

Growing the Pipeline of Coal-to-Clean Projects

Technical Report of the
Coal Transition Commission

November 2025

Contents

Foreword	ii
Acknowledgements	iii
Executive Summary	1
Chapter 1 The Landscape of Coal-to-Clean Projects	7
Chapter 2 Prioritising Coal Assets for Early Retirement	12
Chapter 3 Identifying Solutions for Prioritised Coal Assets	16
3.1 Types of coal-to-clean solutions	16
3.2 Applicability of solutions to plant types	20
Chapter 4 Mapping Opportunities to Build the Coal-to-Clean Project Pipeline	23
4.1 Deregulated markets	25
4.2 IPPs in single-buyer markets	28
4.3 Vertically integrated utility markets	29
Chapter 5 Unlocking the Next Wave of Coal-to-Clean Projects	30
Appendices	32
A.1: Global coal-to-clean projects	32
A.2: Global coal-to-clean initiatives	33
A.3: Data analysis methodology for global coal fleet analysis	36

Foreword

Tackling coal emissions is critical to reach the temperature goal of the Paris Agreement. It is also a key opportunity for building modern, secure, and competitive energy systems, ensuring sustainable growth, energy security and sovereignty. This is the mandate given to the Coal Transition Commission: a unique initiative chaired by France and Indonesia to discuss one of the most challenging questions of the climate and energy agenda.

Delivering this transition in emerging markets is a complex challenge, which involves rewiring energy systems while expanding access, meeting fast growing energy demand, and minimising the impact on workers and communities. Energy systems are complex, very different from one country to another, and there is no “one size fits all” solution. Each country’s pathway must be nationally driven, just and aligned with socio-economic development goals.

As set out in the Pact for Prosperity, People and the Planet, no country should have to choose between fighting poverty and addressing climate change. We need to find practical solutions, and this is exactly what the Coal Transition Commission has been doing over the last two years.

In 2025, the Coal Transition Commission has focused on generating solutions to two real challenges of transition, building on the first report published at COP29: how to scale up the pipeline of coal retirement projects, and how to quickly build the flexibility modern energy systems require.

This report focuses on the first question. Over the last five years we have seen the first coal to clean projects deliver real results, achieving substantial reductions in emissions while generating benefits for economies and communities. This report pulls out some of the key learnings and signposts routes for replicating these successes, while emphasising that no one size fits all. We need to continue to innovate to find solutions that genuinely address the broad range of challenges that different coal dependent economies face, while building the institutional and regulatory foundations where needed.

This nuanced message reflects well the ethos of our joint endeavour through the Coal Transition Commission, but also the added value of international cooperation. We know that solutions for the real world are complicated and involve careful weighing of risks and opportunities but we are committed to show that there is a pathway forwards.

We must now move to implementation. We stand ready to work with governments and utilities who are willing to take advantage of the opportunities that have been demonstrated and to support them to build country- and context-driven roadmaps, to address technical challenges and fiscal constraints and to build international support mechanisms.

The Coal Transition Commission’s members together constitute a remarkable reservoir of experience, expertise and resources that can be harnessed to help design and help deliver practical roadmaps for transition, tailored to the varied challenges coal-dependent economies face. Together we can accelerate progress towards cleaner, more secure and affordable energy systems. As we celebrate the 10th anniversary of the Paris Agreement, this fits perfectly with the collective ambition to make COP30 an “implementation COP”.



Farah Heliantina

*Assistant Deputy for Acceleration of Energy Transition,
Coordinating Ministry for Economic Affairs, Indonesia*



Benoît Faraco

*Climate Ambassador,
France*

Acknowledgements

This Coal Transition Commission (CTC) technical report is the result of extensive consultations with national policymakers, multilateral development banks, international and technical organisations, and expert bodies. Consultation workshops and meetings were held over the past year with representatives from various governments and organisations offering valuable insights and feedback. We are grateful for their input.

We would like to express our sincere thanks to RMI for conducting the technical analysis that underpins this report and for gathering and organising the experiences and reflections of those who took part in the consultations. The lead authors of this report are Fola Aminu, Diego Angel Hakim, Dhroovaa Khannan, Helen Lien, David Lone and Tyeler Matsuo.

Consultations and preparation of the report was coordinated by the Secretariat of the CTC, hosted by the Powering Past Coal Alliance, in close collaboration with the French and Indonesian governments, the co-chairs of the Coal Transition Commission. The guidance and constant support of Benoît Faraco, Climate Ambassador for the French Government, Farah Heliantina, Assistant Deputy for Accelerating the Energy Transition in the Indonesian Coordinating Ministry of Economic Affairs, and Rachmat Kaimuddin, Deputy Coordinating Minister for Basic Infrastructure in the Indonesian Coordinating Ministry of Infrastructure and Regional Development has been particularly valuable. The work of the CTC and this report have also benefited from the sustained support and input from the PPCA co-chairs, the Governments of Canada and the UK.

Special thanks go to the following organisations and initiatives for their valuable contributions:

The Governments of Germany, Kazakhstan, Pakistan and Singapore, South Africa's Presidential Commission (PCC) and the European External Action Service (EEAS), as well as the Asian Development Bank (ADB), Bloomberg Philanthropies (Annya Shneider), Carbon Trust, Climate Imperative, Climate Investment Funds (CIF), ClimateWorks Foundation (Shoon So Oo), Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ and IKI JET), E3G, Growald Climate Fund, Iniciativa Climática de México, The Institute for Climate Economics (I4CE), Inter-American Development Bank Invest (IDB Invest), the Monetary Authority of Singapore (MAS), Pooled Fund on International Energy (PIE), Private Power and Infrastructure Board (PPIB, Pakistan), The Rockefeller Foundation, SEA Energy Transition Partnership (UNOPS), Tara Climate Foundation and the World Bank.

While the authors and the Secretariat of the Coal Transition Commission have done their best to reflect the valuable insights provided by all of these organisations, we recognise that our efforts have been at best partial. The final text of the report has been prepared by the Secretariat of the Coal Transition Commission and should not be taken as representing the views of any of the above organisations.

Executive Summary

Despite the clear economic, energy security, climate and health imperatives driving a growing number of countries to accelerate their coal-to-clean transitions, the pipeline of bankable projects remains limited. Closing this implementation gap is a central issue that will need to be addressed to support acceleration of coal-to-clean transitions, especially in emerging markets and developing economies (EMDEs). However, countries looking to accelerate the transition from coal to clean energy face significant challenges. These include difficulties in integrating clean energy resources at the pace required to meet rising energy demands and the important role the coal industry can play in creating livelihoods for workers and communities. EMDEs are often dealing with the added challenge of a young – and for the most part currently profitable – coal fleet with outstanding contractual and financial obligations. These conditions create barriers to coal-to-clean replacement, even if the economics, energy security and other policy and regulations (e.g., pollution regulations) increasingly point to the benefits of clean technologies. As a result, power systems worldwide continue to rely heavily on coal-fired power, which represented 35% of global power generation in 2024.¹

The past five years have seen some promising innovation in early coal retirement and clean replacement projects (or coal-to-clean projects). Pioneering coal-to-clean projects have delivered substantial emissions reductions while delivering benefits for plant owners, communities, electricity customers, and countries, demonstrating the potential to deploy practical solutions where supportive enabling conditions are in place. Many of these projects have paired enabling conditions – such as supportive policy environments, political commitments, power sector plans, and conditions that support clean energy deployment and integration – with innovative financial, technical and contractual solutions that can serve as a starting point for scaling, whether through their replication or by informing broader enabling policy and planning.

Although some of the first coal-to-clean pilots have now been completed, providing real-world success cases, the pipeline of coal-to-clean projects has been slow to scale in EMDEs. Originating coal-to-clean projects requires a baseline of political and economic willingness within a country to discuss and engage with coal transition. From this foundation, project origination typically involves:

- Identifying promising assets to transition, considering factors such as alignment with power sector development plans, energy security, industrial competitiveness, social impacts, emissions and health impacts, and other policy goals.
- Finding viable solutions for prioritised assets.
- Coordinating approvals and implementation across diverse stakeholder groups.

Each of these steps has often entailed bespoke, iterative processes, requiring significant resources to support a single project from its inception to its execution. While coal-to-clean project origination is unlikely to be standardised, there are emerging lessons to learn from pilot projects and initiatives to inform continued efforts to build the pipeline of projects globally.

¹ International Energy Agency, Global Energy Review, 2025.

This report aims to identify opportunities and strategies to scale the pipeline of coal-to-clean projects in line with recommendations from the Coal Transition Commission's (CTC) 2024 report, which highlighted early coal asset retirement as the most important long-term lever to reduce coal power emissions, representing an estimated two-thirds of necessary emissions reductions in a 1.5°C-consistent pathway.² In particular, this report takes stock of lessons learnt across geographies and projects to identify:

- How coal-to-clean projects have originated to date (Chapter 1).
- Factors that influence the transition-readiness of assets and the tools available to support policymakers and power sector planners to prioritise assets for early retirement (Chapter 2).
- Existing and emerging solutions to enable early coal retirement and clean replacement and how they may be replicated across the global coal fleet (Chapter 3).
- Specific opportunities to grow the coal-to-clean project pipeline in different markets (Chapter 4).
- Recommendations for unlocking the next wave of projects (Chapter 5).

Key findings

The findings below are not intended to be prescriptive but rather provide indicative direction for potential coal-to-clean project opportunities and gaps, with the hope that policymakers, public or private energy generation companies, financial institutions and other key stakeholders use it as a foundation for informed dialogue and collaborative action. They are based on an assessment of a subset of the global coal fleet against two factors: 1) transition-readiness based on key enabling conditions at the country level;³ and 2) the applicability of existing coal-to-clean solutions at the asset level.⁴ It is intended as a first pass to highlight markets and asset types where there may be stronger near-term opportunities as well as key gaps to originating additional projects. Notably, coal fleets in a single country or region may span multiple readiness levels according to the three categories outlined below.

Category 1: An estimated 150 GW – representing 34% of the assessed coal fleet⁵ – exhibits significant near-term opportunity for early retirement and clean replacement, with notable opportunities emerging in East Asia, Europe, and some IPP coal plants in the ASEAN block.⁶ This includes coal plants where country-level factors are more likely to provide the enabling conditions for early coal retirement and where proven solutions (i.e., mechanisms already deployed in projects successfully) could apply. Almost 80% of this capacity includes plants owned by independent power producers (IPPs), and particularly young to mid-aged assets. As a result of their age, these plants offer potential for significant emissions reductions impact if meaningful early retirement can be incentivised.

² Coal Transition Commission, Accelerating Coal to-Clean Energy Transitions, 2024.

³ Enabling conditions assessed include: climate commitments, relevant policies, renewable energy and energy storage deployment, and financing environments among others. See Appendix A.3. for more.

⁴ Most operating coal plants today are providing important grid services, which will often require a portfolio of replacement solutions. This assessment was unable to assess the asset-specific replacement needs and its technical viability, but instead identified country-level markers for readiness, such as renewable energy and storage deployment. Similarly, it did not conduct a financial analysis at the asset level, but identified where certain coal-to-clean solutions are likely to be applicable.

⁵ The analysis currently excludes coal assets in China, India, and the United States, as these markets all have sizeable coal fleets with significant variation in market structure and enabling conditions at a subnational level. Assessing these markets would require greater data and analytical granularity, which could be the focus of future work. Coal assets in North Korea and Russia were also excluded from the analysis.

⁶ Particularly for ASEAN coal assets operating in deregulated markets and/or owned by IPPs.

Though these younger IPP-owned assets tend to have outstanding debt obligations and plant value, which can pose barriers to their early retirement, they are also more likely to present opportunities to refinance debt, adjust existing contracts, or tap into other revenue streams like transition credits or results-based finance to support their early retirement. In the Philippines, for example, an estimated 70% of the fleet could explore the deployment of existing coal-to-clean financing solutions – particularly structures such as debt refinancing or relevering. These asset types are also where stronger project precedents exist, such as the South Luzon Thermal Energy Corporation project in the Philippines or Engie Energia's Tocopilla project in Chile. Near-term opportunities also exist in pockets in some single-buyer markets and vertically-integrated markets with high shares of IPP participation, such as Malaysia, Thailand, Indonesia – especially for plants that have existing asset-level debt that presents opportunities for relevering or refinancing.

Category 2: In contrast, 170 GW (~38% of the assessed coal fleet) exhibits stronger enabling conditions at a country level, but do not yet have a pathway to implement proven coal-to-clean solutions. These conditions are exhibited in a notable share of assets in East Asia, ASEAN,⁷ Europe, and in Latin America & the Caribbean (LAC). Within this group are some vertically integrated utility (VIU)-owned assets (e.g., roughly half of the capacity in Malaysia and in Indonesia still requires proving out and innovation in solutions, especially for utility-owned assets).⁸ Since VIUs often own large portions of national coal fleets, piloting innovative approaches in these contexts could have high scaling potential by demonstrating pathways for system-wide transition. However, most of the proven coal retirement solutions are more applicable to assets with well-defined financing and remuneration, rather than the corporate financing and tariff models typical of VIUs. Further, many VIUs may be facing financial constraints (e.g., due to debt levels, credit rating or access to finance) that limit their ability to utilise innovative financing solutions, particularly where solutions require them to take on additional debt in the near term.

