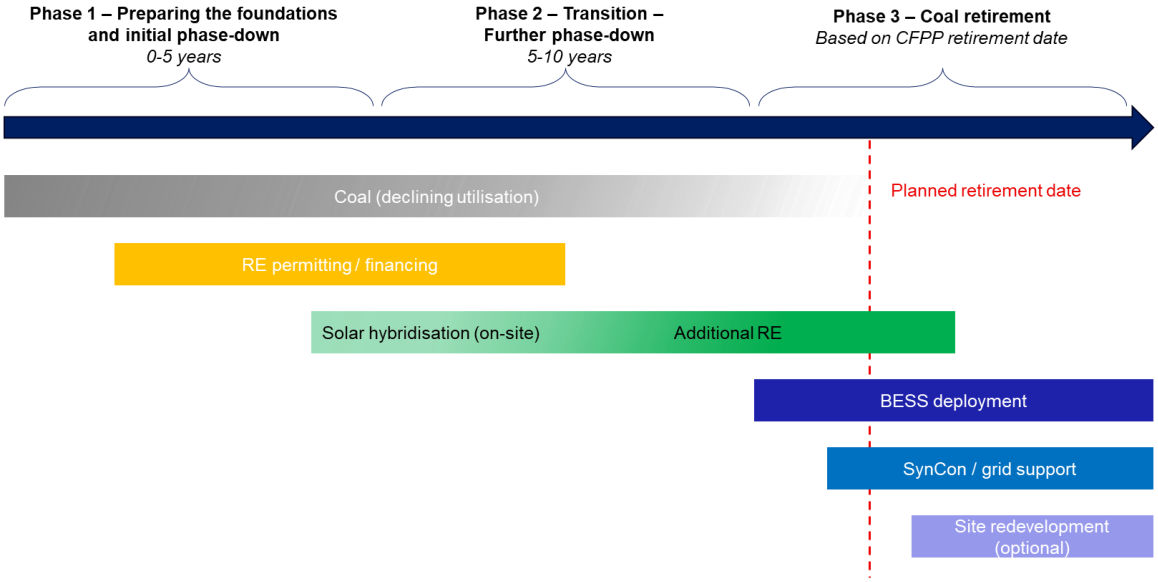
Many AMS continue to depend on relatively young CFPPs for system reliability, energy security and affordability, while also facing rapidly growing electricity demand. Abrupt retirement of coal assets could create challenges related to replacement capacity, grid stability, stranded assets, outstanding debt obligations, and employment impacts in coal-dependent communities. A phased approach allows governments and utilities to balance

reliability, affordability and decarbonisation objectives while progressively preparing the system for higher shares of renewable energy. However, the phased approach must be carefully managed. A grid connected coal phase down might result in another infrastructure lock-in if the phase down results in extending the life of the CFPP asset.

Transition measures can be sequenced to support a planned coal retirement date. Early actions may focus on renewable energy permitting, financing and on-site hybridisation, followed by deployment of additional renewable generation, battery storage and grid-support technologies. Coal utilisation declines over time as replacement resources come online, enabling retirement to occur once alternative sources of energy and system services are in place. This approach helps reduce implementation risks, improves political acceptability, and provides time to address workforce, community and financing requirements.

An example of this sequencing in a generalised ASEAN context might involve a relatively young CFPP reducing baseload operation in the near-term, while a portion of the site is used to install solar PV. Over the following decade, BESS and grid support equipment could be added, allowing coal generation to decline further until coal units are entirely retired with the site continuing to operate as a combination of solar generation, storage, and grid services. This is visually represented in the timeline below.

Figure 5 Sequenced approach to coal repurposing in ASEAN

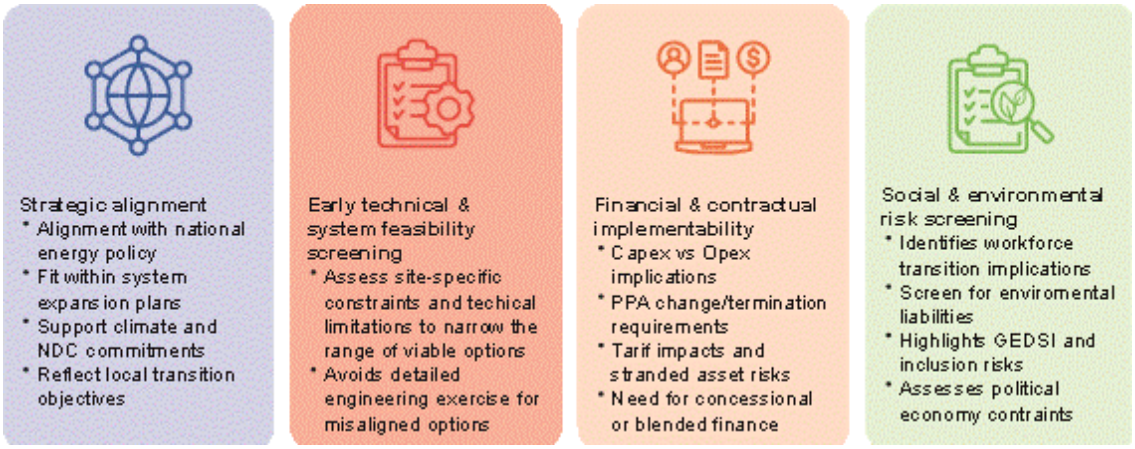


Source: ECA under the Green Grid Rising Workstream I, ASEAN-UK Green Transition Fund – Clean and Just Energy Transition

4. Framework for developing CFPP repurposing pre-feasibility assessments

The purpose of this playbook is to provide a structured framework to guide decision-makers in determining appropriate CFPP repurposing options for specific sites. Given the number of available repurposing options, a framework provides a structured process of assessing the suitability of the options for specific contexts. While high-level multi-criteria analysis can help identify the most promising repurposing options, analysis needs to extend beyond this and consider a wide range of impacts at a more granular level. The figure below provides an overview of the potential objectives of a pre-feasibility study.

Figure 3 Purposes of a pre-feasibility study



Source: ECA under the Green Grid Rising Workstream I, ASEAN-UK Green Transition Fund – Clean and Just Energy Transition

The framework provides a multi-step process to assessing the most suitable repurposing options for a specific CFPP. It is structured around five sequential steps, illustrated below.

Figure 4 Framework for developing a pre-feasibility study



Source: ECA under the Green Grid Rising Workstream I, ASEAN-UK Green Transition Fund – Clean and Just Energy Transition

4.1. Framing

The first step is to define the objectives of CFPP repurposing. These may differ between countries and sites, depending on national policies, power-system conditions, and local development priorities.

Potential objectives include supporting the integration of variable renewable energy, improving grid flexibility and system reliability, contributing to decarbonisation, repurposing existing infrastructure and land, and supporting local economic development and a managed transition for affected communities. Some options, including nuclear power, carbon capture and storage, or waste-to-energy facilities, may be restricted by national regulations, environmental considerations, or public acceptance. Consequently, technically feasible options may not always be legally, politically, or socially viable.

All assessments should apply the following guardrails:

- Repurposing should not extend CFPP operation beyond the agreed retirement date.
- Repurposing should deliver credible net emissions reductions relative to an appropriate baseline or counterfactual, considering the direct emissions as well as material lifecycle and wider power-system effects where relevant.
- Phase-down options should be treated as transitional measures within a managed pathway to full phase-out, rather than as alternatives to phase-out.

4.2. Options

Before undertaking detailed analysis, options should be screened against knockout criteria. Options should be excluded where they:

- Extend coal generation beyond the agreed retirement timeline.
- Lack a binding and time-bound retirement schedule, where continued or flexible coal operation is proposed.
- Depend on fuel supplies or technologies that are not commercially available or credible.
- Result in higher lifecycle or system-wide emissions than the defined counterfactual or other credible alternatives.
- Require contractual or financial restructuring for which there is no credible pathway to stakeholder agreement.

CFPP repurposing options may vary according to the extent to which coal generation is reduced and the future role of the site in the power system or local economy. Options are not necessarily mutually exclusive and may be implemented in phases—for example, an initial phase-down followed by full phase-out. However, options that conflict with decarbonisation objectives, system requirements, or practical constraints should be screened out before detailed assessment.

4.3. Screening

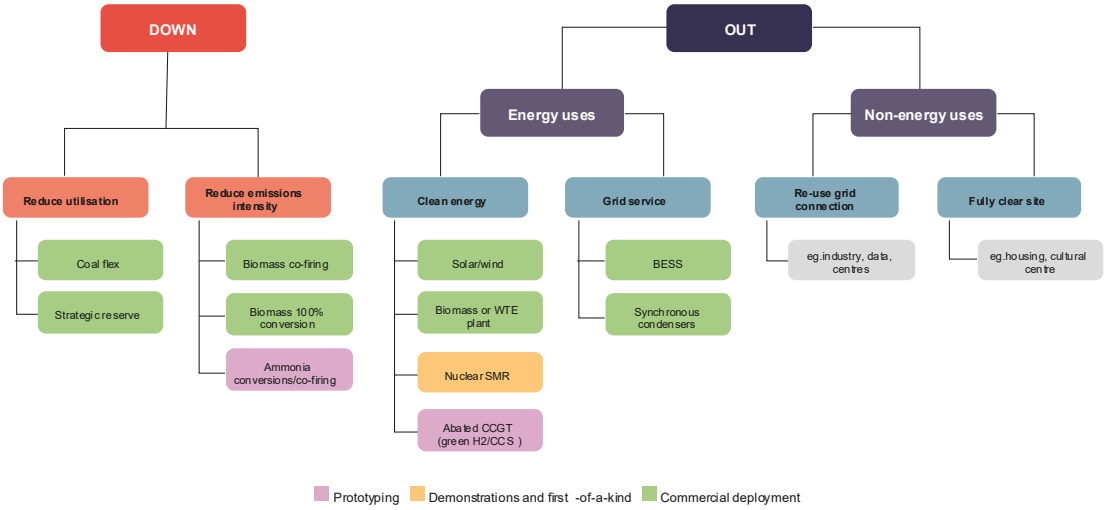
The screening stage assesses repurposing options against the objectives, constraints, timeframe, and indicative budget established during the framing stage. It considers each option’s technical and commercial maturity, indicative cost, and likely deliverability.

The purpose is to identify realistic options for detailed assessment and eliminate those that are clearly unsuitable at an early stage. Screening should be indicative and comparative rather than based on detailed project-level modelling.

4.3.1. Technical screening

Different CFPP repurposing options have different levels of maturity – both technically and commercially – impacting the extent to which they can realistically be deployed in given timeframes. While some repurposing options involve technologies which have been widely deployed on a commercial scale, including across ASEAN, others remain relatively nascent and have been limited to demonstration or initial prototypes. A summary of the relative technological readiness is provided in the figure below.

Figure 5 Technical maturity of CFPP repurposing options



Source: IEA. 17 Feb 2026. Clean Energy Technology Guide | IEA. 2022 and ECA assessment | Ammonia conversion or co-firing is not supported under the UK Government's International Fossil Fuel Policy | Only CCGT abatement with 100% green hydrogen is supported under the UK Government's International Fossil Fuel Policy. Abated CCGT should be treated as an option of last resort, only in exceptional circumstances where a demonstrable system need exists, no viable renewable alternative is available, and the investment does not delay or undermine the transition to clean energy.

Many technologies have been commercially deployed. However, other technologies are at lower levels of maturity. One way to assess it is through the Technology Readiness Level (TRL) scale. Technologies with a higher TRL have a lower risk associated with their technological performance. The different stages of the TRL are provided in **Error! Reference source not found.**. The table below provides an overview of the TRL for each repurposing option. Note that in some cases, there could be several variations to the TRL, based on the local context and in ongoing developments for repurposing.

Many repurposing options are at high stages of technical readiness. For example, solar technology is well established and can be easily deployed across ASEAN on a relatively short time frame. Similarly, there is an established base of evidence for retrofitting coal plants to allow for flexible operations.

On the other hand, some technologies are at lower stages of maturity. This means they are unlikely to be appropriate for CFPP repurposing in the near to medium-term, and in some

cases may be over a decade away from becoming realistic candidates for repurposing at a commercial scale in ASEAN.

This includes nuclear SMRs. While a promising technology, there are currently only two SMRs in operation around the globe, with an additional five units under construction. Nonetheless, the maturity of this technology is expected to continue to develop. Similarly, abatement options for CCGTs, including CCS and green hydrogen, are not mature or not available at scale. For example, currently, less than 1% of global hydrogen is supplied through low-carbon technologies.