This group of assets also includes older IPP-owned coal assets (>20 years). Although older coal assets are less likely to have outstanding obligations that prevent their retirement, many have recovered their capital costs, are still providing energy services, and are both profitable and required in the grid as a result. For example, Colombia has enabling conditions at the country level but requires solutions to support the transition and replacement of older coal assets that are providing capacity services. In Kazakhstan, financing solutions and incentives are required to support the transition of older coal plants providing combined heat and power.

Plant owners therefore require financial incentives to transition to clean alternatives, but are less able to tap into concessional financing or transition credit revenue to support that transition due to perceived credibility risks. While to date, retiring older assets has been perceived as less impactful compared to targeting younger plants, near-term action to enable the transition of these older coal assets could still provide both direct and catalytic impact. Countries may be more interested in first prioritising and testing solutions for their older plants before considering scaling to their younger coal assets, and retiring a coal plant even a few years early can deliver meaningful emissions reductions – particularly for less efficient, emissions-intensive plants. Further, the opportunity to utilise existing grid infrastructure and deploy less mature but critical clean energy solutions, such as standalone storage, on coal plant sites offers further catalytic potential to enable the coal-to-clean transition moving forward.

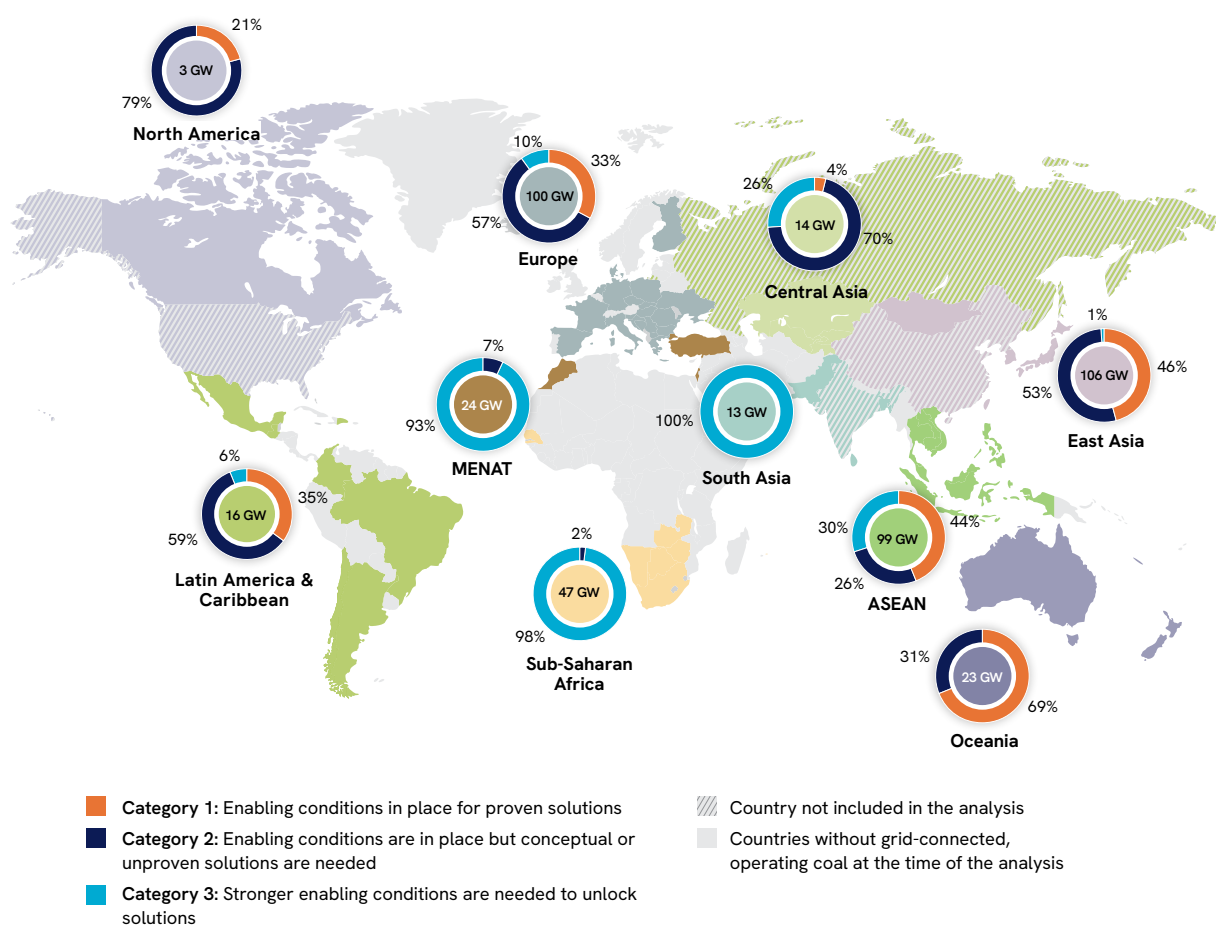
⁷ Applicable particularly to assets owned and operated by vertically integrated utilities (VIUs).

⁸ VIUs are utilities that own and operate all three types of electric grid assets: generation, transmission and distribution. In EMDEs, many VIUs are state-owned (public) utilities as well.

Category 3: Approximately 125 GW (~28% of the assessed coal fleet) is in markets where stronger enabling conditions are needed to scale action at the asset level, which includes a significant share of coal capacity in Sub-Saharan Africa, South Asia, ASEAN, and the Middle East, North Africa & Türkiye (MENAT). Several of these include markets with both young, VIU-owned plants and where coal represents a significant share of existing generation. While efforts to strengthen enabling conditions will be critical to scale coal-to-clean projects in these markets, in the near term pilots may still be valuable, but may require the use of concessional finance to support project viability. Such pilots not only provide significant emissions impact, but can also build ambition, inform broader policy shifts, and de-risk approaches and tools that will be needed to eventually scale action across the coal fleet.

Alongside project-level pilots, however, it is critical to address systemic enabling conditions. While the enabling conditions and constraints will vary, across many of these markets, two important enablers may help unlock additional coal-to-clean projects: 1) stronger conditions for renewable energy (RE) deployment, including grid flexibility to support RE integration; and 2) stronger political engagement, commitments and plans to enable coal transition, which can support the credibility of financing to support coal-to-clean projects in a country, especially in countries with high coal dependency.

Applicability of coal-to-clean solutions by region



Summary of recommendations

Taken together, the findings highlight that opportunities to accelerate coal-to-clean transitions are real but uneven. Proven solutions are concentrated in younger, IPP-owned assets, while assets held by vertically integrated utilities and older plants often fall outside the scope of existing solutions. And in many markets, the absence of strong enabling conditions remains a significant constraint. The recommendations that follow outline how stakeholders can act on these dynamics to grow the global pipeline of coal-to-clean projects.

Recommendation one (Category 1) – Scale the pipeline of projects that can deploy proven solutions:

In countries with strong enabling conditions, including stronger policies, plans, and conditions that support deployment and integration of renewable energy, the priority should be to replicate and scale proven solutions. Debt refinancing or other cost of capital solutions offer an opportunity for replication for young to middle-aged IPP coal plants, particularly when coal retirement can be combined with new clean energy investments that offer upside to investors. To support replication and scaling, MDBs and DFIs could support private capital mobilisation, through standardisation of project parameters, such as GHG emissions impact assessment and calibration, as well as complementary risk mitigation structures and solutions targeted at coal-to-clean projects. In addition, countries can consider testing coal-to-clean procurement mechanisms (e.g., domestic auctions for clean energy paired with coal retirement), as was recommended in the 2024 report.

Recommendation two (Category 2) – Prove out emerging solutions with high scaling potential:

The analysis shows that, at a global level, at least one proven coal-to-clean solution, such as debt refinancing or relevering, could support the transition of approximately 33% of the assessed coal fleet (out of 445 GW grid connected coal capacity analysed across 61 countries). Several other coal-to-clean solutions – including additional revenue models such as transition credits, or contractual solutions such as coal-to-clean PPA switching – offer strong potential for replication across the coal fleet, but require additional proof-of-concept and testing in real projects. Some IPP-owned plants are already undergoing feasibility assessments for transition credits. Continuing to develop guardrails and stress-test credible transition crediting approaches in different markets and contexts will be critical to understand risks and replicability. In particular, piloting a transition credit project for a VIU-owned asset can be an important first step to assessing their potential to address some of the ~130 GW of coal in regulated markets. For coal-to-clean PPA projects, contract renegotiation and procurement can be complex and bespoke. As system operators and regulators learn from initial projects, they can work to increasingly clarify contract renegotiation processes.

Recommendation three (Category 2) – Innovate where solutions are still needed: Many assets do not fit neatly into proven models. These contexts require targeted innovation, particularly for state-owned plants in VIU markets and older assets. Governments, public and private energy companies, financiers, and technical partners could collaborate to tailor financial, technical and policy support to develop and de-risk first-of-kind approaches. In VIU markets, solutions are needed to address the debt constraints many utilities may face. While revenue models such as transition credits offer one outlet, utilities, governments and DFIs can also explore other mechanisms, including off-balance sheet solutions, such as managed transition funds or special purpose vehicles, or debt-for-climate swaps. For older assets, especially where plants continue to provide grid services (capacity, voltage regulation), countries can explore revenue models to remunerate these services while reducing their generation and overall life. DFIs can also explore possibilities to use concessional financing

to incentivise site repurposing to clean grid solutions, particularly where these solutions are less commercially viable in EMDEs today (e.g., standalone storage, synchronous condensers).

Recommendation four (Category 3) – Build the enabling foundations where needed: In geographies where stronger enabling conditions are required, the immediate priority should be to invest in planning, institutional capacity and regulatory environment needed to unlock future coal-to-clean project pipelines. Governments and utilities can lead by setting credible phaseout targets informed by climate science and developing plans aligned with those targets. Technical assistance can help explore different solutions that enhance grid flexibility. This can help deliver clear business cases for interventions and investments that deliver renewables integration, reserving limited concessional capital for judicious deployment in pilots where absolutely essential. This along with development partners, civil society and technical experts can help build the institutional and regulatory capacity needed to attract investment and ensure equitable outcomes.

Recommendation five – Target concessional finance strategically and seek to catalyse other sorts of finance, including private and innovative finance into transactions: Concessional finance should be deployed where it can have the greatest catalytic effect. Blended finance approaches can be particularly important when piloting emerging mechanisms, such as bringing in private commercial finance as well as use of transition credits. For example, price guarantees for high-integrity transition credits can help de-risk projects while crowding in private finance for coal-to-clean projects. In markets with significant coal fleets that lack strong enabling conditions today, greater concessionality may be justified. This includes support for initial pilots, where they can build ambition or inform broader policy, or to support other enabling activities such as grid flexibility that supports RE integration.

Recommendation six – Improve coordination across the ecosystem: Support for coal-to-clean transitions remains fragmented. Even in markets with enabling conditions, a lack of coordination across project preparation components and stakeholders required to enable project approvals may slow project origination and financing. To address this, financiers can coordinate closely with governments, power sector decision-makers, and technical assistance providers to strengthen handoffs, align mandates, and share data across the project cycle. The CTC could play a convening role here, helping to consolidate lessons from early pilots and disseminate them across geographies.

CHAPTER 1

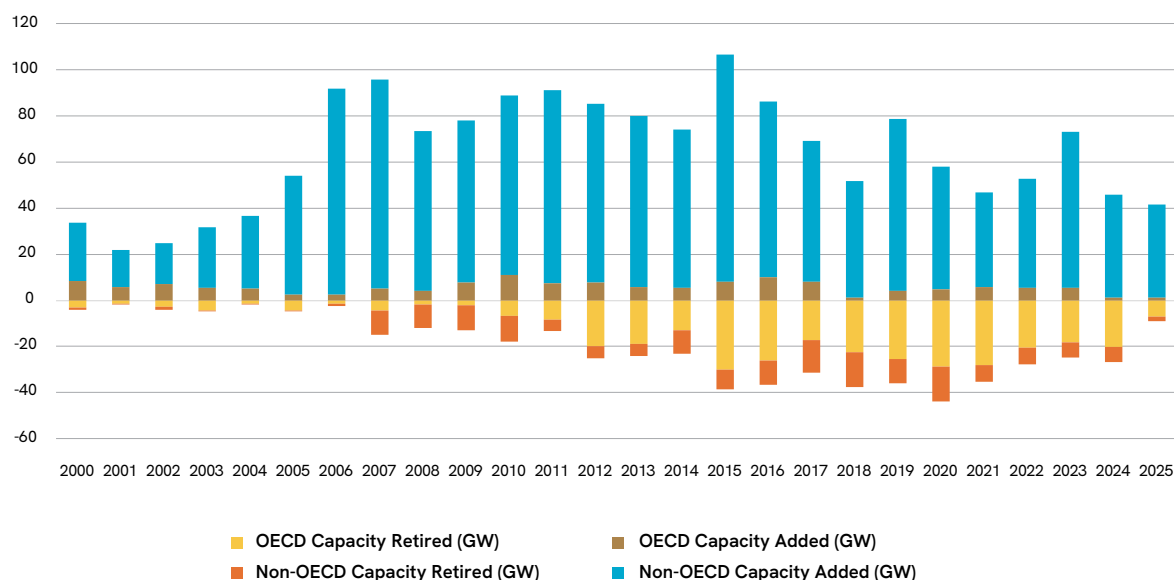
The Landscape of Coal-to-Clean Projects

Although the world's power systems still rely on over 2 TW of operating coal-fired capacity – representing 35% of global electricity generation – the direction of travel is beginning to change.^{9,10}

The pace of new coal construction is slowing, retirements are increasing, and more governments are setting phase-out targets. In 2024, global coal fleet growth slowed to its weakest pace in over 20 years.¹¹ Across OECD countries, coal generation has declined from around 36% of total electricity in 2007 to just 17% in 2023.¹² One-third of OECD nations are now coal-free, and nearly three-quarters aim to exit coal by 2030.¹³ In 2024, the UK became the first G7 nation to completely eliminate coal power.¹⁴

However, total coal capacity has continued to rise globally, and progress has varied considerably across geographies (a trend that is incompatible with the goals of the Paris Agreement, see Figure 1). In non-OECD countries, for example, net capacity additions have continued to outpace retirements: in 2024, OECD economies accounted for the majority of the 25.2 GW of global retirements, whereas China and other non-OECD regions retired only a fraction of that total.