These considerations highlight the importance of distinguishing between near-term repurposing options that can support coal retirement within the next few years, and longer-term transition pathways that may only become viable once technologies mature. Examples of the deployment of different repurposing options are provided in Annex A.

Table 2 Indicative TRL for CFPP repurposing options

Typology option		TRL for ASEAN	Rationale
Coal phase-down (Transitional)			
Reducing utilisation			
1	Flexible coal refit	9	Widely deployed, including in ASEAN
2	Strategic contingency	9	No technological barrier (policy/regulatory only) Successfully deployed in several countries globally
Reducing emissions intensity			
3	Biomass co-firing	7-9	Proven technology, including in ASEAN. Limitations caused by feedstock supply chains
4	Biomass conversion (50-100%)	6-8	Proven technology globally, but none implemented in ASEAN Significant limitations caused by feedstock supply chains and constraints
5	Ammonia conversion/co-firing	5	Limited pilots at low blending rates in Japan
Coal phase-out			
Energy uses			
Clean energy			
6	Wind / solar (+ BESS)	8-9	Proven technology, both globally and in ASEAN Limited experience in repurposing existing sites in ASEAN

	Typology option	TRL for ASEAN	Rationale
7	Biomass power	7-9	Proven technology, including in ASEAN Significant limitations caused by feedstock supply chains and constraints
8	Waste-to-energy	7-9	Proven mature technology, though limited scale deployment across ASEAN
9	Nuclear SMR	3-6	Limited number of SMRs in operation globally Very long lead times, especially in countries with no existing nuclear power
10	Abated CCGT with CCS or green hydrogen	4-6	While CCGT technology is mature (9), CCS for power plants and green hydrogen production at a large scale and green hydrogen co-firing are limited in maturity and scale
Grid services			
11	Standalone BESS	9	Proven technology, including in ASEAN
12	Synchronous condensers	9	Proven technology
Non-energy uses			
13	Reuse grid connection	8-9	No significant technical barrier, but limited precedent in ASEAN
14	Fully clear site	9	No significant technical barrier Proven technology in ASEAN

Source: ECA analysis under the Green Grid Rising Workstream I, ASEAN-UK Green Transition Fund – Clean and Just Energy Transition, based on ETP Clean Energy Technology Guide (2026)
Note: Biomass repurposing options are not supported under the scope of the UK-funded programme and would require separate assessment against sustainability criteria. Abated CCGT with less than 100% green hydrogen blending is not supported under the UK Government's International Fossil Fuel Policy.

For energy uses, technology readiness should be considered alongside benchmark assumptions for the expected utilisation and operational availability of each option. This classification helps narrow the focus towards options that best support the objectives established during framing. It should not, however, result in a definitive selection at the screening stage, as options may be complementary and combined or sequenced within a hybrid pathway.

At the screening stage, transparent benchmarks should be used rather than project-level modelling. For generating technologies, capacity factor is annual net generation divided by maximum possible generation, while availability is the proportion of time the asset is technically capable of operating. Benchmarks should reflect national, or sub-national, data where available and be refined using site-specific evidence during the assessment stage.

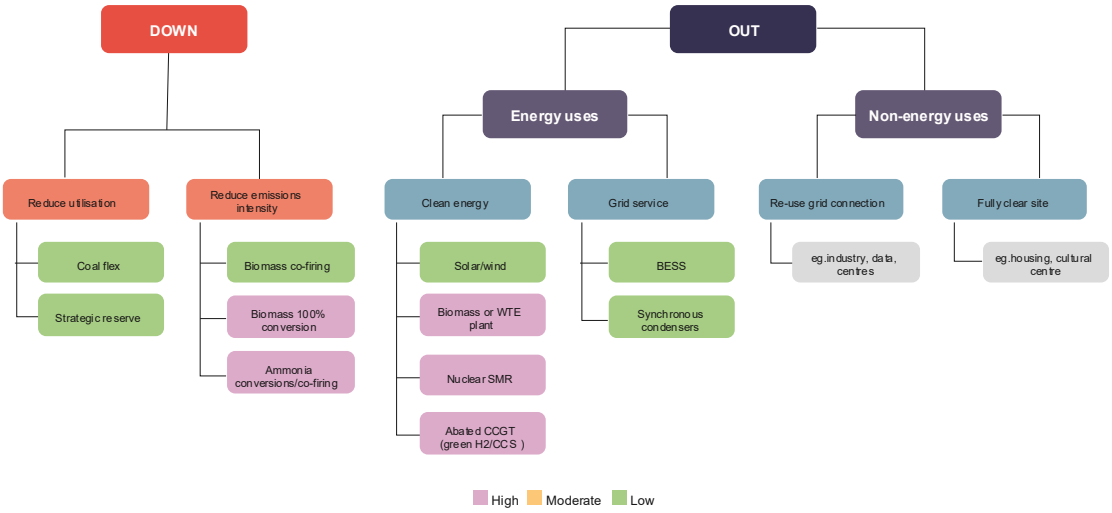
During the screening stage, options may be classified according to their expected operating role:

- **Firm or baseload generation**: Options intended to provide sustained, dispatchable output, such as nuclear SMRs, co-firing or conversion options which reduce emissions intensity, waste-to-energy and potentially abated CCGT. Co-firing may retain an operating profile similar to the existing CFPP, although utilisation may be constrained by fuel availability, cost or transition policy.
- **Flexible or reserve generation**: Options intended to respond to variations in demand and renewable generation rather than operate continuously, including flexible coal refits and strategic contingency.
- **Variable renewable generation**: Solar and wind output depends primarily on the available renewable resource. Screening should therefore apply benchmark capacity-factor ranges appropriate to the country or resource class.
- **Storage and grid services**: Standalone BESS and synchronous condensers do not fit conventional generation categories. Use storage-performance metrics for BESS and service-availability metrics for synchronous condensers.

4.3.2. Financial feasibility

The objective of financial feasibility screening is to determine the relative viability of repurposing options by comparing the relative costs of these options. At the screening stage, the analysis is indicative, focusing on order of magnitude comparisons, rather than specific project-level financial modelling. In doing so, consideration needs to be given to different types of costs associated with CFPP repurposing. At this stage, this includes the direct costs associated with the capital investment required to implement the CFPP repurposing option, as well as the change in the operating and fuel costs arising from the repurposed option. The figure below provides an indicative overview of the relative cost of different options. These are intended to highlight the relative costs of repurposing options, based on current benchmark costs. They will vary based on the specific site and country, given, for example, fuel costs can vary significantly across ASEAN.

Figure 6 Overview of CFPP repurposing option costs (direct investment, operating and fuel costs)



Source: ECA under the Green Grid Rising Workstream I, ASEAN-UK Green Transition Fund – Clean and Just Energy Transition, based on Danish Energy Agency. 2025. Technology Data for the Indonesian Power Sector and IEA 2022. Only

CCGT abatement with 100% green hydrogen is supported under the UK Government's International Fossil Fuel Policy. Abated CCGT should be treated as an option of last resort, considered only in exceptional circumstances where a demonstrable system need exists, no viable renewable alternative is available, and the investment does not delay or undermine the transition to clean energy. Ammonia and biomass co-firing are not supported under the scope of the UK-funded programme. References to these options are included solely for analytical completeness and comparative assessment and do not constitute a recommendation for adoption or implementation.

This shows that options which focus on reducing utilisation, delivering grid services, or providing renewable energy have comparatively low costs. Less mature technologies have higher costs, in part due to the high capital costs, as well as comparatively high fuel costs.

Different repurposing options fundamentally differ in whether they are capital-intensive or fuel and operation-intensive, which has important implications for financing structures and tariffs. Utilities in single-buyer systems, for instance, may prefer lower capex options that can be financed through existing tariffs or on balance sheets, as higher capex alternatives often require new financing vehicles or concessional capital. Early screening can therefore help evaluate whether upfront capital can be mobilised or whether lower capex options are more appropriate for a particular system.

4.4. Assessment

The screening of repurposing options should have reduced the range of feasible options to a much narrower set of options. This then allows for a more detailed assessment of selected repurposing options through a pre-feasibility assessment or study. Such an assessment takes place at the plant or site-level and therefore takes into closer consideration site-specific aspects and information.

This assessment should form the core of the pre-feasibility assessment. Note that, as this assessment should be relevant to the specific site, it is important to begin by collating robust data for both the existing site that is being repurposed, as well as the repurposing options which are being considered in more detail in the assessment stage. An illustration of key input data parameters and sources is provided below.

Table 3 Summary of key input data and sources

Input category	Variable	Description/examples	Potential data sources
Plant characteristics	Plant name, location, technology type	Basic plant identifiers	National plant registries, utility disclosures
	Installed capacity (MW)	Nameplate capacity	Utility filings, regulator data
	Commissioning year/age	Plant vintage	Utility or regulator data
	Expected remaining lifetime	Years until retirement	Regulatory assumptions, utility disclosures
Operational data	Historical annual generation (MWh)	Past output levels	System operator statistics
	Capacity factor	Derived from generation and capacity	System operator data

Input category	Variable	Description/examples	Potential data sources
	Operating mode	Baseload/flexible/ reserve	Utility or operator classification
Emissions	CO_2 intensity ($kgCO_2/MWh$)	Direct emissions intensity	National inventories, IPCC defaults
	Air pollutant factors	SO_2, NO_x, PM proxies	National environmental agencies
Local environment	Air quality proxy	AQI category or equivalent	National air quality agencies
	Population exposure proxy	Population affected	Census data, GIS layers
Prices & finance	Wholesale electricity price path	Future price assumptions	Government outlooks, market reports
	Discount rate	Social or financial discounting	Policy assumptions
Fuel prices	Coal, biomass, ammonia prices	Fuel cost assumptions	Government energy statistics
Capex benchmarks	Renewables, storage, grid assets	Technology investment costs	National technology catalogues
	CCS/fuel conversion capex	Abatement technologies	National datasets
Opex benchmarks	Fixed and variable O&M	By technology	National technology data
Financial parameters	Inflation, market risk premia, LIBHOR	Financing costs	National and global market data
Decommissioning	Coal retirement costs	Closure and remediation	Regulatory guidance
Resource availability	Solar and wind resource class	Site-specific resource quality	National resource maps, GIS,
Site characteristics	Available land/footprint	Repurposing potential	Satellite imagery, GIS
Grid context	Connection voltage and capacity	Grid integration constraints	System operator data
	Congestion/grid strength proxy	Network limitations	System planning reports
Employment	Jobs per MW	Coal, renewables, storage	Industry benchmarks
System value inputs	Flexibility category	System services contribution	Expert judgement
	Reliability/availability proxy	Contribution to adequacy	System operator assumptions

Source: ECA under the Green Grid Rising Workstream I, ASEAN-UK Green Transition Fund – Clean and Just Energy Transition

The remainder of this section provides an overview of key aspects which need to be considered as part of the assessment.

4.4.1. Site characteristics

The attractiveness of CFPP repurposing is in part the result of CFPP sites being relatively attractive, as they allow for existing land and grids to be reused. However, the physical footprint and layout of a site can limit the range of feasible repurposing options. Similarly, the location of the site can also impact which options are feasible. The assessment should review the existing size and layout of the site and compare this with the land requirements for the various repurposing options.

Key considerations

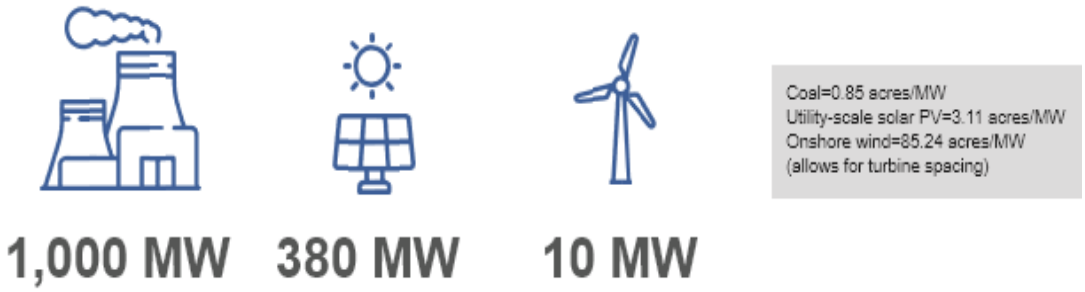
- Repurposing options that rely heavily on existing infrastructure (grid services) are generally easier to implement on constrained sites, while renewable repowering or industrial redevelopment may require substantial space or site reconfiguration.
- Sites located near urban/industrial demand centres can support a broad range of repurposing options, while remote plants may be more suitable for energy uses.
- Legal and ownership arrangements can influence the feasibility of site reuse, particularly for non-energy applications.