Figure 1. Annual net change in coal-fired power capacity in OECD and non-OECD countries



⁹ Global Energy Monitor, Global Coal Plant Tracker, July 2025.

¹⁰ International Energy Agency, Global Energy Review 2025, March 2025.

¹¹ Global Energy Monitor, Boom and Bust Coal 2025, 2025.

¹² Ember, Global Electricity Review, 2024.

¹³ Powering Past Coal Alliance, Coal Phase-Out Commitments, 2024.

¹⁴ E3G, UK Coal Phase-Out Milestone, 2024.

These trends highlight key challenges facing EMDEs in their coal-to-clean transitions. In many OECD countries, certain factors have generally supported the closure and increasing retirements of coal: electricity demand growth has been less rapid, while coal plants are older and more exposed to competition from cleaner generation and regulatory pressure. In contrast, until recent years, new coal generation was often the lowest cost technology to meet growing electricity demands in EMDEs (though this is no longer the case in most markets), leaving these countries with relatively young coal fleets with significant remaining value.¹⁵ Further, the business models and contractual structures that helped support investment in these plants mean coal plants may often still be profitable, face few economic pressures to retire today, and cannot easily be closed through mandated closures or other indirect regulation, such as pollution limits.

In light of these challenges, identifying and progressing coal-to-clean projects in EMDEs has been slow, requiring dedicated, coordinated efforts to originate opportunities. To date, most opportunities have originated through a handful of well-established channels, each led by different actors and supported by distinct tools. These channels include: 1) country-led transition planning processes, 2) development finance institution-led financing, for example from multilateral development banks (MDBs), and 3) direct support to interested governments and plant owners from non-governmental technical assistance (TA) providers. Already, several of these efforts have come together to originate specific projects (see Figure 2 below). Strengthening the connections across these efforts is essential to ensure support is effective, build confidence and interest in coal-to-clean projects, and ensure lessons learned from projects are fed back into policy and planning processes.

These three origination venues are summarised below, while a more comprehensive list of specific initiatives is provided in the appendix of this report.

Country-led transition planning: Country-led transition planning evaluates coal transition projects through a multidimensional approach reflecting both national priorities and broader equitable decarbonisation principles.¹⁶ While specific processes vary by country, governments – often through energy ministries, utilities or regulators – increasingly integrate coal retirement into long-term power system planning. This involves aligning with national policy goals, modelling system reliability and reserve margins, and sequencing clean replacement and grid resources.

For example, South Africa’s Just Energy Transition Investment Plan (JET-IP) has earmarked ~15 GW of coal capacity for phased retirement by 2030, explicitly linked to plans for new renewables and grid investment.¹⁷ Similarly, in Indonesia’s Comprehensive Investment and Policy Plan (CIPP) under its Just Energy Transition Partnership (JETP), the government has identified specific coal plants to transition, prioritising those with high emissions intensity and shorter remaining power purchase agreements (PPAs).¹⁸ In Vietnam’s Eighth Power Development Plan (PDP8), the government has set criteria to limit new coal construction and signalled which existing units may retire earlier, based on age and cost competitiveness with renewables.¹⁹

¹⁵ International Renewable Energy Agency, Renewable Power Generation Costs In 2024, July 2025.

¹⁶ Just Energy Transition Partnerships; Toward a Collective Assessment, United Nations Research Institute for Social Development, 2023.

¹⁷ Presidency of the Republic of South Africa, South Africa’s Just Energy Transition Investment Plan 2023–2027, 2022.

¹⁸ Government of Indonesia, Comprehensive Investment and Policy Plan (CIPP) for the Just Energy Transition Partnership, 2023.

¹⁹ Government of Vietnam, Eighth National Power Development Plan (PDP8) 2021–2030, with a Vision to 2050, 2023.

Alongside technical and financial feasibility, governments are also embedding social criteria such as community engagement, just transition measures and employment protection in their coal transition planning. For instance, South Africa's JETP includes ring-fenced funding for worker reskilling and community transition programmes tied to coal plant closures. This structured approach has been central to JETPs and similar processes, providing a basis for shortlisting specific coal-to-clean assets for potential retirement.

Development finance institutions, such as multilateral development banks (MDBs): Development finance institutions, particularly MDBs, can act as catalysts of project origination in EMDEs. Through their engagement with countries in providing capital and policy guidance, they can often surface candidate coal-to-clean projects, working in partnership with governments, utilities and sometimes directly with plant owners. For example, through its Energy Transition Mechanism (ETM), the Asian Development Bank (ADB) has worked with governments to identify specific coal plants that could be refinanced and retired early, and to design blended finance packages to make those projects feasible.²⁰ Similarly, the Climate Investment Funds' Accelerating Coal Transition (CIF ACT) programme supports governments in various countries to prioritise coal-to-clean projects within national investment plans and link them to concessional finance and policy reforms.^{21,22}

When originating projects, MDBs and DFIs apply a wide set of criteria: alignment with national priorities, system reliability needs, financial viability, and social and environmental safeguards. In practice, this means they look for projects that can deliver manageable risks and returns, contribute to climate and development objectives, and embed just transition measures for workers and communities. Because MDBs can proactively align finance with policy priorities, their initiatives have become a critical source of project origination, not just providers of capital.

Plant owner or government demand for support from technical assistance providers: A third source of coal-to-clean projects comes from plant owners or governments that express interest in exploring early retirement for specific assets. Once this demand exists, technical assistance providers – often funded by philanthropies or bilateral donors – play a critical role in supporting projects and helping them move toward implementation.

Typically involving partnerships among international and local organisations and technical experts, technical assistance providers offer flexible support, allowing adaptation to diverse institutional and energy contexts. Generally, initiatives have focused on three core areas: asset-level viability (evaluating financial viability and needs, contractual obligations), system-level alignment (ensuring asset decisions support broader national strategies and identifying local grid needs to ensure reliability), and supporting stakeholder coordination. Examples include initiatives such as the Coal Asset Transition Accelerator (CATA), the Coal to Clean Credit Initiative (CCCI), and the Southeast Asia Energy Transition Partnership.^{23,24,25}

²⁰ Asian Development Bank, Energy Transition Mechanism: Frequently Asked Questions, 2022.

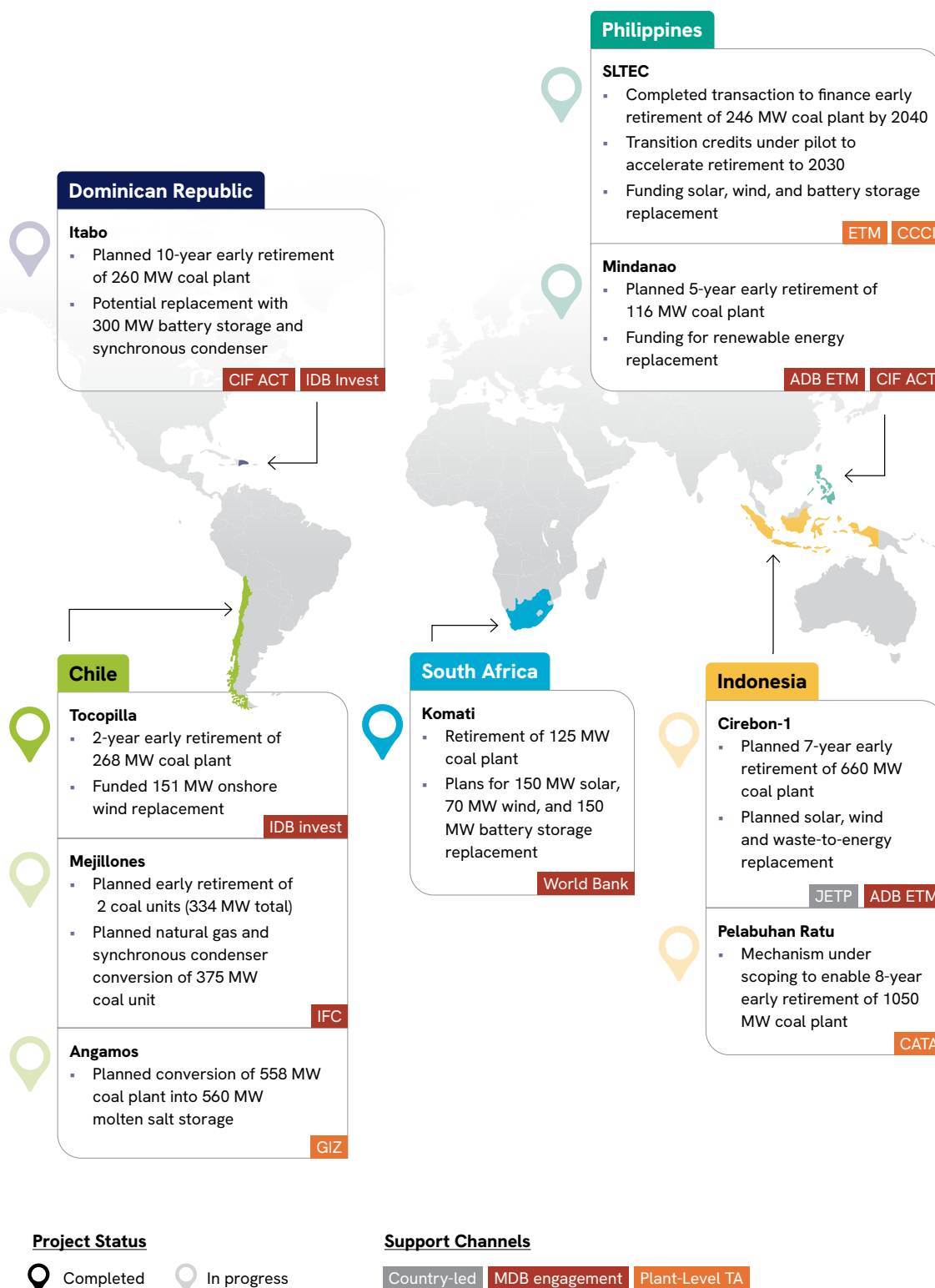
²¹ Climate Investment Funds, Accelerating Coal Transition (ACT) Investment Program, 2021.

²² Draft CIF ACT investment plans for North Macedonia and the Dominican Republic include explicit funding for just transition planning (both countries), socio-economic regeneration in coal heavy regions (North Macedonia), and strengthening institutional and regulatory frameworks (Dominican Republic) to build the enabling condition for successful coal-to-clean transitions in addition to targeted early coal asset retirement support.

²³ Coal Asset Transition Accelerator (CATA), CATA's Approach, 2021.

²⁴ Rockefeller Foundation, Coal to Clean Credits Initiative, 2023.

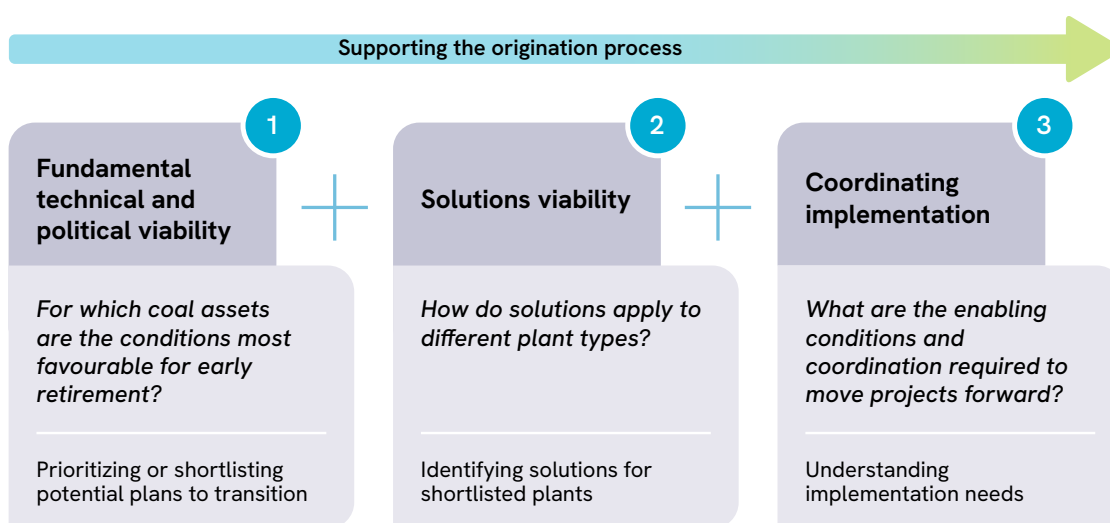
²⁵ Southeast Asia Energy Transition Partnership, About Us, 2025.

Figure 2. Examples of completed and ongoing coal-to-clean projects²⁶

²⁶ See Appendix A.2 for detailed explanations of each support channel, and the type of finance and coal-to-clean solutions being used. See Appendix A.1 for detailed explanations of ongoing/completed coal-to-clean projects and the type of solutions being used.

Together, these origination channels span key steps in the project origination process (see Figure 3). Originating coal-to-clean projects requires a baseline of political and economic willingness within a country to discuss and engage with coal transition. From this foundation, project origination typically involves: 1) prioritising specific coal assets for early retirement, which often involves a combination of assessing their alignment with policy goals, plans and their technical constraints; 2) identifying potentially viable solutions to enable their early retirement; and 3) enabling and coordinating implementation during the project preparation and approval process. In the following sections, this technical report takes stock of approaches and tools to support countries and plant owners to navigate these steps. It then applies these approaches to the global coal fleet to surface emerging opportunities and challenges to growing the pipeline of coal-to-clean projects globally.

Figure 3. Key steps for coal-to-clean project origination



CHAPTER 2

Prioritising Coal Assets for Early Retirement

The first step in project origination is typically identifying potential coal assets for early retirement. In prioritising assets to retire early, countries face multiple, often competing objectives: safeguarding energy security in the face of rising demand, containing costs to maintain electricity affordability, ensuring a just transition for workers and communities whose livelihoods depend on coal, and reducing pollution and health impacts. At the same time, many governments are working to attract new investment in clean energy and economic development opportunities for local and regional communities and meet climate targets. Beyond these overall policy goals, governments may have specific strategic or political reasons for prioritising specific assets.

Due to these complexities, governments – especially in markets with large coal fleets – and their partners are increasingly turning to structured frameworks to help screen and shortlist plants. Many of these tools are multi-criteria analyses that set out clear technical, economic, social and political criteria for prioritisation, replacing ad-hoc decision-making with a more structured approach. In doing so, they can support governments to balance competing objectives and help ensure that transition pathways remain politically and socially viable.

The tools available to support governments and power sector planners to prioritise assets to evaluate for early retirement tend to operate at different levels of application. Global and national policy frameworks provide strategic guidance on balancing climate ambition, energy security and just transition objectives. Rather than identifying specific assets, these frameworks intend to provide overall guidance on how coal transitions can be approached from a planning perspective. Country-level programmatic and investment planning frameworks translate country priorities into action-able plans – coordinating government, utilities and financiers to identify candidate plants, sequence retirements with clean energy additions, and design financing approaches. Asset-level screening tools offer the most granular perspective, ranking individual plants against criteria such as emissions, costs, system role and social impacts. Governments may use one or several of these approaches depending on context, but together they offer complementary pathways – from high-level guidance, to national planning, to project-level prioritisation.

Global/national policy framework: IEA – *Coal in Net Zero Transitions*.²⁷ The IEA's Coal in Net Zero Transitions (2022) report provides structured guidance for governments on sequencing coal retirements while safeguarding system reliability, affordability and just transition outcomes. The framework emphasizes aligning coal phase-out with clean replacement capacity, embedding worker and community support, and balancing energy security with emissions goals. Applied to coal-to-clean transitions, IEA's approach helps countries ensure that early coal retirement strategies are not only climate-aligned but also technically feasible and socially sustainable.

²⁷ International Energy Agency, *Coal in Net Zero Transitions: Strategies for Emerging and Developing Economies*, 2022.

Country-level investment planning framework: ADB – Opportunities to Accelerate Coal-to-Clean Power Transition in Selected Southeast Asian Developing Member Countries.²⁸ The Carbon Trust, in collaboration with Asia Group Advisors (AGA) and Climate Smart Ventures (CSV), as part of an Energy Transition Mechanism pre-feasibility study, prepared for ADB a multi-criteria analysis framework to inform coal transition planning in Indonesia, the Philippines and Vietnam. The analysis assessed plants for accelerated retirement according to three overall criteria related to energy security, cost, and emissions reduction potential. It then estimated potential financing needs for early retirement for prioritised assets (see Box 1 for details).

Asset-level screening tool: Climate Investment Funds (CIF) — Repurposing Coal Assets Tool (ReACT).²⁹ CIF’s ReACT tool enables key decision makers among governments and asset owners to identify the most suitable CFPPs for early retirement and also explore potential repurposing solutions. The Tool’s algorithm allows for up to 200 CFPPs to be screened across technical, financial and socioeconomic indicators to generate comparative rankings to identify which CFPPs could be most viable for early retirement or repurposing. These insights utilising modeled emissions reductions and operating costs can also be used to explore a range of climate-smart alternatives and repurposing pathways (both energy and non-energy related). The modules may either be used sequentially or independently depending on the user’s objectives.

Asset-level screening tool: TransitionZero — Coal Asset Transition (CAT) Tool.³⁰ TransitionZero’s CAT tool provides plant-level assessments that integrate financial, environmental and social metrics of coal plants in Malaysia, Indonesia and the Philippines. By combining data on operating costs, emissions and profitability, the tool calculates a “true cost” of coal generation. Users can adjust weightings to reflect national priorities – for example, emphasising energy security, affordability or climate ambition. The CAT tool can therefore be used by governments and utilities to identify which coal plants are the strongest candidates for transition under different policy scenarios, complementing broader system planning exercises.

Taken together, these frameworks highlight cross-cutting themes that consistently shape coal-to-clean transitions across countries. First, energy security is the primary filter: coal-to-clean projects are only viable where retirements can be sequenced with replacement capacity so that system reliability and energy security are maintained. Second, economic and financial viability are necessary but not sufficient: durable transitions also require embedding environmental and social criteria to ensure affordability, community acceptance and just transition outcomes. Finally, catalytic impact matters: stakeholders prioritise projects that can unlock broader investment, policy reform or innovation, helping transitions scale beyond isolated pilots. Frameworks often capture this indirectly through criteria such as replicability of solutions, alignment with national reform priorities or the potential to demonstrate new financing approaches. Underpinning all of these are deeper structural conditions – such as the degree of coal dependency in the economy, the alignment of institutional and policy goals, and the readiness of the system to integrate clean energy – which ultimately determine whether frameworks can translate into implementable project pipelines.

²⁸ Asian Development Bank, Regional: Opportunities to Accelerate Coal to Clean Power Transition in Selected Southeast Asian Developing Member Countries, 2023.

²⁹ Climate Investment Funds, Guide to Repurposing Coal Assets (ReACT Tool), 2023.

³⁰ TransitionZero, Coal Asset Transition (CAT) Tool Methodology, 2024.

Box 1: ADB – Opportunities to Accelerate Coal to Clean Power Transition in Selected Southeast Asian Developing Member Countries

In countries with a significant number of coal-fired power plants (CFPPs) the determination for potential early retirement requires a multi-pronged approach including top-down system-level analysis and bottom-up direct interaction with owners and operators of the CFPPs themselves. This combined approach can ensure that plants that are identified will, through further analysis and structuring, have the highest potential to reach transaction closure from owners, system operators (i.e. the state utility) and the government, all of which are required to proceed with an early retirement.

A system-level approach can utilise a multi-criteria analysis (MCA) that is an analytical process to compare and rank CFPPs based on technical, economic, social and commercial criteria. Through weighting these aspects in a context appropriate for a specific country the information provides a key to identifying which CFPPs could be included in the candidate pool for early retirement. If this is done during a prefeasibility study, it will typically be repeated during a feasibility stage with an expanded scope and adjustments based on the inputs from relevant government and private sector stakeholders.

In parallel, or following the MCA, direct engagement with the operators of the plants is performed to determine interest with

owners of CFPPs (including both independent power producers and utility-owned plants) to ensure that the potential for early retirement will align with corporate objectives. Based on experience, CFPP owners can be broadly put into three categories:

1. Do not want to participate as they would like to simply proceed under a business-as-usual scenario.
2. Willing to engage on a purely commercial approach that will primarily seek to maximise compensation to retire the CFPP early based on valuation of the plant and existing contracts.
3. Have developed a strategy to exit coal ownership and are interested to develop approaches that would support this strategy and engage on structuring a transaction for early retirement.

Of the three options above, generally the last option is the only viable approach, as it can minimise the concessional resources needed to accomplish the early retirement and proactively engage in negotiations, that, while done on a commercial basis, will also seek other goals such as corporate sustainability, social responsibility and climate objectives.

Combining the two approaches can identify plants that can be retired early with the least impact to the power system and highest benefit to the country, along with a willing owner who will engage in further analysis to fully determine if a transaction can proceed.

Text provided by the Asian Development Bank.

Box 2: TransitionZero's CAT Tool: An open, structured approach to identifying coal transition opportunities in Southeast Asia

TransitionZero's Coal Asset Transition (CAT) tool was developed on the premise that effective coal phase-out strategies must be grounded in robust asset- and system-level data. Yet, in Southeast Asia, much of this critical information – such as plant technology specifications, historical operational performance, cash flows, emissions footprints, power purchase agreement (PPA) terms and role in the broader supply mix – has remained scattered across sources, rarely consolidated in official disclosures, and often inaccessible to the wider public, available only to off-takers, plant owners and their lenders. This lack of transparency has made it difficult for energy planners and other stakeholders interested in driving the coal-to-clean transition in these markets to make informed, system-appropriate decisions on how to implement coal phase-out strategies.

The CAT tool addresses this gap by collecting, harmonising, and processing plant-level metrics under a standardised analytical framework. By enabling a consistent, comparative view across Southeast Asia's coal fleets, the tool supports the screening, ranking and shortlisting of assets for transition interventions based on the metrics most critical to the user

The breadth of data and indicators provides stakeholders with a starting point to:

- Assess financial implications of early retirement or repurposing, using information on PPA tenure, PPA buy-out costs and clean energy replacement costs
- Evaluate system-level impacts, drawing on grid location and historical utilisation rates to identify plants whose retirement may or may not affect grid stability or reliability
- Identify high-impact, cost-effective transition candidates, where retirement would deliver the greatest emissions reductions and economic benefits, based on plant emissions intensity, thermal efficiency, utilisation rates and abatement costs
- Sequence interventions to align with national economic strategies, power sector plans and just transition priorities.

Since its launch, the CAT tool has been used by a wide range of stakeholders – including international financial institutions, asset managers, philanthropies and civil society organisations – in practical policy and advocacy contexts. In each of these cases, the CAT tool has provided a shared, data-informed evidence base, enabling these stakeholders to work from a common understanding of the region's coal fleet and its transition outlook.

Text provided by TransitionZero.

CHAPTER 3

Identifying Solutions for Prioritised Coal Assets

While the above tools can help identify potential assets to retire, developing appropriate solutions for shortlisted projects has proven a significant bottleneck. This section therefore aims to help decision makers quickly understand the coal-to-clean solution landscape and how it may apply to different types of assets.

3.1 Types of coal-to-clean solutions

As shown in Figure 2, several projects have already demonstrated innovative ways to retire coal plants ahead of their planned end of life (Appendix A.1 also provides a non-exhaustive list of ongoing or successful coal-to-clean projects). While the overall number of coal-to-clean projects remains modest, they already demonstrate practical solutions for materially shortening the operating life of coal plants while meeting energy security needs and supporting local communities. These early examples offer concrete solutions and approaches for plant owners and policymakers and provide a basis to evaluate the key conditions needed for their application.

Solutions deployed in coal-to-clean projects to date include both financial and non-financial mechanisms, often deployed together in an integrated package (see Box 3 on Tocopilla as an example). Even when coal assets are prioritised for early retirement, they are still often providing valuable grid services and generating revenues for their owners. In the absence of interventions, they are unlikely to retire early due to their existing financial position or contractual obligations. As a result, coal-to-clean solutions to date have aimed to incentivise the early retirement of coal plants through a range of financial and contractual solutions, summarised below. Many also include outlets for mobilising additional finance to support workers and communities impacted by coal plant closures.

1. **Optimising Cost of Capital (CoC):** These solutions focus on adjusting the overall cost of capital of a coal asset, allowing it to achieve its necessary returns over an accelerating timeline. Specific strategies include refinancing or restructuring existing debt with lower cost or longer tenor financing, relevering (i.e. increasing the share of lower cost debt compared to equity), or changing equity ownership.³¹ Examples include securitisation – such as ratepayer-backed bonds in the US – blended refinancing structures like ADB’s Energy Transition Mechanism, sustainability-linked lending, national ETM funds in Indonesia, and coal transition funds.
2. **Revenue models:** These solutions are focused on generating the necessary revenue streams to enable a coal plant to fulfil its obligations on an accelerated timeline. They include solutions that link funding to the climate or social benefits of early retirement, such as transition credits (see Box 4) or climate-linked grants or payments. They can also include models to monetise non-energy generation services of coal plants (e.g., remuneration for capacity or other grid services),

³¹ These strategies typically require a reduction in overall project risk, and so may inherently need to be coupled with contractual solutions or other de-risking instruments.

allowing them to realise returns while reducing plant emissions and supporting retirement on an accelerated timeline.