Size

The first aspect to consider is the size of the site and the extent to which new infrastructure can be accommodated within the layout of the site. The latter point is particularly relevant when existing structures from the CFPP are expected to remain in time and would constrain the part of the site which is available for new structures.

Several repurposing options have (very) large land requirements. The figure below shows land footprint constraints of solar and wind and highlights the footprint mismatch between coal plants and renewables, explaining why full renewable repowering may be difficult on existing coal plant sites.

Figure 7 Land footprint of different technologies



Source: ECA under the Green Grid Rising Workstream I, ASEAN-UK Green Transition Fund – Clean and Just Energy Transition, based on the US Department of Energy, Energy Markets & Planning, India Central Electricity Authority

Access and location

The site of the CFPP also needs to be considered. Electricity can be transmitted over long distances, whereas heat or hydrogen are expensive to transport and, in the absence of significant local demand, may prove infeasible. The location also matters in regard to the impact on the system. Sites located closer to major load centres may provide higher value for grid or energy repurposing options due to being able to deliver ancillary services, reserve capacity, or flexibility operations to support VRE integration. In contrast, sites located further away from demand centres may face limited opportunities to provide such services, reducing the overall technical and economic attractiveness of these options.

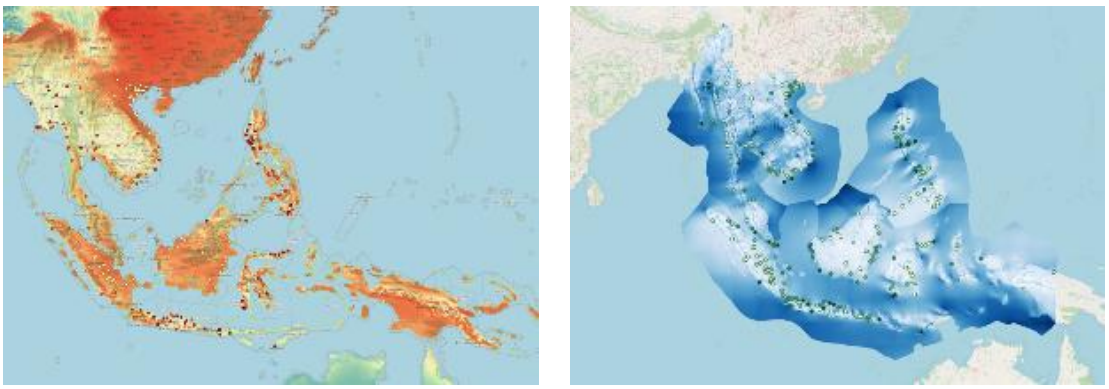
Some repurposing options may face safety or land-use restrictions, particularly in densely populated areas. WtE facilities, SMR or hydrogen infrastructure, for example, may require additional safety buffers or zoning approvals.

Land ownership may also add limitations. In many countries, coal plants are located on land owned by state utilities or leased under long-term agreements. This is particularly relevant in countries such as Viet Nam and Indonesia, where several CFPP sites are built on state-owned land provided under long-term concessions or leases, particularly where CFPPs are developed by IPPs. Under these structures, the land may revert to the state once the concession period terminates at the end of the PPA or when the generation license terminates.

Renewable energy potential

For repurposing options focused on renewable energy, the assessment should also consider the renewable potential. Even if an option is technically possible, it may not be practical if local resource conditions are unfavourable. ASEAN generally benefits from strong solar potential but there are material variations between sites, while wind resources are more unevenly distributed, as shown in Figure 8. Estimates of the capacity-factors for solar and wind can be taken from publicly available sources such as renewables.ninja, if detailed resource assessments do not exist in that region. These should be adjusted, where possible, to reflect site-specific factors such as terrain, orientation and potential shading.

Figure 8 Solar and wind resource potential in ASEAN



Source: ECA under the Green Grid Rising Workstream I, ASEAN-UK Green Transition Fund – Clean and Just Energy Transition | CFPP locations = GEM 2025 | Solar and wind potential sourced using renewables.ninja

4.4.2. System impact

The assessment should also consider the impact of different repurposing options on the broader power system. This includes the effects on reliability, replacement capacity requirements, local network constraints and overall system costs. The objective of the system impact assessment at the pre-feasibility stage is to identify potential constraints or impacts which would impact the feasibility of given options, ahead of more detailed engineering analysis being done. The focus is therefore on determining whether proposed options are broadly compatible with plant characteristics and system needs, rather than moving into detailed design considerations[7].

Key takeaways

- As VRE penetration increases, systems may require new sources of grid support services such as SynCon or BESS.
- Similarly, coal flexibility could be a transitional measure enabling CFPPs to transition from baseload operation to supporting solar and wind integration.
- Local constraints such as weak transmission network, voltage stability requirements or limited regional interconnection may restrict the retirement or repurposing of CFPPs where they continue to provide important local grid services.

Reliability

System-level needs and plant-level options are not always aligned, particularly in developing countries where CFPPs play multiple roles beyond power generation, often providing operating reserves, frequency and voltage stability. As countries integrate more wind and solar power, maintaining system stability may require new sources of grid support services to replace those traditionally provided by thermal plants.

This can be achieved by options such as SynCon or BESS to help maintain some of these services after coal generation is phased out, or through retrofitting CFPPs for flexible operations as an interim measure until additional renewable or low-carbon firm generation and/or storage is developed.

The assessment should consider whether CFPPs are able to cycle and if coal flexibility is a feasible option. This should cover minimum stable generation, ramp rates, start-up times, cycling capability and the effect of increased cycling on plant efficiency, degradation and forced outages. Note that for flexible coal generation, legal, commercial and regulatory barriers will also need to be considered, as set out in Section 4.4.4. Similarly, tight reserve margins may limit options that involve early retirement or full repurposing of CFPPs in favour of alternatives that retain dispatchable capacity or provide strategic reserves.

[7] World Bank (2021). Coal Plant Repurposing for Ageing Coal Fleets in Developing Countries. ESMAP

Replacement capacity

For all repurposing pathways, the assessment should consider whether the system can continue to meet peak demand and reserve requirements. The capacity adequacy margin, should be calculated using:

> *Capacity adequacy margin (MW) = Total effective available capacity − Peak demand − Operating reserve requirement*

In doing so, the assessment should consider planned and forced outages, derating, and where relevant, ramp-rate and start-up constraints to calculate the effective available capacity, rather than the installed capacity. For VRE and storage, only the dependable contribution during the assessed peak period should be counted. The assessment should test peak-demand, low-VRE and coincident-outage scenarios. However, it may rely on benchmark values by technology, with more detailed dispatch and reliability modelling undertaken at the full feasibility stage where material constraints are identified. Whether replacement capacity is required depends on existing reserve margins, expected demand growth, and the availability of alternative generation or storage resources. In some cases, replacement capacity may already be planned as part of national power development plans or RE targets. It is also worth noting that replacement capacity does not need to be located at the same site as the retiring CFPP, although additional transmission investments may be required to relocate generation.

Economic viability should also be assessed in terms of overall system value, not only project-level costs. Some pathways may appear uneconomic at the plant level but provide wider benefits by avoiding infrastructure investment, reducing curtailment or improving grid reliability.

Local constraints

Transmission and network constraints can also significantly affect the feasibility of coal plant repurposing, particularly in regions where grid infrastructure is limited. Factors such as voltage level, available export capacity, system stability, and local network congestion can significantly limit the integration of new-generation, storage, or power-electronics-based technologies. Even if a technology is technically mature and commercially attractive, it may not be viable if the grid cannot accommodate additional power flows or maintain system stability. Grid-related constraints often become the binding factor in repurposing decisions, outweighing the choice of generation technology itself. Sites with strong, unconstrained connections can support a wide range of options, including renewable generation, storage, and hybrid systems. Conversely, sites located in weak or congested parts of the network may be better suited for repurposing pathways that provide system support, such as grid services, flexibility, or voltage support, rather than additional energy generation.

System stability requirements are an important factor to determine which option is most suitable for a specific context. Where CFPPs provide inertia, SynCon may substitute generation, while BESS alone may not be sufficient unless grid-forming. This is a particularly pressing issue for small or islanded systems.

4.4.3. Costs and financing

The screening stage considered the costs of different repurposing options at a high level, focusing on relative order of magnitude effects. This was focused on the direct costs,

including the capital expenditure associated with the repurposing options, as well as operating costs and fuel costs for any repurposing option.

As part of the assessment stage, a more detailed assessment of costs should be conducted. This ought to extend beyond the direct costs, which themselves need to be considered in more detail, to also consider indirect and residual costs. At the same time, a review of potential financing pathways should be conducted to explore potential options for financing the repurposing, including accessing international climate finance.

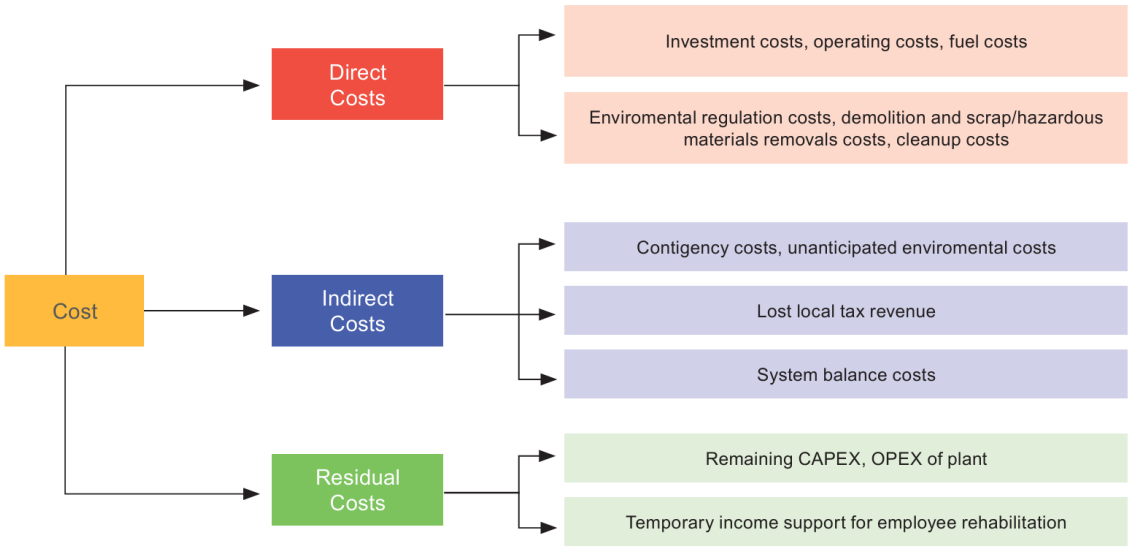
Key takeaways

- Cost-recovery is a key barrier to various repurposing options requiring blended finance to address stranded assets and financing risks.
- Capital-intensive vs fuel-intensive technologies create different financing needs, risk profiles and tariff impacts. This trade-off is important to policymakers.
- Repurposing options that enable new clean energy investment are often better positioned to attract concessional climate finance and carbon revenue streams.

Costs

The assessment must consider the costs associated with different repurposing options. In doing so, it can be useful to distinguish between the different types of costs associated with CFPP repurposing. These are summarised in the diagram below.

Figure 9 Typology of costs



Source: ECA under the Green Grid Rising Workstream I, ASEAN-UK Green Transition Fund – Clean and Just Energy Transition

An important consideration when evaluating CFPP repurposing is the cost of site clearance and environmental remediation. Retiring a CFPP typically requires dismantling major infrastructure, removing hazardous materials, and addressing environmental liabilities such as coal ash storage, contaminated soil, or groundwater pollution.

In some cases, repurposing the site for new energy infrastructure (eg. BESS, solar, or grid services) can reduce these costs. Reusing parts of the existing infrastructure, including buildings, grid interconnections, cooling systems etc may allow certain structures to remain in place. Conversely, some repurposing options may first require extensive site remediation, particularly where land contamination poses environmental or safety risks.

Another factor is the presence of carbon pricing or emissions regulation. Where carbon pricing mechanisms exist coal-fired generation may face additional operating costs reflecting the carbon dioxide emissions associated with burning coal.

Financing

The choice of coal repurposing pathways is also influenced by the availability of financing. In many countries, access to concessional finance and climate-related funding can significantly affect the economic attractiveness of different repurposing options. The Komati project discussed in the annex is one of the largest global efforts to decommission and repurpose a CFPP, showing how providing financing at affordable terms can deliver significant benefits both in terms of renewable reinvestment and transition support for impacted communities[8].

The availability of carbon finance mechanisms can also influence the economics of repurposing. Projects that deliver measurable emissions reductions may generate revenue through the sale of carbon credits under voluntary or compliance carbon markets.

International climate finance institutions and development banks increasingly prioritise investments that contribute directly to emissions reductions and clean energy deployment. So, mobilising public funds for certain pathways may be politically challenging. For instance, coal flexibility investments pose reputational and financing risks to investors seeking climate impact as they lack the certainty. This creates a constraint for many ASEAN countries, particularly those that rely on concessional financing to support energy transition investments and where options that cannot access climate finance may be considerably more difficult to implement, even if technically feasible.

The availability of concessional finance and other sources of funding depends on the country- and sector-specific context as well as the selected CFPP repurposing option. For instance, utility financing provided by state-owned utilities or government-backed entities is best suited for grid services or strategic reserves. On the other hand, early retirement or repurposing options with strong climate benefits but weak commercial returns typically rely on concessional public finance and international support from multilateral development banks, climate funds and bilateral donors. Some grid services alternatives and non-energy uses are most likely to require blended finance and risk-sharing mechanisms to reduce perceived technology or policy risks, as in the case of fuel-switching options, hybridisation or large-scale site redevelopment. Finally, commercial (project) finance from commercial banks and infrastructure funds is best suited for more mature technologies and options with clearer revenue streams, given it requires bankable contracts and regulatory stability.

[8] World Bank (2023). Scaling Up to Phase Down: Financing Energy Transitions in the Power Sector

Box 1 Transition credits as new financing mechanism

Transition credits are a market-based instrument designed to help finance coal transitions by generating a performance-linked revenue stream tied to verified emissions reductions. Their purpose is to complement existing financing mechanisms to help close financial gaps and improve the economics of early coal retirement, particularly in emerging markets.

Several carbon market methodologies for project-based transition credits are either available or under development. Among these, Verra's VM0052 methodology is being applied as a pilot to the SLTEC plant in the Philippines, where transition credits could generate up to USD 800 million revenue between 2031 and 2040 from the plant's early retirement and its replacement with clean energy. ACEN intends to replace the plant's 246 MW coal capacity with a 400 MW clean energy facility combining solar and battery storage, sized to match the roughly 1.8 TWh of annual output currently generated by the coal plant on a like-for-like basis.

The pilot illustrates both the potential and the complexity of the instrument: while transition credits can provide a meaningful supplementary revenue stream, their integrity depends on robust safeguards, including ensuring that retired coal generation is directly replaced by clean energy rather than displaced to other fossil fuel sources elsewhere in the system, and that emissions reductions are genuinely additional, meaning early retirement would not have occurred on the same timeline without the credit revenue.

Source: IEA (2026). Financing the Modernisation of Power Systems Beyond Coal

4.4.4. Legal, regulatory and commercial constraints

Legal and regulatory frameworks also determine which CFPP repurposing pathways are implementable in practice. CFPPs across ASEAN countries are embedded in long-term contractual, licensing and institutional arrangements designed for baseload coal-fired generation and frequently misaligned with the new roles envisaged by repurposing.

Key takeaways

- Policy objectives and planning priorities and their associated trade-offs drive the ranking and shortlisting of transition pathways for different country contexts.
- PPAs and contractual requirements are often the most important constraint on repurposing decisions, alongside legal restrictions and plant ownership structures.
- Many repurposing options provide services not explicitly remunerated under existing tariff or market frameworks.

Contracts and PPAs

Many CFPPS are operated under long-term PPAs or regulated cost-recovery mechanisms that specify fuel type and technology, determine minimum dispatch or availability obligations and assume continued electricity generation over decades. Repurposing strategies that fundamentally change plant operations, fuel use or the function of the power plant may conflict with these contractual features.

PPAs are frequently one of the most binding constraints on repurposing decisions. Options such as BESS, SynCon or renewable repowering often require PPA termination or fundamental restructuring. For coal flexibility strategies, the risk of retrofits prolonging contractual coal lock-in requires PPAs to be explicitly amended to commit to eventually phase-down.

PPAs in ASEAN countries are typically long-term, linked to state-owned utilities and include take-or-pay arrangements. While PPAs may coexist with spot trading opportunities that may offer some room for adjustment, rigid PPAs in single-buyer systems account for a large share of the revenue stream. Many of these contracts were signed before the onset of the energy transition and exhibit common features summarised below.

The average remaining lifespan of coal PPAs ranges from 8.8 years in Malaysia to 17.5 years in Indonesia. While some plants in the region have displayed some degree of flexibility by adjusting annual dispatch in response to changing system conditions, PPAs are expected to continue to influence dispatch in the coming years.

Legal and permitting

In addition to PPAs, most CFPPs hold licenses for specific fuel (coal), technologies and are linked to environmental permits calibrated to coal-fired generation. Licensing and permitting regimes are not designed for repurposing which may require new or amended licenses, particularly in countries where regulatory frameworks are tightly coupled to generation planning and approvals for capacity expansion, which makes repurposing options outside power generation relatively difficult to implement. Coal repurposing could also expose regulatory gaps that require new classifications rather than simple amendments.

Ownership structures also play a decisive role The institutional context is particularly relevant across ASEAN, where state-owned utilities, IPPs and captive generators coexist. CFPPs owned by state-owned utilities are generally easier to repurpose from an institutional perspective than those owned by IPPs, since utilities often combine ownership, system planning and dispatch responsibilities and can consider repurposing options as part of a broader least-cost system planning. Examples across ASEAN include PLN in Indonesia and EGAT in Thailand, retaining significant control over generation and transmission planning.

In some cases, legal frameworks governing state-owned assets can create additional constraints. For example, in Indonesia, laws designed to prevent losses to state assets may restrict the early retirement of state-owned CFPPs if doing so would require compensation below their book value. This constraint has practical implications for coal transition financing mechanisms, as discussed in the box below, providing an illustrative example.

Box 2 Legal and regulatory constraints in Indonesia

Indonesia's power sector is vertically integrated through the state-owned utility Perusahaan Listrik Negara (PLN). While PLN historically owned most of the generation fleet, IPPs have been playing an increasingly prominent role in electricity generation and currently account for nearly 50% of total coal power installed capacity. As noted above, laws are currently in place to prevent losses to state-owned assets. Therefore, while the government is prioritising the phase-down of coal, the current focus is on CFPPs owned by PLN that are fully depreciated and about to retire as power plants owned by IPPs are generally newer assets. Transactions reducing the value of state assets could potentially expose decision-makers to legal investigations. This constraint has practical implications for coal transition financing mechanisms. Under the Energy Transition Mechanism (ETM) supported by multilateral development banks, initial efforts in Indonesia have focused primarily on IPP plants, typically governed by contractual arrangements that may allow negotiated early retirement or restructuring without triggering the same legal risks associated with state-owned assets.

Source: Agora, ICSC & IESR (2023); IEA (2022); Climate Smart Ventures (2026)

Finally, repurposing projects may also require new environmental impact assessments, grid connection approvals, and construction permits, particularly if the site is redeveloped for a different technology which can affect both the cost and timeline of repurposing projects.

For policymakers, early assessment of these legal and regulatory constraints is critical to identify which repurposing pathways are realistically implementable within existing legal and permitting frameworks.

4.4.5. Environmental impacts

The assessment should also consider health and environmental impacts of different repurposing options. These impacts can be significant, both with regards to meeting the proposed objectives of CFPP repurposing as well as in managing socio-political buy-in from different repurposing options. To ensure they are adequately addressed as part of the pre-feasibility assessment such impacts should be monetised where possible.

Key takeaways

- Closing CFPPs only reduces emissions if the electricity system replaces them with low-carbon resources rather than fossil generation elsewhere.
- Some repurposing options – particularly biomass – may create upstream environmental risks, such as deforestation or unsustainable biomass sourcing.
- Environmental benefits can extend beyond climate impacts to local air quality, water use and public health.
- Environmental remediation costs can materially affect repurposing viability, particularly for non-energy uses.

Greenhouse gas emissions

Emissions trajectories differ significantly across repurposing pathways. Some options maintain residual fossil exposure, while others remove it entirely. Some alternatives deliver incremental emission reductions (ie, coal flexibility retrofits and co-firing options), others lead to partial decarbonisation (ie, biomass conversion, CCGT with CCS and hydrogen blends) while deeper decarbonisation can be achieved through renewable repowering, grid services options such as standalone BESS and SynCon and non-energy reuse.

The environmental assessment should be carried out against long-term decarbonisation trajectories and not only short-term emissions reduction. As noted earlier, under coal flexibility retrofits, the coal plant continues to generate an uncertain level of emissions and reductions can only be achieved if usage meaningfully declines, subject to the asset's technology and efficiency. Flexibly operated coal plants also remain a significant source of air pollutants which increases at lower loads due to less efficient combustion and degraded equipment performance.

Without clear phase-out commitments and timelines, this pathway may inadvertently increase cumulative emissions due to cycling inefficiencies and life extension[9]. In the case of flexible operation, for instance, a declining cap on operational emissions intensity (CO_2 per kWh generated) could be imposed to ensure alignment with climate objectives. Other disincentives such as carbon pricing may also be implemented to align legal incentives with transition goals[10]. These benchmarks should be tightened over time and encourage a gradual shift towards clean flexibility sources as the power system evolves. Linking CFPPs' eligibility for retrofits to meeting or beating these benchmarks may be one approach to address short-term system needs without displacing clean alternatives[11].

In addition to site-level greenhouse gas impacts, coal repurposing affects overall system emissions, depending on how the electricity system replaces lost generation. Emissions impacts should therefore be assessed relative to a clearly defined counterfactual, such as continued operation of the CFPP to its planned retirement date or another credible system development pathway. The assessment should consider material changes in direct operational emissions and, where relevant to the comparison, lifecycle emissions associated with fuels, replacement infrastructure and wider power-system effects. The level of analysis should be proportionate to the pre-feasibility stage, with more detailed lifecycle or system modelling undertaken where these effects could materially affect the comparison between options.

Health impacts

CFPPs are one of major sources of local air pollution, including particulate matter, sulfur dioxide and nitrogen oxides (ie, ammonia combustion). Repurposing options that eliminate coal combustion can deliver important benefits by reducing air pollution, but the alternatives must be carefully assessed. For instance, co-firing ammonia with coal is estimated to increase air pollution substantially, creating major health risks, with PM2.5 and toxic particles projected to increase by 67% at 20% co-firing rates, and by 167% at 50% co-firing rates[12].

CFPPs also have significant water impacts, including cooling water use and thermal discharge into rivers or coastal waters, which may be a particularly critical issue in water-stressed regions. Environmental assessments should consider both improvements and potential new risks associated with different repurposing pathways.

Supply chain

Coal plants are typically linked to broader supply chains, particularly coal mining and transport sectors. Retiring or repurposing coal capacity may therefore affect upstream industries and the communities that depend on them. For example, reduced coal demand may affect mining regions, rail operators, and port infrastructure. These impacts may occur far from the plant itself and may require targeted policy support or regional transition strategies.

[9] Agora, ICSC & IESR (2023). Transitioning away from coal in Indonesia, Vietnam and the Philippines. Overview of the coal sector with a focus on its economic relevance and policy framework. Agora Energiewende, Institute for Climate and Sustainable Cities, Institute for Essential Services Reform

[10] NewClimate & I4CE (2024). Financing coal phase-out: Public development banks' role in the early retirement of coal plants

[11] CTC (2025). From Flex to Phase-Out. Technical Report of Coal Transition Commission Assessing the Role of Coal Flexibility in Accelerating Coal-to-Clean Transitions in Emerging Markets and Developing Economies

[12] E3G (2023). Explained: Why ammonia co-firing with coal in Southeast Asia is a risky approach

In some cases, fuel supply chains can also affect the feasibility of alternative CFPP repurposing options that are more vulnerable to fuel availability and price risks. The biomass co-firing or conversion alternatives, for instance, rely on sustainable feedstock volumes, logistic and transport costs as well as competing land uses.

4.4.6. Social impacts

Coal plants are often deeply embedded in local economies and employment structures. Repurposing decisions have important social and distributional consequences, affecting workers, communities, and supply chains. At the same time, the energy transition can create new economic opportunities, particularly in renewable energy and related industries. A successful coal transition requires a plan that accounts for the social and economic impacts of CFPP repurposing that places stakeholders at the centre of this plan to ensure broad social and political buy-in to repurposing.