3. **Contractual solutions:** In many cases, early retirement depends on reshaping the underlying agreements that govern a plant's operations and revenues. This can include renegotiating a coal plant's existing power sector contracts (e.g., power purchase agreements (PPAs)) or incentivising the replacement of coal with clean energy contracts. Examples include coal-to-clean PPAs – such as the Tocopilla project in Chile (see box below) – or reducing the risk of existing contracts to enable projects to achieve risk-adjusted returns on a shorter time period – such as the SLTEC project in the Philippines (see Appendix A.1 for details).

Box 3: Project example – Tocopilla

In 2022, ENGIE Energía Chile (EECL) retired two units at the Tocopilla coal plant nearly two years ahead of schedule, as part of an agreement with the Chilean government to accelerate the country's coal phase-out. The deal was anchored around a \$125 million blended financing package arranged by IDB Invest to primarily fund the 151 MW Calama wind farm, which would replace the plant's generation capacity. The package combined a \$74 million senior loan from IDB Invest, \$36 million from the China Fund for Latin America and the Caribbean, and \$15 million of concessional capital from the Clean Technology Fund.³²

The innovative structure linked the early retirement of Tocopilla's coal units to the financing terms of the clean replacement project. Specifically, IDB Invest deployed

a methodology to monetise and link the avoided emissions from early coal plant closure to a lower interest payment on the concessional tranche of the loan package, increasing EECL's savings the earlier the units were retired. Preliminary calculations estimate between 500,000 and 700,000 tons of abated carbon emissions through the early retirement of the coal units, saving EECL \$1.5–\$2.1 million in interest payments at maturity. This approach provided ENGIE with financing to build new renewable energy while directly incentivising the early retirement of coal capacity.³³

The Tocopilla transaction illustrates how cost of capital optimisation, concessional finance and results-based mechanisms can be combined to accelerate coal retirement. It also helped pioneer the concept of results-based finance – by establishing a floor price for avoided emissions – as a model that could be replicated in other markets in Latin America and beyond.³⁴

³² IDB Invest, Innovative Incentives for Early Coal Plant Phase-Out: The Case of ENGIE in Chile, 2022.

³³ RMI, Transition Finance Case Studies: Tocopilla Units 14 and 15 – Results-Based Loan Incentive, 2023.

³⁴ Climate Investment Funds (CIF), Power Moves: How Chile Incentivized Early Retirement of Coal Power Plants, 2024.

Box 4: Monetary Authority of Singapore's Transition Credits Coalition: Accelerating Coal-to-Clean Transition through Transition Credits

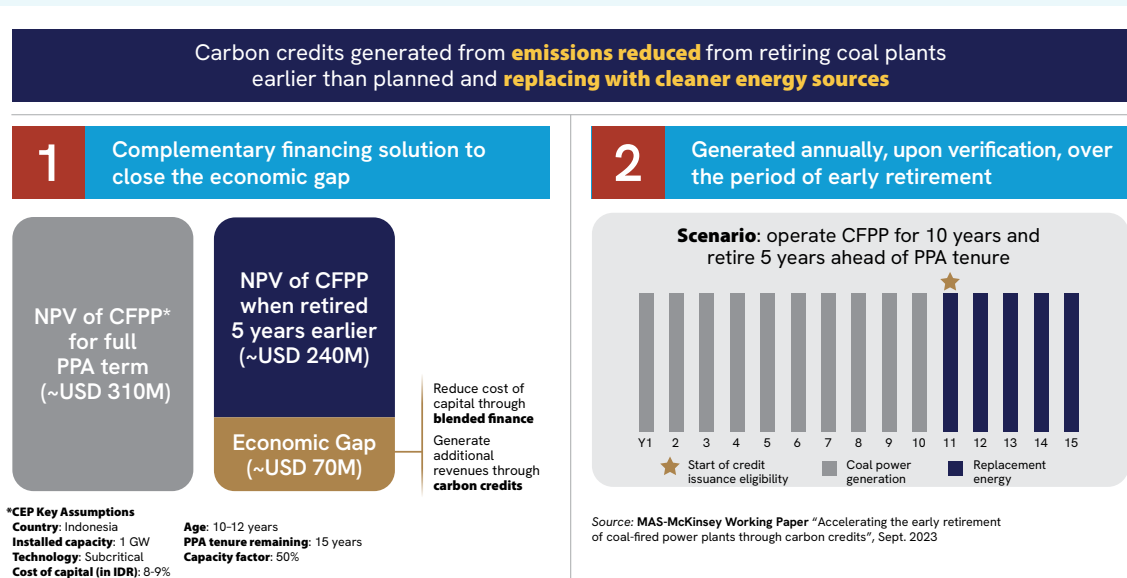
High-integrity carbon credits generated from the emissions reductions by retiring coal-fired power plants (CFPPs) earlier than planned and replacing their output with clean energy alternatives ("Energy Transition Credits") can serve as a complementary financing instrument to close the economic gap for the early retirement of CFPPs, and at the same time, support Just Transition efforts in affected communities, increasing the viability of coal retirement projects.

The Transition Credits Coalition (TRACTION) was convened at COP28, bringing together more than 30 members and knowledge partners across carbon

services, energy financing, project development, risk management and NGOs to identify system-wide barriers and solutions for transition credits to be utilised as a credible financing instrument.

For energy transition credits to be credible, high-quality and trusted by the industry, they need to meet key high-integrity attributes.³⁵ These are: (i) ensuring additionality of the credits, (ii) permanence of emissions reductions and reducing leakage, (iii) robust quantification of emissions reductions, and (iv) contributions to Just Transition and sustainable development goals. CFPPs that can meet these high-integrity attributes are more likely to deliver genuine, permanent and verifiable climate impact.

To this end, TRACTION developed a selection and prioritisation framework, incorporating these key integrity attributes from existing guidance documents³⁶ and



³⁵ TRACTION has looked across coal phase-out financing guidelines, taxonomies and draft transition credit methodologies to identify the common high-integrity attributes. More details can be found in TRACTION Interim Report, published in November 2024.

³⁶ Three key coal MPO financing frameworks were studied: (i) Financing the Managed Phaseout of Coal-Fired Power Plants in Asia Pacific by GFANZ APAC, 2023; (ii) ASEAN Taxonomy for Sustainable Finance, ASEAN Taxonomy Board, 2024; and (iii) Singapore-Asia Taxonomy for Sustainable Finance | 2023 Edition, Monetary Authority of Singapore, 2023.

methodologies.³⁷ This framework provides stakeholders with a practical tool to screen coal assets systematically and to focus energy transition credit efforts where they can have the greatest integrity and impact.

The **Selection Criteria** provides a clear framework to determine whether a CFPP meets the requisite integrity considerations to generate transition credits. For example, to ensure financial additionality i.e. to identify CFPPs which are expected to remain profitable, CFPPs need to exhibit positive utilisation and cashflows for a number of years. To demonstrate regulatory/policy additionality, these assets cannot be in a jurisdiction where a mandatory phase-out requirement by the host jurisdiction is already in place.

- The **Prioritisation Criteria** helps stakeholders rank projects within a portfolio to prioritise those with higher feasibility for transition credit application based on (i) asset-level factors such as potential emissions reduction and jobs impact, and (ii) market-level attributes such as market readiness for coal phase-out (e.g. coal dependence and renewable energy prospect) and carbon credits generation.

Taken together, the selection and prioritisation criteria provide a practical tool for:

Project developers, development partners and financiers to identify promising assets and markets for viable energy transition credit projects.

- CFPP owners to assess the potential to apply energy transition credits on eligible assets as part of a wider coal transition plan.
- Public institutions to identify opportunities for policy or regulatory action to improve their market readiness for the use of energy transition credits, and incorporate such credits into energy transition plans.

The full framework, along with potential applications, is set out in the TRACTION Final Report launched at COP30. The full report details practical insights, frameworks and tools across key enablers of integrity, scalability and demand-building. This can lay the groundwork for stakeholders across the ecosystems to use it to develop, structure and finance high-integrity transition credit projects, particularly for Asia where it is critical to maintain energy security and affordability amid pursuit of its decarbonisation goals.

³⁷ Methodologies included in this synthesis include: (i) VM0052: Accelerated Retirement Of Coal-Fired Power Plants Using a Just Transition, Verra, 2025; (ii) Facilitating a Just Transition Through The Early Phase-out of Coal Fired Power Plants, Gold Standard, 2024; (iii) Asian Development Bank (ADB) methodology draft (not available publicly and was provided to TRACTION by ADB); and (iv) Methodology for Early Phaseout of CFPP with Just Transition by Replacing with Clean Energy Sources, Sustainability Economics (submitted to Asia Carbon Institute), 2024.

While these solutions are frequently cited in coal-to-clean discussions, it is important to note that they are at different stages of maturity. Some solutions have already been implemented in projects – such as refinancing and sustainability-linked loans – and have a track record in financial markets outside of coal-to-clean projects. Others are still in the pilot phase, including coal-to-clean PPAs or transition credits, which are being tested in specific transactions but are not yet mainstreamed. Still others remain conceptual, such as jurisdictional crediting models or revenue models for flexibility, which have been proposed but not yet applied in practice. This uneven maturity underscores both the importance of scaling up what is proven and continuing to innovate with first-of-kind pilots and concepts.

As outlined in Chapter 3 of the CTC's 2024 report, financing for coal-to-clean solutions can be mobilised from public finance, private finance, or blended finance. These sources can be applied across all three solution types, often in combination. Public finance commonly sets the enabling conditions and may cover systemic risks, such as through grants or financing for just transition support. Blended finance can bridge finance gaps and de-risks participation for commercial finance, for example through subordinated debt participation, guarantees or other instruments – and can be critical for de-risking first-of-kind solutions. Private finance can then scale up financing when enabling conditions exist and projects are bankable, for example through sustainability-linked loans or the purchase of transition credits.

3.2 Applicability of solutions to plant types

The solutions outlined in the previous section may not apply in all contexts: they may be more applicable to certain plant types or require specific enabling conditions for their implementation. While various plant-specific characteristics will affect the applicability of coal-to-clean solutions, this technical report focuses primarily on a plant's market context as a key differentiator of assets. The CTC's 2024 report identified three market archetypes – deregulated markets, single-buyer markets and vertically integrated markets – to illustrate how challenges to coal-to-clean transitions might vary across different contexts.³⁸ While in reality markets will exist on a spectrum, this technical report adopts these same categories to assess the potential applicability of coal-to-clean solutions. The following summary of that mapping of solutions to different market types draws on lessons from existing projects as well as stakeholder consultations.

Coal plants in deregulated markets

Description: In this technical report, deregulated markets refer to markets that have competitive mechanisms for electricity generation, where independent power producers (IPPs) typically sell electricity and other services in the wholesale market and/or through bilateral contracts. In these markets, coal plants may have some short- to medium-term obligations and revenue certainty through their contracts, which can create near-term barriers to their retirement. However, due to the competitive nature of markets, these plants also face long-term market risks. As a result, policy and regulation that supports the economic competitiveness of clean alternatives (e.g., carbon pricing, addressing fossil fuel subsidies) will be critical for the coal-to-clean transition. Where existing contracts still pose a near-term barrier to coal retirements, additional coal-to-clean solutions may be needed.

Potential suitability of coal-to-clean solutions

- **Optimising CoC:** Plants often have well-defined infrastructure financing schemes, offering strong potential for refinancing or other cost of capital optimisation solutions. These solutions, however, may not be suitable for older plants with little remaining debt or value.

³⁸ Captive plants were not considered within this report. Captive plants – particularly those serving industrial facilities – also face persistent barriers to transition and lack proven solutions. These plants are typically governed by rigid offtake structures, limited regulatory oversight and minimal access to external finance or grid flexibility. Their transition pathways depend on enablers outside the power sector – for example, industrial policy decision makers or productive-sector financiers – and still require substantial technoeconomic work.

- **Revenue Models:** Transition credits may be more challenging to utilise in these markets, given challenges in estimating a plant's future operation (i.e. challenges in demonstrating additionality and setting a baseline). Auctions for coal-to-clean contracts could be considered, where system operators or regulators solicit bids for clean replacement capacity tied to accelerated coal retirement. Non-energy revenue models, for example monetising flexibility or other grid services, may be possible but are so far unproven and require well-functioning ancillary service markets.
- **Contractual Solutions:** Future uncertainties of coal plant revenues can open the door to incentivise coal-to-clean switching, particularly if clean alternatives offer the potential for upside. A wider range of off-takers and markets for different energy and grid services offers potential for innovative contract and revenue structures to incentivise early retirement and clean replacement.