Key takeaways

- Worker transition planning and community engagement must begin early in CFPP repurposing discussions.
- CFPPs are a major source of stable, full-time employment, and their repurposing directly displace a large number of workers. On the other hand, the transition also has the potential to generate significant new employment opportunities.
- Repurposing can help sustain local economies through site redevelopment for renewable energy, industrial or commercial activities.
- Without targeted support including retraining, local development, and inclusive hiring, some workers and communities may face disproportionate impacts.

Workforce

CFPPs are a major source of stable, full-time employment, and their repurposing – particularly phase-out measures – can directly displace many workers. Phase-down pathways may have less severe impacts on employment in the near-term, but workers may face shorter contracts, fewer working hours or uncertain career trajectories as plants operate below capacity. This erosion of job stability can discourage skill redevelopment, reduce productivity, and create a sense of precarity among the workforces.

At the same time, the employment impact can be offset through green jobs which are created through the repurposing activities. Research by the World Bank shows that CFPP repurposing can generate jobs in construction, operations, and local supply chains, although successful transitions require targeted workforce support and retraining programmes[13]. Other studies analysing coal-to-renewables transitions show significant employment expansion from large-scale deployment of solar, wind and storage. One study from Indonesia shows that the development of utility-scale solar creates a significant number of jobs. It

[13] ESMAP (2023). Employment Impacts of Closure and Repurposing of Coal Power Plants: Job Creation Potential of the Clean Energy Transition

estimates that the development of 1,000 MW of utility-scale solar creates 6,700 indirect job-years in the manufacturing of equipment and components, compared to 5,400 for a CFPP[14]. 1,000 MW of utility-scale solar is associated with 13,000 direct job-years in construction and installation (11,200 for CFPPs) and 700 job-years in ongoing O&M (1,400 for CFPPs). This highlights potential employment benefits arising from the repurposing of CFPP assets with other clean energy assets. In addition, there are also potential employment opportunities associated with decommissioning, which can help cushion the impact during the transition. The same study estimates the decommissioning of 1,000 MW of CFPP capacity is associated with 1,650 job years[15].

An assessment of employment opportunities in South Korea finds that replacing coal with renewable energy could generate nearly three times more jobs than continuing coal-fired generation between 2020 and 2030. The study found that job losses related to coal phase-out would be outweighed by the newly created jobs in RE and storage technologies for all provinces, and that even those provinces reliant on coal could achieve newly created jobs in construction, O&M of solar, wind and storage. The job creation potential in O&M of new RE and storage systems alone was estimated to outweigh the job losses from closing all CFPPs across the country by 2029[16].

However, the jobs are not necessarily replaced on a one for one basis. Differences in the required training, higher skill thresholds, or geographic mismatches may cause significant short-term distortions. The table below provides an overview of how adverse impacts on the workforce can be mitigated, based on a review of relevant case studies.

Table 4 Case studies of mitigating workforce transition

Country	Brief description
 Philippines	The Philippines announced a moratorium on new CFPPs in 2020, expected to promote the renewables sector and increase corresponding green jobs. The Green Jobs Act of 2016 was also passed to create green jobs and build resilience against climate change. The Act provides a 50% tax deduction on expenses incurred in training personnel and waives taxes and duties on the import of capital equipment used for the promotion of green jobs. The Act also assign different government agencies specific tasks to plan for green jobs, serving as a foundation to reskill workers and transition them into green industries.
 Spain	Hunosa, a state-owned coal mining company in Spain, transformed existing coal mines into new mining-related ventures such as mining consulting services and transforming old mines into museums. Compensation was also offered to cover the technical and social costs of the coal mines affected by the reforms as well as provisions for rehabilitating old mines.
 Poland	The Mining Social Package was launched in 1998 to offer voluntary retirement to coal miners with the inclusion of different financial instruments ranging from unconditional redundancy payments to reskilling courses. Policy instruments were also introduced for coal-dependent communities, such as preferential term loans

[14] Halimatussadiah A et al. 2024 Employment Impacts of Energy Transition in Indonesia. LPEM-FEB UI Working Paper 081

[15] Ibid.

[16] Climate Analytics & Solutions for Our Climate (2021). Employment opportunities from a coal-to-renewables transition in South Korea

Country	Brief description
	and special conditions for property acquisition. In April 2021, the government agreed to provide coal miners with early retirement at 80% of their salary and a severance pay of up to US$32,000, to mitigate the adverse impacts of phasing out coal by 2049.
 Greece	A pilot programme implemented across three Greek municipalities implemented three main active labour market programmes (ALMPs) including wage subsidies, entrepreneurship, and demand-responsive training (theoretical training and internship). The pilot highlighted the need for training programmes to focus on identified skill gaps and the importance of partnerships with key stakeholders (ie, employer associations) to address the barriers to employment opportunities.
 South Africa	The government introduced the National Employment Vulnerability Assessment (NEVA) and sector job resilience plans (SJRPs) to ensure a just energy transition. The NEVA is meant to assess the impact of climate change on jobs to identify required interventions while the SJRP aims at exploring job creation opportunities.

Source: CIF (2023)

Local communities

CFPP also sustain local economies through supplier contracts, tax contributions, and induced household spending. Coal repurposing could have adverse impacts on the local economy, depending on the ability of the local administration to absorb the shock and develop alternative opportunities. The resulting loss of stable income sources undermines household welfare and can exacerbate inequality in coal-dependent regions. When such capacity is limited, the closure or phase-down of a coal plant can accelerate economic decline and reduce community resilience.

Under a phase-down approach, communities could retain some revenue and supplier linkages, but the gradual contraction of coal activity creates prolonged uncertainty. Local governments may struggle to plan effectively when faced with shrinking yet unpredictable revenues. Households, too, may delay major investments or migration decisions in anticipation of eventual retirement. Over time, this uncertainty can weaken community resilience and erode social cohesion, even in the absence of an outright closure.

Designing a plan early on in the process is therefore critical to address any livelihood challenges faced by the local community due to the closure or repurposing of the CFPP. The international experience shows that these measures should aim to strengthen the local economy, improve infrastructure and promote community cohesion, and can be grouped into:

- Short-term measures to alleviate poverty through welfare payments for early retirement, as in Spain.
- Medium-term measures targeting job creation by capitalising on existing skills and providing support for reskilling.
- Long-term measures supporting education and innovation and providing a workforce for the new focus industries.

Gender Equality, Disability, and Social Inclusion

Workforce transition is a structural gender issue as energy sectors tend to be male dominated in technical and operational roles associated with relatively high and stable wages, while women are disproportionately represented in informal service roles and often underrepresented in new energy sectors unless explicitly targeted. Additionally, women-headed households relying on small enterprise and informal work near the plant area are likely to be impacted by the decline in local demand and face economic vulnerabilities[17].

Without targeted inclusion strategies, coal repurposing risks can exacerbate gender gaps. The just transition guidelines from ILO (2015) emphasise the need for policy frameworks to support justice and social inclusion in energy transition job markets[18]. This is particularly relevant for repurposing pathways such as renewable repowering or non-energy reuse that are more likely to displace coal-specific skillsets and create new jobs that may require different qualifications compared to incremental options such as flexibility and co-firing that may preserve employment structures in the short-term. It is critical to undertake early workforce planning including gender-disaggregated analysis and retraining opportunities.

Box 3 Gendered impacts of CFPP retirement in Indonesia

A 2024 study by CELIOS and Yayasan Indonesia CERAH examined the socio-economic impacts of early retirement of selected Indonesian CFPPs, including Cirebon-1. It highlights gendered income impacts and household vulnerabilities associated with coal repurposing. Although coal employment is predominantly male, income shocks can disproportionately affect women through reduced household financial stability, increased unpaid care work and economic stress. Displaced workers may also move into manufacturing, logistics and services, potentially increasing competition in traditionally female-dominated, low-wage sectors. Targeted labour transition policies are therefore needed to avoid reinforcing gender inequalities. The study further finds that gender intersects with disability, income, age and indigenous identity, compounding risks for communities with limited economic diversification, indigenous groups and informal workers. GEDSI integration should therefore extend beyond reskilling to include gender-responsive labour transition programmes, household-level socio-economic assessments, inclusive stakeholder engagement and targeted support for vulnerable groups. While flexibility retrofits or grid services may reduce displacement risks compared with retirement, they also require proactive GEDSI planning to address broader social and gendered vulnerabilities.

Source: Yayasan Indonesia CERAH & Centre for Economic and Law Studies (CELIOS) (2024)

Repurposing can create new economic opportunities and can pave the way for more activities beyond extractive industries and coal generation sectors, with the potential to broaden employment pathways, with diverse impacts on women, youth and people with disabilities. However, without explicit inclusion policies, women and marginalised groups may be excluded from training or face workplace barriers, or local communities may not benefit from new investments, highlighting the need for transition frameworks to align coal repurposing with broader development objectives.

[17] Asia-Pacific Portal for Gender Equality (2024). Gender equality enables a just energy transition. 20 November 2024

[18] International Labour Organization (ILO) (2015). Guidelines for a just transition towards environmentally sustainable economies and societies for all. Geneva: International Labour Organization

4.5. Implementation

Once repurposing pathways have been shortlisted, the pre-feasibility study should assess their implementation requirements, risks, and enabling conditions. It should identify barriers, clarify institutional responsibilities, and define the steps required to progress toward full feasibility and investment.

The assessment should cover:

- Operational, financial, legal, contractual, social, and environmental risks, together with potential mitigation measures.
- Stakeholder and institutional roles, responsibilities, and coordination requirements.
- A preliminary implementation roadmap with sequenced actions, including early coordination among system operators, regulators, and asset owners.
- Potential transitional revenue mechanisms and financing or investment structures.

4.5.1. Risk identification and mitigation

Among these steps, the pre-feasibility study must also assess risks and how to mitigate them. Risk identification and mitigation focus on managing operational and system risks associated with the selected repurposing pathway during the transition phase. For instance, flexible coal deployment requires key guardrails such as maintaining minimum technical operating limits to avoid accelerated asset degradation, prioritising flexibility roles such as ramping support and reserve provision over prolonged energy dispatch, aligning flexible operation with grid stability needs including inertia and voltage support, and avoiding retrofit decisions that could create long-term lock-in beyond the intended transition horizon[19].

An overview of the key typologies of risk and potential mitigation measures as well as how these should be incorporated in a pre-feasibility study is provide in **Error! Reference source not found.**.

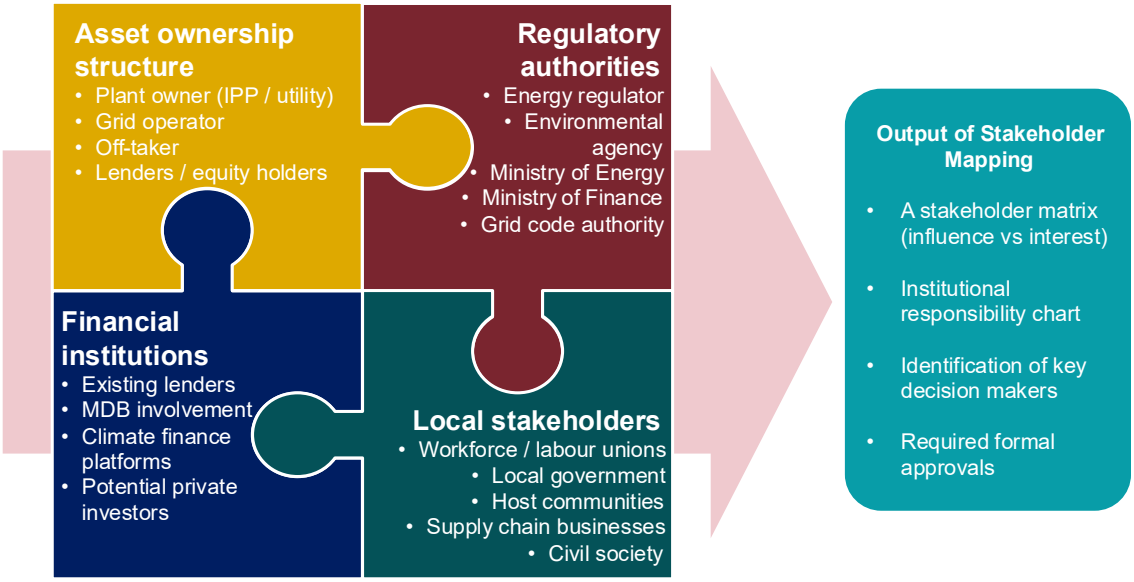
4.5.2. Stakeholder engagement

Stakeholder and institutional mapping

The successful implementation of CFPP repurposing requires the involvement of a wide range of institution and stakeholders. The first step is to conduct a comprehensive stakeholder and institutional mapping to clarify the roles, responsibilities, and coordination mechanisms required to operationalise repurposing pathways. Figure 10 provides an overview of a stakeholder mapping exercise.