Independent Power Producer coal plants in single-buyer markets

Description: In these markets, planning is centralised, but the procurement of electricity is typically competitive. A designated entity – often a state-owned utility – exclusively procures and dispatches power, which could come from its own generation assets or IPPs. IPPs sell electricity or other services (e.g., capacity) through long-term contracts, or power purchase agreements (PPAs), with the single buyer. Unlike in countries with competitive wholesale power markets, where coal plants are exposed to greater market uncertainty and risk, PPAs in single-buyer markets typically have carefully allocated risks and sufficient returns over the economic lifetime of the asset. They therefore face very few market pressures to retire ahead of their contract term.

Potential suitability of coal-to-clean solutions

- **Optimising CoC:** Similar to deregulated markets, plants often have well-defined infrastructure financing schemes, offering strong potential for refinancing or other cost of capital optimisation solutions. These solutions, however, may not be suitable for older plants with little remaining debt or value.
- **Revenue Models:** Transition credits may be well-suited for these plants, as the clarity of contract terms can support the credibility of emissions reduction claims. Auctions could be used by the single buyer to deliver coal-to-clean compensation to IPPs while balancing system reliability needs. While flexible revenue models are possible, they remain untested and can be complex where transparent markets for grid services do not exist.
- **Contractual Solutions:** The existence of clear contractual structures offers the opportunity for PPA renegotiation or coal-to-clean PPA switching. However, incentivising this transition can be difficult. Well-structured, long-term coal PPAs offer little incentive to retire plants early. Renegotiating coal PPAs can be resource-intensive and requires strong buy-in, financial capacity and institutional capabilities of the single-buyer offtaker.

Vertically integrated utility (VIU) markets

Description: A single utility (or holding company) owns and operates generation, transmission and distribution, with centralized planning driving investment and system operation. While IPPs may be allowed through selective tenders, the VIU retains control over most decision-making. As a regulated entity, VIUs are typically allowed a regulated rate of return on their investments. These returns are built into regulator-approved electricity tariffs, and may be supplemented through additional public sector support or subsidies in some markets.

Potential suitability of coal-to-clean solutions

- **Optimising CoC:** Refinancing or sustainability-linked lending can support the early retirement of coal plants at a plant or corporate level (e.g., sustainability-linked lending tied to a utility's transition KPIs). However, the ability to utilise these instruments is strongly dependent on the utility's financial health, as well as their ambition and capacity for delivering the transition.
- **Revenue Models:** Transition credits at a jurisdictional or asset level may be possible with a robust policy framework and strong transition plan. Auctions do not apply, since they require competition among several generators.
- **Contractual Solutions:** These solutions tend to not apply for these asset types as their remuneration is determined according to regulated tariffs, rather than through clear electricity contracts.

Table 1 provides a summary of the types of solutions that may be most relevant in different contexts. The interaction of market structure, solution maturity and enabling conditions shapes which plant types may provide coal-to-clean opportunities. The analytical results in the next section build on this logic, showing how these dynamics map onto real coal fleets in different geographic contexts.

Table 1. Coal-to-clean solutions by market structure

KEY			
	Deployed – Solution has led to completed projects in corresponding market structures		
	Applicable but unproven – Solution is still in piloting stages or has not been completed in corresponding market structure		
	Still conceptual – Solution could apply but no pilot, ongoing or completed projects exist in corresponding market structure		
Market structure	Optimising Cost of Capital	Revenue Models	Contractual Solutions
Deregulated markets	 Debt refinancing, relevering, or extending loan tenors  Ownership transfer	 Transition credits  Auctions  Revenue models for flexibility	 Coal-to-clean contracts  Derisking existing contracts  Sustainability-linked debt
Independent Power Producers in single-buyer markets	 Debt refinancing, relevering, or extending loan tenors  Ownership transfer	 Transition credits  Auctions  Revenue models for flexibility	 Coal-to-clean contracts  Sustainability-linked debt
Vertically integrated utility (VIU) markets	 Debt refinancing, relevering, or extending loan tenors  Ownership transfer	 Transition credits	 Sustainability-linked debt

Note: See Appendix A.1 for examples of ongoing/completed coal-to-clean projects and the type of solutions being used in each project.

CHAPTER 4

Mapping Opportunities to Build the Coal-to-Clean Project Pipeline

This section summarises results of a data analysis focused on identifying project opportunities across a subset of the global coal fleet.³⁹ This analysis is intended to provide a heat map of opportunities to dig deeper into coal-to-clean project opportunities; it is not deterministic. It uses selection criteria from existing frameworks and past project experiences to screen coal plants against several factors, including country-level enabling conditions and the applicability of coal-to-clean solutions (cost of capital, revenue models and contractual solutions). The appendix includes additional details on the methodology. Given data constraints, it does not consider nuances in local technical or socio-environmental issues, such as if a coal plant is required for grid stability issues beyond simply balancing supply-demand, if an institutional and governance structure makes it easier or harder to implement a just transition plan at the asset level, or if a plant owner may be more likely to consider asset transitions (e.g., due to corporate-level climate commitments).⁴⁰ As a result, this analysis can be considered as a starting point for overall potential, and can be used as a tool to support engagement with plant owners or to identify specific assets where more granular power system or just transition analyses would be helpful.

Overall, the analysis found three broad categories of opportunities (Figure 4):⁴¹

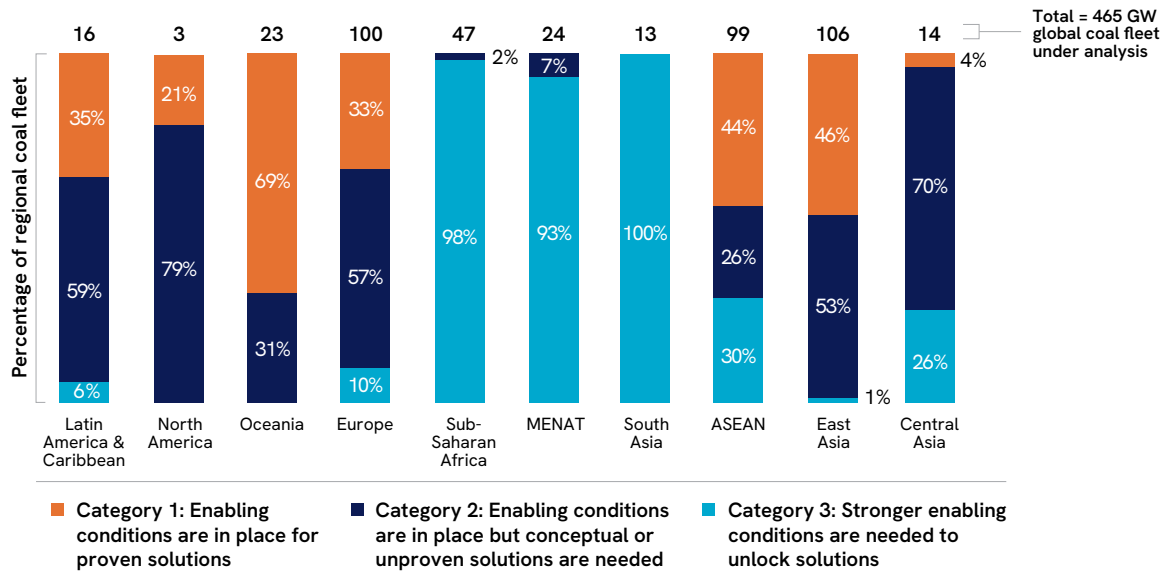
- Category 1: Assets where deploying already proven solutions might increase the pipeline of coal-to-clean transition projects,
- Category 2: Assets where no proven solutions are directly applicable and therefore require innovation to develop out conceptual or unproven solutions, and
- Category 3: Assets where no proven solutions are directly applicable because the country contexts exhibit gaps in the enabling conditions that are necessary for existing mechanisms to be effective.

³⁹ The analysis currently excludes coal assets in China, India and the United States, as these markets all have sizeable coal fleets with significant variation in market structure and enabling conditions at a subnational level. Assessing these markets would require greater data and analytical granularity, which could be the focus of future work. Coal assets in North Korea and Russia were also excluded from the analysis.

⁴⁰ While the analysis does aim to capture coal transition appetite through factors such as coal or climate commitments, coal dependency, or the maturity of renewable energy integration, these factors may not always be strong predictors of political will.

⁴¹ In this breakdown, proven mechanisms refer to mechanisms that either have reached legally binding agreements and financial close in more than one country, or that have already led to at least one physical plant retirement in at least one country. Examples include refinancing, sustainability-linked financial instruments, and ownership transfer/asset sale transactions. Unproven mechanisms refer to mechanisms that have been applied to pilot projects or are currently under exploration, but have not become legally binding for a coal-to-clean project to take place. Conceptual mechanisms refer to those which have only been proposed in thought leadership or academic literature.

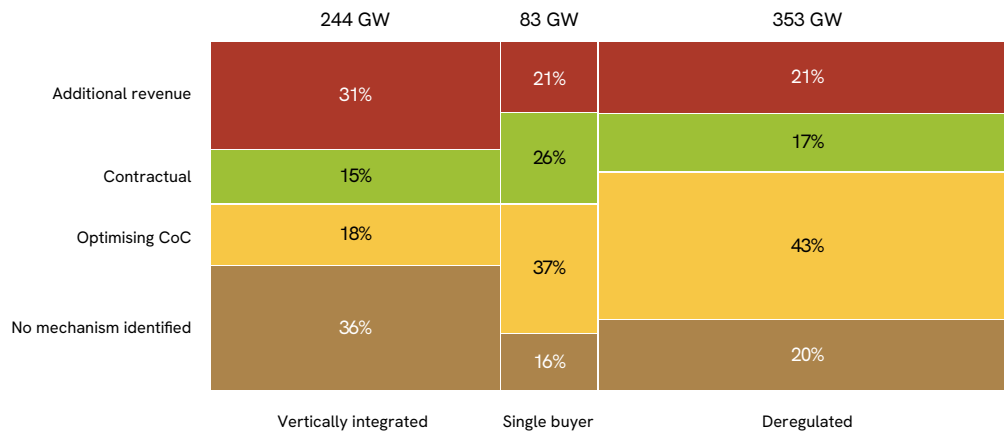
Figure 4: Solution applicability across the global coal fleet



Within the coal fleets where no proven mechanism is yet compatible, the analysis surfaces three key areas that are hindering opportunities to unlock coal-to-clean project pipelines:

1. **High and growing coal dependence and limited coal transition ambition:** The analysis shows that, for fleets where no proven mechanisms are yet compatible, more than 53% of capacity⁴² lies in markets with higher-than-average coal dependency and lack either a coal phase-out commitment or a moratorium policy that limits new coal development. Without clear policy directives at a country level, financing of coal-to-clean projects for these fleets poses emissions leakage and credibility risks that limit the applicability of existing solutions.
2. **Strengthening the clean energy deployment ecosystem, including the creation of plans and mechanisms to deploy grid flexibility resources:** This is especially critical in markets where coal makes up a smaller share of generation, since it often serves as backup for other primary energy sources (such as hydro or gas). In these contexts, grid flexibility solutions can help replace coal's supporting role and reduce reliance on it altogether.
3. **Real or perceived investment risks at the country level:** This is especially important for solutions that hinge on optimising a project's risk-return profile (mainly the Optimising CoC and Contractual Solutions models). More than 98% of coal plants in countries without an identified mechanism do not have either an investment-grade sovereign credit rating or a B-level rating with a positive rating outlook. These markets may require additional concessional support given financing challenges.

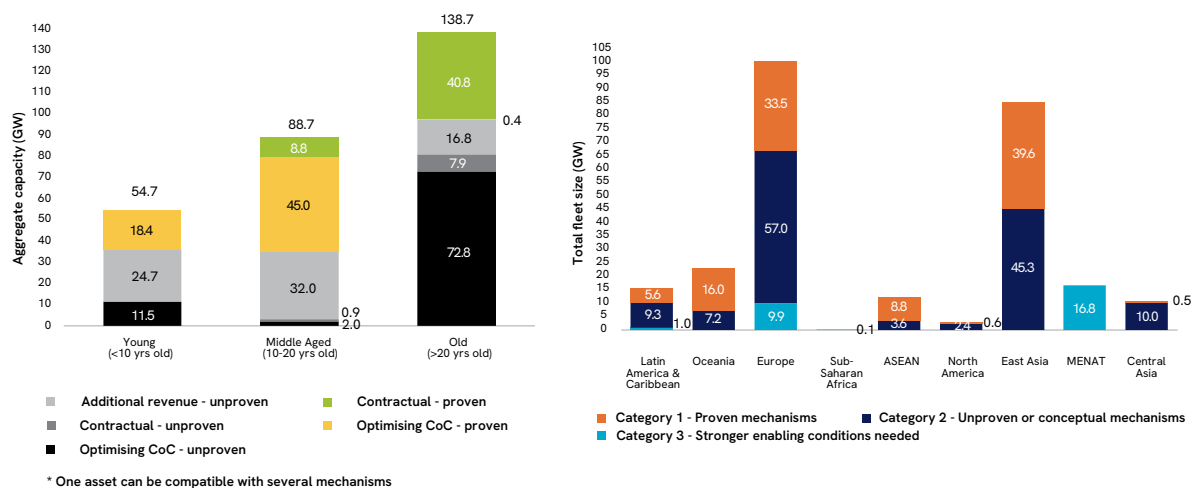
⁴² Assessed as the percentage of capacity that is coal-fired.