[19] CTC (2025). From Flex to Phase-Out. Technical Report of Coal Transition Commission Assessing the Role of Coal Flexibility in Accelerating Coal-to-Clean Transitions in Emerging Markets and Developing Economies

Figure 10 Stakeholder mapping



Source: ECA under the Green Grid Rising Workstream I, ASEAN-UK Green Transition Fund – Clean and Just Energy Transition

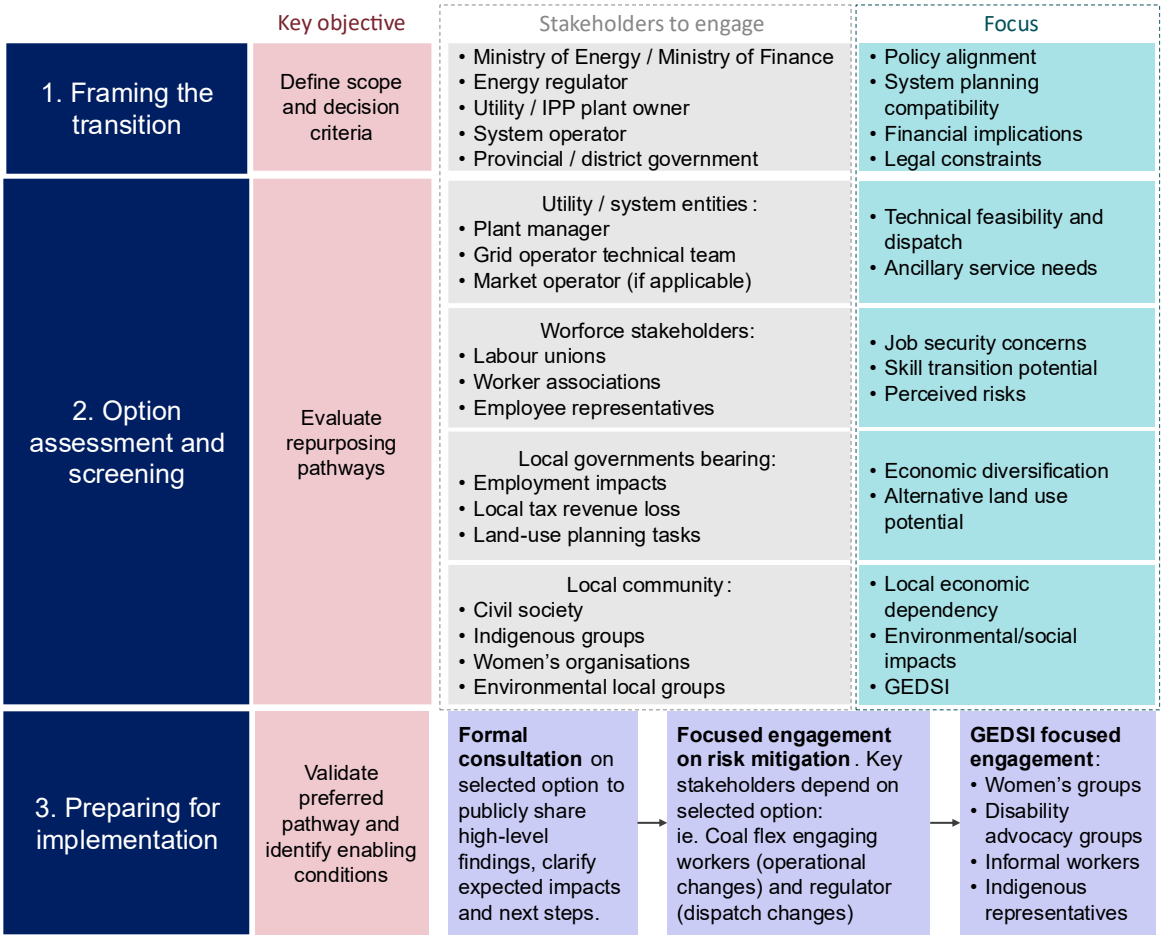
Stakeholder engagement

Engagement should include utilities, system operators, workers, communities, local governments, and vulnerable groups. Women, Indigenous Peoples, informal workers, and other at-risk groups should be represented to ensure the process is inclusive and socially legitimate. Engagement should be transparent, accessible, and sensitive to local conditions. It should communicate potential impacts on jobs, tariffs, environmental remediation, and site redevelopment, supported by gender-disaggregated and social vulnerability data[20].

At the pre-feasibility stage, engagement should gather local knowledge, identify social and political risks, incorporate community priorities, and refine the repurposing pathway where necessary. The engagement process and the parties to engage should be aligned with each phase of the pre-feasibility study, as illustrated below.

[20] ILO (2015). Guidelines for a just transition towards environmentally sustainable economies and societies for all. International Labour Organization

Figure 11 Stakeholder engagement by phase



Source: ECA under the Green Grid Rising Workstream I, ASEAN-UK Green Transition Fund – Clean and Just Energy Transition

The pre-feasibility study should include a concise stakeholder mapping with an engagement schedule by phase alongside a summary of key consultation findings, identified concerns and mitigation measures to ensure stakeholder engagement is part of the formal analytic process rather than an informal outreach activity.

The New Climate Institute highlights it is also critical for engagement strategies to be tailored to the specific stakeholder group that is being engaged and the role it plays in the coal transition[21]:

- Government stakeholders: Support ambitious, climate-aligned coal phase-out strategies, strengthen institutional capacity, and identify public financing instruments. Government ownership can be supported through technical committees or inter-ministerial task forces.

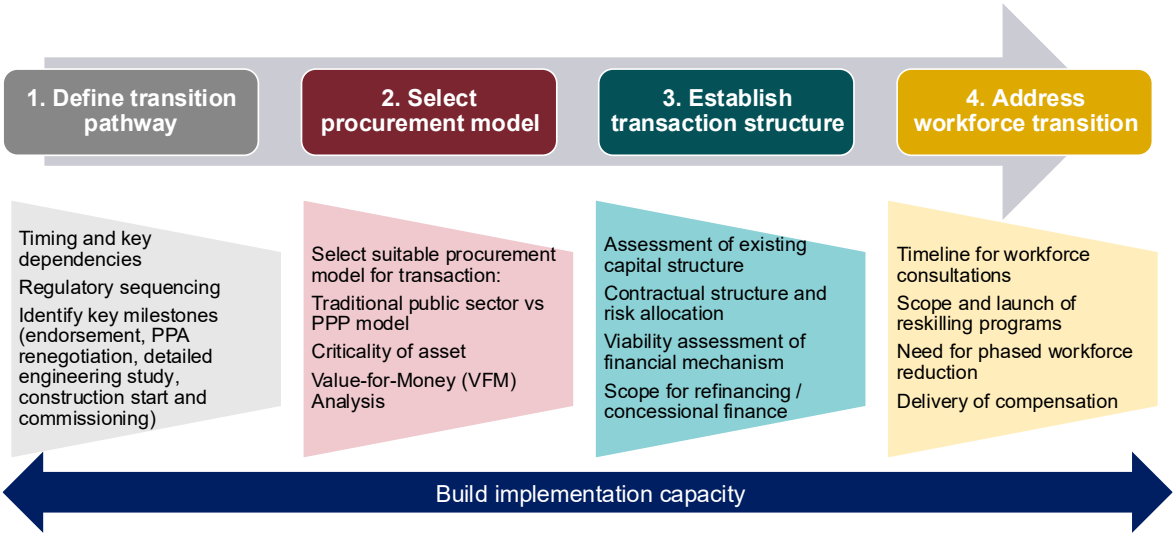
[21] NewClimate & I4CE (2024). Financing coal phase-out: Public development banks' role in the early retirement of coal plants

- Utilities: Address business-model changes, mobilisation of private capital for renewables and storage, integrated resource planning, and decommissioning and site-remediation requirements.
- Independent power producers: Review PPAs to identify barriers to repurposing and assess options for contract termination or restructuring. Bilateral consultations, legal reviews, and structured negotiation forums can support transparent agreements.

4.5.3. Preliminary implementation roadmap

A preliminary implementation roadmap translates shortlisted repurposing pathways into sequenced enabling actions, focusing on regulatory readiness, procurement preparation, and financing structuring required to operationalise coal transition initiatives. Rather than defining fixed timelines, the roadmap prioritises early coordination between system operators, regulators, and asset owners to reduce delivery risks and clarify institutional responsibilities, supporting the design of competitive procurement processes, transitional revenue mechanisms, and investment structures that recognise the system value of flexibility and grid services, among other options[22],[23]. Coal transition financing frameworks also need to be considered to assess the role of blended finance, risk-sharing instruments, and phased contracting strategies to mobilise capital while maintaining system reliability during the transition period[24]. An overview of a preliminary roadmap for implementation is illustrated in Figure 12.

Figure 12 Preliminary implementation roadmap



Source: ECA under the Green Grid Rising Workstream I, ASEAN-UK Green Transition Fund – Clean and Just Energy Transition

- **The first step is to define the selected transition pathway and identify the key milestones**, including government endorsement, PPA renegotiation agreements and

[22] CIF (2023). ReACT. A simplified Guide to Repurpose Coal Assets. Climate Investment Funds. March 2023

[23] CTC (2024). Accelerating Coal-to-Clean Energy Transitions: First Report and Recommendations of the Coal Transition Commission. November 2024

[24] RMI (2022). Guidelines for financing a credible coal transition. A framework for assessing the climate and social outcomes of coal transition mechanisms. November 2022

regulatory approvals where required, detailed engineering studies, decommissioning of the existing asset (where relevant) or construction (and operation) of the new asset and commissioning.

- **The next step is to select a suitable procurement model** for the repurposing transaction which could follow a traditional public sector model or a public-private partnership (PPP) structure. The choice will depend on the criticality of the asset as the repurposing of certain CFPPs of strategic relevance to the off-taker may need to be handled by the government or state-owned enterprises. For non-critical assets, value-for-money analysis can be used to make the selection by comparing the whole-of-life cost of repurposing the CFPP under alternative models. PPPs may offer increased financial flexibility by aligning expenditures over the life of the asset, enhance performance through best practices by private sector and optimise risk allocation[25].

- **To establish a framework for implementing the transaction,** a detailed commercial and risk assessment should be undertaken covering:

    - Existing capital structure of the asset – In the case of IPPs with outstanding debt, for instance, the assessment should consider the cost of penalties and other implications of lenders seeking repayment. For state-owned plants, if decommissioning is involved, the existing asset may need to be written off the balance sheet with accounting implications. There may also be covenants and restrictions to be managed at the government level.

    - Contractual structure and risk allocation – Considerations must be provided to ensure a bankable structure for the repurposing project, taking into account the unique risks associated with each repurposing solution. A detailed market assessment should be carried out to develop a risk allocation framework that is acceptable to off-takers, sponsors, lenders and other stakeholders.

    - Viability assessment – This will depend on various factors such as the existing CFPP underlying cash flows, the selected option and the proposed financial mechanism. The assessment should involve a detailed analysis of overall costs and revenues, and the requirements for any grant or concessionary support from donors. Financial incentives such as tax breaks or reductions could also be explored, as well as credit enhancement products such as partial risk guarantees, political risk insurance and liquidity guarantees to de-risk the investment. The viability assessment should also provide a competitive solution for end-consumers and take into account their perspective[73].

- **The last step is to address the workforce transition** to ensure social considerations are embedded in the process. It should clarify the timeline for workforce consultations, the launch of reskilling programmes (if relevant) whether phased workforce reduction is likely to occur and the delivery of compensation. Analysis of CFPP closure case studies showed that CFPP workers develop industry-

[25] CIF (2023). ReACT. A simplified Guide to Repurpose Coal Assets. Climate Investment Funds. March 2023

related specific skills on the job site and face significant challenges in transitioning to well-paying jobs with similar standing and quality given their specific skills.

Throughout each stage, it is also critical to assess and built internal capacity to structure and implement the selected repurposing option, with support and technical assistance provided by development finance institutions, if required.

Annex A Overview of CFPP repurposing options

Coal phase-down

Coal phase-down repurposing options offer a limited, transitional solution in ASEAN's energy transition journey. While they can deliver near-term emissions reductions over the remaining operating life of a CFPP, they are not substitutes for plant retirement and phase-out. Accordingly, such measures must be strictly time-bound, must not involve capital investments that extend the technical, operational, or commercial life of the asset, and must be undertaken only within the context of a defined and adequately funded decommissioning plan.

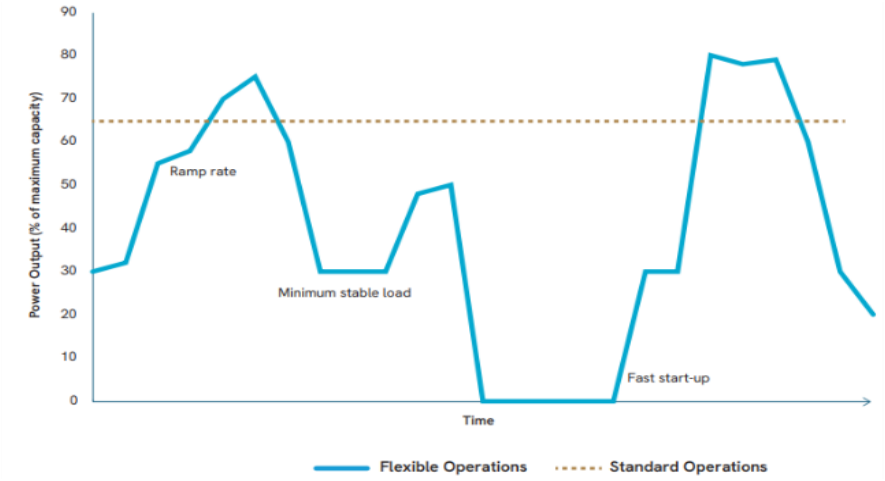
Crucially, coal phase-down should not be considered as a potential replacement for coal phase-out, which must remain the ultimate goal to ensure ASEAN countries stay on track to meet their climate commitments. However, they can act as useful tools for combined repurposing pathways, supporting ASEAN to reduce emissions intensity in the near-term.

Reducing utilisation

Flexible coal refit – Flexible coal refitting involves implementing technical upgrades and operational changes to allow a coal unit to respond dynamically to system requirements and operate reliably at varying load levels, as opposed to traditional baseload operation. This allows the plant's utilisation to be reduced, with the focus shifting towards providing balancing and residual load services. Typical measures to support this include:

- Lowering the minimum stable load - This allows the plant to remain online while renewables provide energy and ramp up faster when needed.
- Increasing ramp rates to increase the plant's ability to respond to fluctuations in renewable generation.
- Enabling faster start-up and shutdown, and modifying control systems and boilers to tolerate frequent cycling

Figure 13 Technical parameters for coal flexibility



Source: Coal Transition Commission (CTC). 2025. From Flex to Phase-Out

The flexibility this repurposing option provides can play a useful role in the short to medium-term to support the integration of additional VRE or in countries which have near-term capacity gaps as a result of rapid demand growth. It should not be considered as a repurposing option in its own right, but as an However, it should not be considered as a repurposing option in its own right, but rather an interim system stability instrument to support the transition process as part of a repurposing pathway. In particular, coal flexibility should only be considered under strict guardrails. These include the existence of a clearly defined and binding retirement date and limits on operating hours to ensure that coal is used only when necessary for system stability, and avoidance of contractual arrangements – such as PPA renegotiations – that would incentivise continued coal generation.

Strategic contingency - An alternative approach to reducing the utilisation of existing CFPPs is to transition them to acting as a strategic contingency or reserve. In this case, the relevant generation capacity is withheld from regular dispatch (but maintained so that it can continue to provide generation in extraordinary circumstances, such as extreme weather or grid outages. It can therefore support resilience and security of supply during an **interim period** which renewable generation and storage are developed.

Box 4 Chile's strategic reserve mechanism

In 2019, almost 40% of Chile's electricity generation mix relied on coal. In recent years, Chile adopted several policy changes aimed at reducing the competitiveness of coal-fired generation, forming a voluntary agreement between the Ministry of Energy and Environment, coal power companies and the Association of Power Generators (AGC) to halt unabated new coal projects and devise a strategy for the gradual shutdown of CFPPs. An initial agreement in 2019 set the early retirement of eight plants accounting for 20% of total installed capacity, subsequently accelerated by the voluntary actions of energy companies targeting a 50% reduction in installed capacity. While asset owners were not awarded any direct compensation for the phase-out, Chile introduced a back-up reserve mechanism, allowing CFPPs with 'Strategic Reserve Status' to receive remuneration equal to 60% of the existing capacity payment for up to five years post-closure, only when called on to dispatch energy to ensure security of supply.

Source: CCAP (2021); World Bank (2024)

Reducing emissions intensity

Options such as biomass/ammonia co-firing and biomass conversion can reduce the emissions intensity of coal-fired generation without fully eliminating reliance on the existing thermal asset. While these pathways may offer incremental emissions reductions under certain circumstances, they should be considered with caution. The UK international fossil fuel policy establishes a clear policy preference for the retirement of fossil fuel assets and their replacement with non-fossil energy infrastructure, with support generally directed towards clean energy alternatives[26].

A key concern is that fuel-switching or co-firing approaches may extend the economic life of existing coal-fired power plants and create incentives to maintain coal infrastructure for

[26] Department for Energy Security & Net Zero (2023). Aligning UK international support for the clean energy transition. Guidance. March 2021 (revised December 2023)

longer than would otherwise occur. For this reason, the UK policy framework emphasises decommissioning, clean energy deployment, and conversion to non-fossil energy infrastructure and highlights that any consideration of co-firing or fuel-conversion pathways should be subject to strict safeguards. This option of co-firing is out of scope of the UK funded programme and available for analytical completeness only.

Biomass co-firing - Biomass co-firing involves **partially substituting coal with sustainably sourced biomass fuels**, within an existing coal-fired boiler. At these low blending ratios, plants usually require limited retrofits and hence limited capital costs. However, the emission reductions are relatively modest and will be insufficient to meet the emission reductions in medium and long-term climate targets. There are serious limitations and risks associated with biomass co-firing. The current cost of biomass feedstock is generally not cost-effective. There are also constraints on the availability of sustainability-sourced feedstock. For eg. in Indonesia, the majority of existing biomass residue feedstock is already being utilised, so there is limited feedstock available for power generation purposes[27]. The widespread repurposing of CFPPs with biomass co-firing could necessitate diverting feedstock from existing uses and/or developing new plantations with consequent risk of deforestation and a net increase in carbon emissions.

Biomass conversion (50-100%) - Biomass conversion entails retrofitting a CFPP so that **biomass becomes the dominant or sole fuel** (typically 50-100% substitution). This typically requires more extensive modifications than co-firing, including boiler replacement or major redesign as well as new biomass handling, storage and feeding systems.

Studies have shown that biomass conversion is only profitable under the lowest assumed cost conditions, with additional capital and operational expenses generally outweighing cost savings.[28]. It is also associated with significant climate and sustainability risks, given the magnitude of feedstock which is required to achieve the desired substitution ratios. For example, the Drax plant in the UK, which has fully converted to biomass, requires imports of 7-8 million tonnes of wood pellets a year, corresponding to tens of millions of trees and requiring ship deliveries every two to three days. The plant was in 2023 the UK's largest single point-source emitter[29], and is reliant on subsidy mechanisms to operate profitably, many of which are due to be withdrawn within the next two years. There is a particularly limited use case across ASEAN, given the limited feedstock and land availability, and the significant risk of increasing lifecycle emissions.

Ammonia conversion/co-firing - Recent developments have also seen pilots, in particular in Japan, for the co-firing or conversion of CFPPs to run using ammonia. This sees low-carbon ammonia, produced by combining nitrogen with hydrogen from electrolysis or natural gas with CO_2 capture, blended with coal or fully replacing coal in an existing unit. The trials to date have used only relatively limited blending ratios (up to 20%) and achieving more than 50% co-firing is unlikely to be feasible in the near to medium future.

As with biomass, low blends have limited capital costs, while higher blends and full conversions require significant retrofits. However, low-carbon ammonia (made by combining)

[27] CREA. 2025. Biomass Co-Firing in Indonesia.
[28] RMI (2024). Finding (Re)Purpose: The Power of a Pre-Feasibility Analysis in Coal Repurposing
[29] The Guardian (2024). Biomass power station produced four times emissions of UK coal plant

can be significantly more expensive than coal per unit energy. Estimates show that 20% co-firing is up to four times more expensive than replacing it with solar or wind power per tonne of CO_2 avoided[30].

The ammonia production process is also associated with significant emissions and other environmental risks. Analysis has shown that co-firing ammonia with coal will increase air pollution substantially, increasing toxic particles by 67% at 20% blending rates and by 167% at 50% co-firing rates[31]. As a result, while ammonia pathways may continue to be explored in specific exploratory contexts, they should not be considered a key repurposing option in a pre-feasibility analysis in most ASEAN countries.

Coal phase-out

Clean energy uses

One of the most important advantages of coal repurposing lies in the ability to reuse existing grid connection infrastructure. CFPPs are typically connected to high-capacity transmission networks and are located at strategically important nodes within the power system. These connections can be extremely valuable in enabling new energy uses, reducing the cost and timeline of repurposing and facilitating the deployment of renewable energy and storage and new transmission links and interconnectors to support the resilience of the power systems[32]. This is particularly true in contexts where there are bottlenecks and long lead times for the development of new grid connections. From a planning perspective, **repurposing strategies that maximise the use of existing grid connections, such as BESS, synchronous condensers, and hybrid renewable systems, are often among the most attractive options**.

It is also worth highlighting that some repurposing pathways discussed in this section, including SMRs or abated CCGTs, **are best understood as longer-term options**. While these technologies are being actively explored in several AMS, including Indonesia and the Philippines, they are not expected to be widely deployable within the timeframes required for near-term coal transition. As shown in Section 5, such technologies have limited technical maturity and should not be prioritised in pre-feasibility study focused on near-term coal retirement, though they may be considered as part of longer-term energy system planning.

Wind / solar (+ BESS) - One of the main options for coal phase-out is to **retire the CFPP and repurpose the site for clean energy**. **Utility-scale renewables, primarily wind turbines and solar PV**, are often paired with BESS to firm output and better integrate into the grid. The coal plant is decommissioned to make the grid connection available, and the related equipment could be demolished to accommodate the site for BESS, subject to space availability and RE potential.

[30] E3G (2023). Explained: Why ammonia co-firing with coal in Southeast Asia is a risky approach

[31] CREA (2023). Air quality implications of coal-ammonia co-firing. Centre for Research on Energy and Clean Air

[32] A separate activity under the Green Grids Rising initiative is exploring interconnectors in the ASEAN Power Grid (APG), including modelling to show how these can support the resilience of power systems. Repurposing the grid connections of CFPPs to support new transmission links and interconnectors is an example of how a holistic, integrated approach to the energy transition can deliver resilience in an efficient manner.

Box 5 Switching to renewable power – Case studies from North America



The San Miguel Electric Cooperative (SMEC) power plant (410 MW), located in Christine, Texas, was originally built as a CFPP to supply rural communities in South Texas. The plant met the region's energy demand for decades until environmental regulations and coal phase-out policies led SMEC to transition to clean energy. The site was converted into an integrated 400 MW solar and 200 MW BESS facility to be completed by 2027. The project received US$1.4 billion via the USDA New Empowering Rural America Programme, including low-interest loans and grants, and is expected to serve 47 counties while achieving a 1.8 million tonnes of annual CO_2 emissions reduction.

Other examples from the developed world are Nanticoke (Canada), an old coal station converted into one of North America's largest solar facilities on the former plant site, and Brayton Point (USA) repurposed for wind generation at a retired coal plant site.

Source: ECA under the Green Grid Rising Workstream I, ASEAN-UK Green Transition Fund – Clean and Just Energy Transition

Biomass power- This option refers to the **development of a new and purpose-built biomass power plant** generating power from biomass fuels. As with the previous alternative, coal plant sites, including transmission, cooling water and land, can be reused after the coal equipment is retired or dismantled. However, feedstock availability, cost, and sustainability limit the feasibility of this option, including in the ASEAN context. Please note that biomass power is not supported under the scope of the UK-funded programme and would require separate assessment against sustainability criteria.

Waste-to-energy (WtE) - WtE entails the **conversion of municipal and industrial waste into electricity or heat**, often via combustion, gasification, or anaerobic digestion, as a productive alternative land-use for coal sites post-closure that makes beneficial use of a waste product and reduces waste to landfill, which in turn reduces methane emissions. The key challenge concerns upgrade requirements for waste collection and logistics, reflecting the need for pre-treatment to ensure suitable solid waste supply enters the system. The volume of suitable materials also defines the extent of power capacity that can be achieved.