Figure 5. Addressable coal capacity by market archetype

As elaborated in Chapter 3, there are wide variations on which mechanisms are most likely to be effective depending on the market archetypes. Figure 5 compiles the total market potential within each market archetype. Because some assets could be compatible with more than one mechanism, the totals shown are larger than the overall coal fleet under analysis. Importantly, Figure 5 reflects technical and structural compatibility at the asset level, regardless of whether enabling conditions currently exist at the country level. This breakdown illustrates that:

1. Most solutions (either proven or unproven/conceptual) to date are better adapted to plants in deregulated markets
2. Optimising CoC solutions can untap the greatest transition potential and catalytic impact of all mechanism types, followed by additional revenue models that require additional demonstration – like revenue for operational flexibility, transition credits (where they can be high integrity) or other forms of emissions reduction monetisation
3. Vertically integrated markets have the greatest support gaps in terms of mechanism compatibility.

4.1 Deregulated markets

Figure 6: Deregulated markets: coal-to-clean opportunity

The analysis for deregulated markets indicates that:

- **Proven solutions are more applicable to young- to mid-aged assets (<20 years):** Optimising CoC solutions can be particularly impactful for mid-aged assets given large remaining plant value and outstanding debt that can be optimised. Contractual solutions can either support cost of capital reductions for a coal plant, allowing its earlier retirement (see SLTEC example), or can create upside incentives to shift coal investments to clean. Transition credits, a type of model for additional revenue, may also be relevant for younger or mid-aged plants that have secured longer-term power sector contracts, which makes emissions reductions claims more credible under proposed credit methodologies. While high-integrity credits could offer potential for longer-term replication, in the near-term, blended finance approaches – for example B loans or subordinated debt – could help de-risk refinancing approaches, while supporting price floor guarantees to crowd in private finance for future transition credit projects.
 - Regions with large shares of young (less than 10 years) and middle-aged (between 10-20 years) coal plants that are compatible with proven solutions in deregulated markets are East Asia (~34% of all its coal fleet) and LAC (~37% of all its coal fleet)
- **Older assets (>20 years), which represent the larger share within deregulated markets, have fewer options to enable their retirement.** Older assets are more likely to already be paid off and may continue to provide upside value to their owners while providing specific reliability services in the grid. For example, older assets may be able to operate at lower utilisation, offering capacity during times of low supply or higher electricity demand. While other technical solutions may be available to replace them, they may face higher capital costs or interconnection constraints that are slowing their deployment. Older assets have little scope for refinancing through optimising CoC or monetising future reliable cash flows through contractual solutions, making it difficult to design solutions that are both financially feasible and low risk. Concessional capital has been used to support early retirement in some cases, but the approach is hard to scale. At present, proven contractual mechanisms apply to some older assets (~40 GW), but the majority of older assets would require further innovation.
 - Regions with the oldest operating fleets in deregulated markets are Europe (~ average 39 years old) and Central Asia (~average 47 years old).

Key enablers: Addressing future coal plant risks, for example through strong coal phase-out commitments and ensuring clean energy can fairly compete with coal plants in electricity markets (e.g., through enabling regulation or carbon pricing) can help support the viability of projects. Where these conditions are present, plants can attract private financial institutions to deploy cost of capital solutions, while also creating opportunities for new revenue models and innovative contract structures. For older, already paid off plants that continue to operate, ensuring a strong pipeline of alternative clean energy technologies can help reduce the need and competitiveness of coal plants in power markets over time, but near-term solutions can accelerate that process of replacement.

Box 5: Project Example: SLTEC

In November 2022, energy company ACEN completed the world's first market-based Energy Transition Mechanism (ETM) transaction for the SLTEC coal plant.⁴³ The deal was driven by ACEN's ambition to lead in the clean energy transition, as well as investor pressure to prevent ongoing operation of the plant post-divestment. The ETM deal utilised a project sale of the plant into a special purpose vehicle (financed through local private debt and equity investors) which facilitated the early retirement of SLTEC to 2040 and reduced the plant operating life by 25 years.

ACEN has developed a just transition plan oriented towards 2040 that maps out the status of affected workers: identifying those expected to retire by that date, those to be rotated to other ACEN renewable energy sites, and those requiring reskilling.⁴⁴ SLTEC currently employs around 195 direct workers and 210 contractors.

To explore the viability of pulling forward retirement 10 years earlier, to 2030, ACEN and the Coal to Clean Credit Initiative (CCCI) announced at COP28 a collaborative effort to explore a transition credit pilot project.⁴⁵ For a 2030 closure to be financially viable, three broad buckets of additional costs

would need to be assessed against a 2040 baseline: forgone cash flows, additional costs associated with building clean energy replacement, and just transition costs for impacted plant workers and local communities. The pilot is currently developing possible sources of buyer demand from both voluntary and compliance markets.

ACEN has indicated that it will engage with local communities and affected workers on a 2030-oriented just transition plan once greater certainty around the transition credits deal is established.⁴⁶ A 2030 retirement would likely require a more extensive and costlier transition plan, reflecting both the accelerated timeline and the larger number of workers projected to still be employed relative to a 2040 retirement.

A combination of contractual renegotiation and cost of capital optimisation under the ETM structure created the foundation for potentially layering in transition credits as an additional revenue stream. Together, the SLTEC ETM deal and the transition credit pilot demonstrate how diverse financing tools can be effectively combined to meaningfully incentivise early coal retirement.

⁴³ ACEN, ACEN completes the world's first ETM transaction for the 246 MW SLTEC coal plant, 2022.

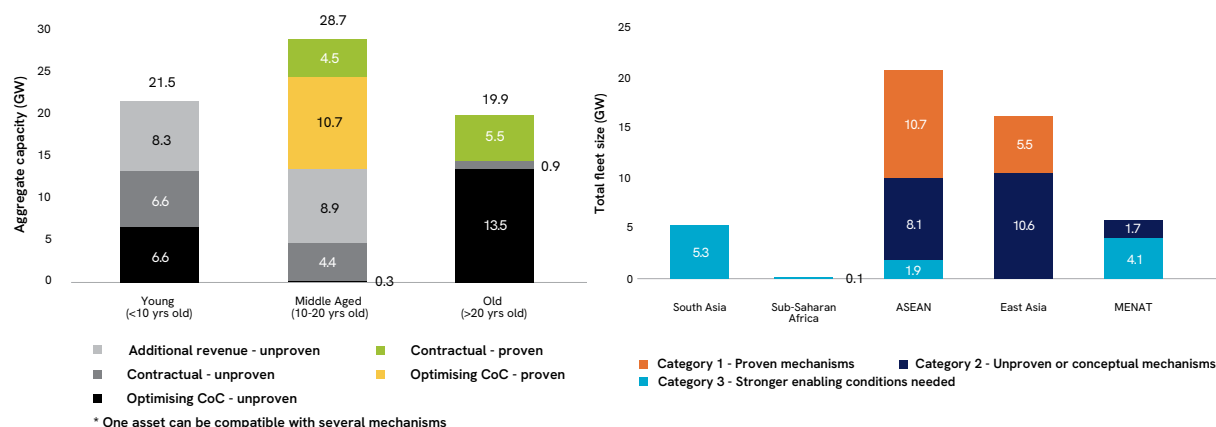
⁴⁴ Just Transition Finance Lab, ACEN Renewables – using transition credits to accelerate coal closure, 2024.

⁴⁵ Rockefeller Foundation, COP28: The Rockefeller Foundation, ACEN Corporation, Monetary Authority of Singapore Partner to Explore Phasing Out Coal Plant in Philippines, 2023.

⁴⁶ Just Transition Finance Lab, ACEN Renewables – using transition credits to accelerate coal closure, 2024.

4.2 IPPs in single-buyer markets

Figure 7. IPPs in single-buyer markets: coal-to-clean opportunity



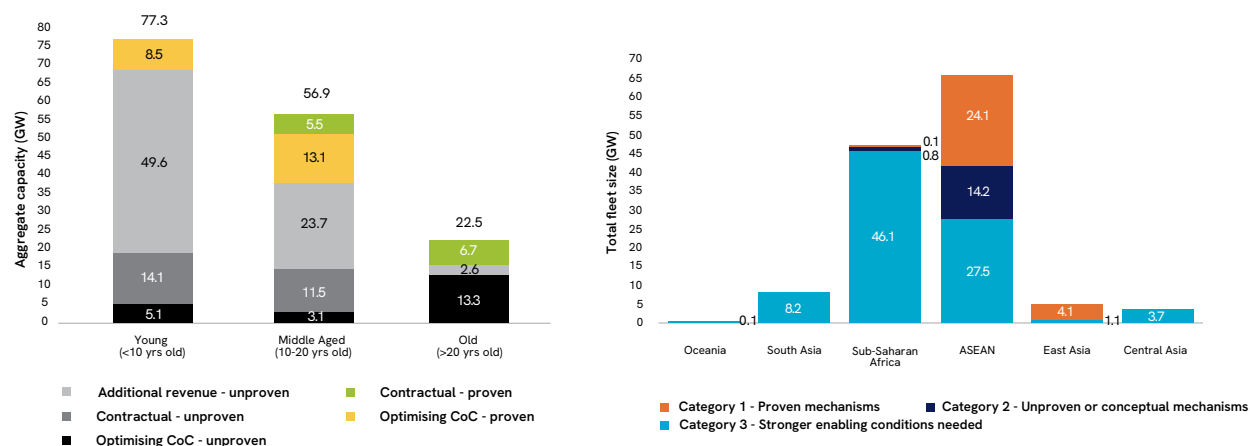
The analysis for IPPs in single-buyer markets indicates that:

- **Middle-aged plants (10–20 years) may offer a ‘sweet spot’ for deploying solutions:** Middle-aged plants have operated long enough to have paid a significant portion of its capital through selling electricity to the single buyer, but still have enough useful life to monetise. Models for additional revenue (e.g., transition credits or monetising non-energy services) can accelerate this capital recovery as the plant continues to be cost-efficient in these markets, in turn allowing outstanding debt and future cash flows to be leveraged to optimise the cost of capital.
 - Countries with the largest shares of middle-aged (between 10–20 years) coal plants that are compatible with proven solutions in single-buyer markets are mainly in ASEAN (~11% of all its coal fleet)
- **Younger plants offer opportunities to utilise additional revenue models, but may require additional concessional or blended finance:** Heavily negotiated or regulated PPAs provide long-term revenue certainty. For younger, larger plants, this stability reduces operational risk over time, allowing the remaining plant value to be harnessed with additional revenue models. Utilising blended finance structures can help further de-risk the transition towards higher penetrations of non-conventional renewables.
 - Regions with the youngest operating fleets in single-buyer markets are South Asia (~average 3.7 years old) and ASEAN (~average 17.6 years old)
- **Older and smaller plants require further testing of solutions:** When plants have smaller plant balances and shorter remaining contract terms, they show limited applicability of Optimising CoC solutions. However, contractual solutions that set a clear transition deadline, such as coal-to-clean PPA procurement, could support the transition of these assets. Most of these solutions remain untested.
 - Regions with high shares of old (more than 20 years) plants in single-buyer markets are East Asia (~11% of all its fleet) and MENAT (~17%)

Key Enablers: Clear policy direction and coordinated planning by system operators can create conditions for plant-level transitions to move forward. In addition to strong offtaker/system operator capabilities, certain legal and regulatory structures to enable the renegotiation of PPAs are required.

4.3 Vertically integrated utility markets

Figure 8. Vertically integrated utility markets: coal-to-clean opportunity



The analysis for VIU markets indicates that:

- A lack of enabling conditions remains a significant barrier to solutions deployment for many assets:** VIU assets are often the focus of policy-driven closure strategies or proposals, such as refinancing (e.g., ratepayer-backed securitisation in the US) or ownership transfer. However, these assets exist in markets where systemic barriers and gaps in the enabling environment – including no clear coal phase-out policy, sovereign credit risk and limited availability of concessional finance – must usually be addressed before transition mechanisms can be effectively deployed.
 - These gaps total up to ~77% of the global fleet in vertically integrated markets with an average age of 16 years
- Solutions are strongly dependent on a utility's access to finance and transition readiness:** Project opportunities prioritised so far have been older, inefficient plants placing strain on utility finances, especially during periods of high fuel costs. Transition pathways for these assets often begin with government-led coordination. Blended structures, backed by multilateral or sovereign finance, are critical to bridging gaps in access to finance and mitigating the risks for inefficient assets. Public financiers play a central role, providing sovereign-level packages that can be on-lent to utilities or directed into specific assets. Analytical insights show younger assets could also be transitioned through similar structures and represent a much larger fraction of the impact potential, but the significant plant balances could entail large financing volumes, which may not be possible given utility or sovereign financing constraints.

Key enablers: Government recognition of the need for transition, combined with strong top-down directives, can attract multilateral funding for jurisdictional-level approaches that link coal phase-out with broader clean energy development. Utility transition plans and the ability for a utility to raise capital against those plans are critical to a transition. Solutions may require regulatory approval.

CHAPTER 5

Unlocking the Next Wave of Coal-to-Clean Projects

Chapters 1 to 4 illustrated how coal-to-clean projects have originated to date, the conditions that influence their readiness, and the solutions that are most applicable across different market structures and asset types. Together, these efforts show that while proven approaches exist and are deployable in some contexts, many coal asset types still remain outside today's solution set, and enabling conditions vary widely across geographies.