While there is a range of components of CFPPs that could be reused for WtE applications, there are also significant differences in the fuel handling and combustion/gasification systems, which require a case-by-case assessment.

Nuclear SMR - Repurposing coal plant sites with Small Modular Reactors (SMR) is another emerging pathway to partially reuse coal infrastructure. The technology is currently not widely deployed and is largely in demonstration or planning phases. According to the SMR Global Tracker by the World Nuclear Association, only two SMR units are currently in operation globally, one in Russia and one in China. The UK has also commissioned the development of three 470 MW SMRs by Rolls-Royce, though these are not expected to come into service until the mid-2030s.

Introducing SMRs also requires extensive regulatory, institutional, and technical infrastructure, particularly in countries that do not currently operate nuclear plants. The International Atomic Energy Agency (IAEA) estimates that countries typically require at least

10-15 years from the initial political decision to introduce nuclear power to the commissioning of a first reactor. This process includes establishing a nuclear regulatory authority, developing safety and licensing frameworks, training technical personnel, and building public and institutional capacity to oversee nuclear operations[33].

Abated CCGTs - Another option is **decommissioning the coal plant and replacing it with natural gas CCGTs** with emissions abated either through the CCS or by combusting green hydrogen. These options maintain a baseload power generation source while reducing emissions through the associated abatement options. Under the CCS option, the CO_2 emissions from the CCGT would be captured and stored, removing a large share of emissions from the atmosphere, while under the green hydrogen option.

However, these options are associated with the risk of fossil fuel dependency lock-in. Replacing coal-fired generation with a new CCGT can reduce emissions relative to coal, but it remains a fossil-fuel-based pathway and consequently risks prolonging fossil fuel dependency. Consistent with the UK international fossil fuel policy, coal-to-gas replacement should therefore be considered only in limited circumstances, and only where **system need, no viable alternative, financing eligibility, decarbonisation alignment, minimising lock-in risk and abatement credibility** conditions can be demonstrated.

The abatement options are also nascent and have limited commercial use cases at scale. CCS is associated with significant costs, including the need for appropriate locations to store the carbon, while green hydrogen production is limited globally[34].

Grid services

Standalone BESS - Another option for CFPP repurposing is to decommission the coal plant and **use the grid connection for a standalone battery energy storage system (BESS)** storing and discharging electricity while providing ancillary services and providing stability to the grid. facilitating the adoption of renewables. Utility-scale BESS can help balance supply and demand for electricity during fluctuations and meet electricity demand during peak times, therefore supporting intermittency from renewable sources and facilitating their adoption. There are no direct carbon emissions from the BESS, which can enable higher integration of VRE and therefore contribute to a reduction in overall emissions. Standalone BESS facilities have minimal operational environmental impact, although battery production and disposal need to be managed responsibly. End-of-life recycling is also critical to minimise waste.

This is one of the most widely deployed coal-to-clean repurposing pathways globally, as CFPPs tend to sit at strategic grid nodes with transmission access as required by batteries. In addition, BESS are fast to deploy and compatible with early coal retirement.

Synchronous condensers - Synchronous condensers (SynCon) are large rotating machines (often converted from existing coal generators by removing the boiler and turbine coupling) **that primarily control reactive power flow,** supporting grid stability through voltage regulation, frequency stabilisation and power factor correction. As with standalone

[33] IAEA. Milestones Approach
[34] Department for Energy Security & Net Zero (2023). Aligning UK international support for the clean energy transition. Guidance. March 2021 (revised December 2023)

BESS, a critical advantage of these systems is the support provided to the grid, which facilitates the increased adoption of VRE.

On the other hand, implementing SynCon in some ASEAN countries is facing some challenges, including high capital costs for installation and maintenance, limited local technical skills and competition from alternative solutions such as BESS.

A recent study investigated the impact of the conversion of synchronous generators at Komati Power Station in South Africa (described below) to synchronous condensers for the purpose of providing grid services. The assessment estimated the conversion of an on-site generating unit of ~100 MVAR is estimated at approximately US$ 16 million versus an equivalent new build cost of US$ 24 million (ie, a saving equal to 35% of the cost of a newly built SynCon). The savings for a larger ~400 MVAR unit, more typical of Eskom's fleet, the saving amounts to 62% for the first unit and 76% for each additional unit, subject to the condition of the generating unit[35].

Box 6 Komati Power Station, South Africa

Komati Power Station, located in Mpumalanga, was commissioned in 1961 and consists of nine coal-fired generators with a total installed capacity of 1 GW. Initially mothballed in the early 1980s due to excess national generation capacity, the plant was selected in 2006 as one of Eskom's "Return to Service" sites[36].

However, decades of operation, ageing infrastructure, and increasingly stringent emissions standards rendered continued operation unviable. The 56-year-old coal plant was decommissioned as part of the Eskom Just Energy Transition Project (EJETP), a $497 million project approved by the World Bank Group in November 2022 at the request of the Government of South Africa[37]. The funds were allocated to support the decommissioning of the Komati CFPP, repurpose the project area with renewable energy and batteries, and create opportunities for workers and communities. The renewable energy selected for the displacement of coal energy closely aligns with the nation's Integrated Resource Plan (IRP) 2019 that advocates for wind and solar as least-cost energy sources that should be prioritised in the energy mix.



Source: Eskom (2025); World Bank (2023)

Non-energy uses

Reuse grid connection - Former CFPPs can be repurposed to reuse the grid connection for economic uses beyond electricity generation, such as:

[35] CSE (2024). Repurposing coal power station generators as synchronous condensers on the South African grid. CSE N°33 - June 2024

[36] Eskom. 2025. Komati Power Station

[37] World Bank. 2023. Eskom Just Energy Transition Project in South Africa

- **Green hydrogen production** – Coal sites are attractive because they often already offer strong grid connections, access to water, as well as proximity to demand centres. The main benefit of this option is that hydrogen supports decarbonisation across various industries, reusing grid and water infrastructure where possible. On the other hand, the capital costs remain very high for limited green hydrogen demand, and hydrogen production requires a large amount of electricity and clean water.

- **Data centres –** Coal plant sites can also be repurposed to host large data centres, in some cases paired with on-site renewables or BESS to manage load and reduce emissions. This alternative offers an opportunity to leverage the existing infrastructure (ie, electrical and cooling systems), promoting economic growth and environmental sustainability while reducing the need for new construction. The main challenge is the higher initial cost and energy consumption, as well as potential infrastructure technical limitations. The potential is strong in countries with fast-growing digital economics such as Malaysia, Indonesia and Viet Nam.

- **Industry or agro-industry** – Another option is to prioritise local economic development over energy functions and redeveloping former coal sites for industrial or agro-industrial uses, including manufacturing, agricultural processing and e-commerce. The main drawback is the high capital costs for retrofitting and land remediation in the case of agricultural processing to address soil and groundwater contamination from coal residues, and potential structural changes to update.

Repurposing coal sites for industrial estates or data centres can provide economically attractive pathways that preserve the value of existing infrastructure. However, these options are only aligned with energy transition objectives if the electricity supply serving the new activity is compatible with decarbonisation goals. Without this pre-requisite, there is a risk that coal generation is effectively replaced by new fossil fuel-based generation, particularly where data centres or industrial loads require a large and reliable supply. In these cases, repurposing may displace rather than reduce emissions. It is therefore critical that policymakers exploring repurposing options explicitly consider the source and carbon intensity of the electricity supply associated with the selected option and prioritise pathways linked to low-carbon sources.

Fully clear site - Finally, the coal plant could be **fully decommissioned with the land sold or transferred for alternative uses** (residential, commercial or mixed). The key advantage is that it provides a clear pathway for transitioning away from coal, eliminating long-term environmental liabilities. It can also unlock significant land value through alternative uses, provided robust land-use planning frameworks are in place, and contamination risks are addressed accordingly. The Tate Modern in the UK, described below, is a well-known example of how a decommissioned CFPP can become a pillar of the local community.

Box 7 Repurposing Bankside Power Station into the Tate Modern (UK)



A well-known example of CFPP repurposing for non-energy use is the transformation of the former Bankside Power Station into the Tate Modern, one of the world's most visited contemporary art museums. The power station was originally built in the 1940s and operated as a CFPP site, subsequently converted to use oil, supplying electricity to London. The facility was decommissioned in 1981 and remained unused for nearly two decades before being selected as the site for a new museum of modern art. The conversion was completed in 2000 and preserved much of the original architecture while adapting the interior for exhibition spaces, public galleries and cultural events, showing how former CFPPs can be reused for cultural uses, particularly in prominent locations near city centres or where land values and redevelopment demand can support large-scale cultural projects.

Source: History of Tate Modern

Annex B Technology Readiness Index

Technology Readiness Index

TRL	Stage	Description
TRL9	Operations	The technology is being operationally used in an active facility
TRL8	Active Commissioning	The technology is undergoing active commissioning
TRL7	Inactive Commissioning	The technology is undergoing inactive commissioning. This can include works testing and factory trials, but it will be on the final designed equipment, which will be tested using inactive simulants comparable to those expected during operations. Testing at or near full throughput will be expected
TRL6	Large Scale	The technology is undergoing testing at or near full-scale size. The design will not have been finalised, and the equipment will be in the process of modification. It may use a limited range of simulants and not achieve full throughput
TRL5	Pilot Scale	The technology is undergoing testing at a small to medium scale size in order to demonstrate specific aspects of the design
TRL4	Bench Scale	The technology is starting to be developed in a laboratory or research facility
TRL3	Proof of Concept	Demonstration, in principle, that the invention has the potential to work
TRL2	Invention and Research	A practical application is invented, or the investigation of phenomena, the acquisition of new knowledge, or the correction and integration of previous knowledge
TRL1	Basic principles	The basic properties have been established

Source: UK Government (Nuclear Decommissioning Authority). 2014. Guidance on Technology Readiness Levels

Annex C Risk identification and mitigation matrix

Overview of key risks and mitigation measures

Risks	Examples of risk in CFPP repurposing	Mitigation	Pre-feasibility study output
Technical risks			
• Retrofit performance uncertainty (ie, flexibility) • Grid integration constraints • Equipment degradation in older units • Technology immaturity (ie, hydrogen blending) • Construction integration in brownfield sites	• Coal flexibility (cycling stress on boilers) • Large-scale BESS (grid compatibility) • Hybridisation (control system integration)	• Independent engineering review • Pilot testing • Phased deployment • Conservative design assumptions	• Technical risk register • Identify detailed required engineering studies in full FS
Financial and market risks			
• Revenue uncertainty (especially for flexibility and storage) • Ancillary service market immaturity • Tariff non-recovery • Stranded asset exposure • Currency risk (if financed externally)	• Grid services in markets without formal compensation mechanisms • Early retirement with PPA termination • High-capex repowering options	• Regulatory reform (capacity payments, ancillary pricing) • Blended financing structures • Government guarantees • Risk-sharing instruments	• Identify financing enablers required before bankability

Risks	Examples of risk in CFPP repurposing	Mitigation	Pre-feasibility study output
Contractual and legal risks			
• PPA termination penalties • Take-or-pay clauses • Dispatch obligations • Licensing constraints • Land tenure ambiguities • Environmental liability transfer	• Coal flexibility (may reduce energy dispatch under energy-based PPAs) • Strategic reserve (requiring classification clarity) • Repowering (may require full contract renegotiation)	• Contract amendment frameworks • Government-facilitated renegotiation • Regulatory waivers • Explicit compensation structures • Clarify end-of-term asset ownership	• Contractual barrier matrix • Required legal reform or renegotiation steps
Environmental, social and political economy risks			
• Community opposition • Site contamination and environmental liabilities • Resistance from coal-linked interests • Utility revenue concerns • Regional economic dependence on coal	• Different impacts on alternative options: • Coal flex (low workforce disruption) • BESS (moderate construction impact) • Retirement (high employment impact)	• Early community engagement • Workforce transition programmes / reskilling • Environmental remediation planning • Phased transition design / transparent timeline for retirement • Regional diversification	• Social risk screening • Political feasibility assessment • Reform sequencing

Source: ECA under the Green Grid Rising Workstream I, ASEAN-UK Green Transition Fund – Clean and Just Energy Transition



The ASEAN-UK Green Transition Fund (GTF) is the UK's flagship programme to accelerate ASEAN's transition to a clean and climate resilient economy. ASEAN UK GTF works with ASEAN institutions and supports ASEAN Member States. This programme is delivered through the UK Partnering for Accelerated Climate Transition (UK PACT) mechanism.

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