Building on the preceding research and analytical evidence, this final section sets out six priorities for unlocking the next wave of projects and growing a replicable coal-to-clean pipeline.

Recommendation one (Category 1) – Scale the pipeline of projects that can deploy proven solutions: In countries with strong enabling conditions, including stronger policies, plans and conditions that support deployment and integration of renewable energy, the priority should be to replicate and scale proven solutions. Debt refinancing or other cost of capital solutions offer an opportunity for replication for young to middle-aged IPP coal plants – particularly when coal retirement can be combined with new clean energy investments that offer upside to investors. To support replication and scaling, MDBs and DFIs could support private capital mobilisation, through standardisation of project parameters, such as GHG emissions impact assessment and calibration, as well as complementary risk mitigation structures and solutions targeted at coal-to-clean projects. In addition, countries can consider testing coal-to-clean procurement mechanisms (e.g., domestic auctions for clean energy paired with coal retirement), as was recommended in the 2024 report.

Recommendation two (Category 2) – Prove out emerging solutions with high scaling potential: The analysis shows that, at a global level, at least one proven coal-to-clean solution, such as debt refinancing or relevering, could support the transition of approximately 33% of the assessed coal fleet (out of 445 GW grid connected coal capacity analysed across 61 countries). Several other coal-to-clean solutions – including additional revenue models such as transition credits, or contractual solutions such as coal-to-clean PPA switching – offer strong potential for replication across the coal fleet, but require additional proof-of-concept and testing in real projects. Some IPP-owned plants are already undergoing feasibility assessments for transition credits. Continuing to develop guardrails and stress-test credible transition crediting approaches in different markets and contexts will be critical to understand risks and replicability. In particular, piloting a transition credit project for a VIU-owned asset can be an important first step to assessing their potential to address some of the ~130 GW of coal in regulated markets. For coal-to-clean PPA projects, contract renegotiation and procurement can be complex and bespoke. As system operators and regulators learn from initial projects, they can work to increasingly clarify contract renegotiation processes.

Recommendation three (Category 2) – Innovate where solutions are still needed: Many assets do not fit neatly into proven models. These contexts require targeted innovation, particularly for state-owned plants in VIU markets and older assets. Governments, public and private energy companies, financiers, and technical partners could collaborate to tailor financial, technical and policy support to develop and de-risk first-of-kind approaches. In VIU markets, solutions are needed to address the

debt constraints many utilities may face. While revenue models such as transition credits offer one outlet, utilities, governments and DFIs can also explore other mechanisms, including off-balance sheet solutions such as managed transition funds or special purpose vehicles or debt-for-climate swaps. For older assets, especially where plants continue to provide grid services (capacity, voltage regulation), countries can explore revenue models to remunerate these services while reducing their generation and overall life. DFIs can also explore possibilities to utilise concessional financing to incentivise site repurposing to clean grid solutions, particularly where these solutions are less commercially viable in EMDEs today (e.g., standalone storage, synchronous condensers).

Recommendation four (Category 3) – Build the enabling foundations where needed: In geographies where stronger enabling conditions are required, the immediate priority should be to invest in the planning, institutional capacity and regulatory environment needed to unlock future coal-to-clean project pipelines. Governments and utilities can lead by setting credible phase-out targets informed by climate science and developing plans aligned with those targets. Technical assistance can help explore different solutions that individually and together enhance grid flexibility. This can help deliver clear business cases for interventions and investments that deliver renewables integration, reserving limited concessional capital for judicious deployment in pilots where absolutely essential. This along with development partners, civil society and technical experts can help build the institutional and regulatory capacity needed to attract investment and ensure equitable outcomes.

Recommendation five – Target concessional finance strategically and seek to catalyse other sorts of finance, including private and innovative finance into transactions: Concessional finance should be deployed where it can have the greatest catalytic effect. Blended finance approaches can be particularly important when piloting emerging mechanisms, such as bringing in private commercial finance as well as use of transition credits. For example, price guarantees for high-integrity transition credits can help de-risk projects while crowding in private finance for coal-to-clean projects. In markets with significant coal fleets that lack strong enabling conditions today, greater concessionality may be justified. This includes support for initial pilots, where they can build ambition or inform broader policy, or to support other enabling activities such as grid flexibility that supports RE integration.

Recommendation six – Improve coordination across the ecosystem: Support for coal-to-clean transitions remains fragmented. Even in markets with enabling conditions, a lack of coordination across project preparation components and stakeholders required to enable project approvals may slow project origination and financing. To address this, financiers can coordinate closely with governments, power sector decision-makers and technical assistance providers to strengthen handoffs, align mandates and share data across the project cycle. The CTC could play a convening role here, helping to consolidate lessons from early pilots and disseminate them across geographies.

Bringing it together

Taken together, these six priorities help establish a set of pathways from today's modest set of coal-to-clean projects towards a replicable global project pipeline. They reflect the central lesson of this technical report: that coal-to-clean transitions succeed where solution maturity, asset context and enabling conditions align. By scaling proven approaches where conditions are favorable, strengthening coordination to reduce friction across the ecosystem, designing targeted innovations for harder-to-transition assets, and investing in the policy and institutional foundations needed in more challenging markets, national and local stakeholders can unlock opportunities to build a credible, investable pathway for the global coal-to-clean transition.

Appendices

A.1: Global coal-to-clean projects

1. Dominican Republic / Itabo and Barahona: In February 2025, the Dominican Republic and Climate Investment Fund's Accelerating Coal Transition programme (CIF ACT) announced an \$85m plan to accelerate the country's coal transition.⁴⁷ \$77.5m of the indicative financing plan is earmarked for the accelerated retirement and replacement of the 270 MW Itabo coal plant and then the 52 MW Barahona coal plant, plus associated transmission system upgrades.
2. Chile / Tocopilla Units 14 and 15: In 2021, Engie Energía Chile (EECL) accelerated the retirements of units 14 and 15 of the Tocopilla coal plant (268 MW) by 22 months as part of a deal with IDB Invest that also financed the 151 MW Calama wind farm.⁴⁸ The blended finance package included a concessional debt tranche whose interest rate decreased given CO₂ savings from accelerated coal unit closure, based on a pre-agreed carbon price.
3. Chile / Mejillones: In June 2023, EECL and the International Finance Corporation (IFC, the World Bank Group's private-sector lending arm) signed a \$400m green and sustainability-linked loan to help the company shift from fossil fuel-based to renewable power generation.⁴⁹ The first key performance indicator tied to the loan's interest rate requires EECL to have retired its remaining 1 GW of coal-fired power by the end of 2026. In line with this, EECL plans to retire units 1 and 2 of the Mejillones coal plant (334 MW) by the end of 2025, convert unit 4 (375 MW) to a gas turbine unit with a synchronous condenser,⁵⁰ and has cancelled plans to build unit 5 (365 MW).⁵¹
4. Chile / Angamos: In October 2022, Chilean IPP AES Andes announced plans to convert its 558 MW Angamos coal plant into 560 MW of molten salt thermal energy storage by 2026.⁵² AES Andes received \$840m from power offtaker BHP group (a copper mining and processing company) for early termination of the PPA for power from the Angamos plant to BHP group – the buyout moved the PPA end date from 2029 to September 2021. Since then, AES Andes has continued to operate the Angamos coal plant by selling power to the Chilean wholesale spot market, and plans to do so until plant retirement and conversion into molten salt storage.⁵³
5. South Africa / Komati: In October 2022, South African utility Eskom officially retired the last unit of the Komati coal plant (125 MW) pursuant a \$497m blended finance package arranged by the World Bank⁵⁴. The project financed the decommissioning of the entire 1 GW coal plant and aims to reskill and redeploy workers to operate renewable energy facilities. As of 2024, Eskom had issued tenders for two RE projects onsite: a 30 MW solar plant and 150 MW of battery storage.⁵⁵

⁴⁷ Climate Investment Funds, Dominican Republic (ACT) Investment Plan, 2025.

⁴⁸ RMI, Transition Finance Case Studies: Tocopilla Units 14 and 15 — Results-Based Loan Incentive, 2024.

⁴⁹ International Finance Corporation, IFC invests in ENGIE's decarbonization program in Chile, 2023.

⁵⁰ Just Transition Finance Lab, Case study ENGIE Chile – tapping multilateral finance to support a just transition, 2024.

⁵¹ Global Energy Monitor, Mejillones Power Station, 2025.

⁵² AES Andes, AES Andes Exploring First-of-its-kind Coal-fired Power Plant to Emission-Free Storage System Conversion, 2022.

⁵³ Global Energy Monitor, Angamos Power Station, 2025.

⁵⁴ World Bank, Factsheet: Eskom Just Energy Transition Project in South Africa, 2023.

⁵⁵ Global Energy Monitor, Komati Power Station, 2025.

6. Indonesia / Cirebon-1: In February 2025, the Indonesian government announced that the retirement of the 660 MW, IPP-owned Cirebon-1 coal plant will be accelerated by 7 years to 2035 using \$300m from the Asian Development Bank's Energy Transition Mechanism (ADB ETM).⁵⁶ As part of the larger Indonesian Just Energy Transition Partnership (JETP) the government plans for the coal plant to be replaced with 1046 MW solar, 1000 MW wind and 12 MW of waste-to-energy.
7. Indonesia / Pelabuhan Ratu: The Indonesian government also announced that the retirement of the 1050 MW, utility-owned Pelabuhan Ratu coal plant will be accelerated by 8 years to 2037 with \$830m in support from the ADB ETM.⁵⁷ The early retirement will be enabled through the sale of the coal plant from current owner Perusahaan Listrik Negara (PLN, Indonesia's state-owned single-buyer utility) to PT Bukit Asam (PTBA, a state-owned mining company).
8. Philippines / SLTEC: In 2022, ACEN Corporation (the energy arm of Ayala Corporation) sold its equity in the 270MW SLTEC coal plant to a special purpose vehicle, reducing the plant's operating life by 25 years to 2040.⁵⁸ By selling to investors with lower return requirements, ACEN enabled an earlier retirement schedule while freeing capital for renewable energy investment. ACEN is also in talks with the Rockefeller Foundation's Coal to Clean Credit Initiative (CCCI) to explore the use of transition credits to further accelerate the plant's retirement by another 10 years.
9. Philippines / Mindanao: In 2024, the Philippines government announced a partnership with the ADB and CIF ACT to accelerate the retirement of the 200MW Mindanao Coal Plant.⁵⁹ The draft CIF ACT plan indicates \$476m in CIF and ADB-arranged financing (a mix of commercial and concessional capital) to decommission the coal plant and accelerate the development of replacement RE.

A.2: Global coal-to-clean initiatives

1. Asian Development Bank's (ADB) Energy Transition Mechanism (ETM): ADB's ETM aims to use blended finance (a mix of commercial and concessional capital) to accelerate the retirement or repurposing of fossil fuel power plants and replace them with clean energy alternatives.⁶⁰ ETM is a scalable, collaborative initiative developed in partnership with developing member countries (DMCs) that will leverage public and private investments – from governments, multilateral banks, private sector investors, philanthropies and long-term investors – to finance country-specific ETM funds in the Asia-Pacific region for early coal asset retirement. The ETM currently supports two planned early retirement projects: Cirebon-1 in Indonesia, and Mindanao in the Philippines.
2. Coal Asset Transition Accelerator (CATA): CATA is a global platform designed to leverage finance and expertise to accelerate the coal-to-clean energy transition. By empowering key stakeholders – including governments, utilities, asset owners, financiers and civil society – with tools, resources and cutting-edge analyses, CATA aims to support the design of just and effective coal transition strategies. Backed by the IKEA Foundation and the Growald Climate Foundation, and initiated by Carbon Trust, RMI, Climate Smart Ventures, and the International Network of Energy Transition Think Tanks, CATA serves as a collaborative hub to drive coordinated action for coal phase-out worldwide.
3. The Coal to Clean Credit Initiative (CCCI): Led by the Rockefeller Foundation with CPI, RMI and South Pole, has developed a carbon crediting methodology to incentivise coal-to-clean transitions. The model envisions issuing "coal-to-clean" credits when coal plants are retired early and replaced with clean alternatives, generating revenue streams that can finance both clean energy investments

⁵⁶ Centre for Research on Energy and Clean Air, Cirebon-1, Indonesia's first coal-to-renewables milestone, 2025.

⁵⁷ Centre for Research on Energy and Clean Air, Cirebon-1, Indonesia's first coal-to-renewables milestone, 2025.

⁵⁸ RMI, Transition Finance Case Studies: ACEN — Project Sale to Special Purpose Vehicle, 2024.

⁵⁹ Climate Investment Funds, Philippines (ACT) Investment Plan, 2024.

⁶⁰ Asian Development Bank, Energy Transition Mechanism, 2024.

and just transition support for workers and communities. CCCI focuses on creating guardrails for high-integrity credits, mobilising buyers, and advancing pilot transactions such as SLTEC in the Philippines, while aiming for global scalability.

4. **Kinetic Coalition:** Kinetic Coalition is an independent non-profit initiative coordinated by the Center for Climate and Energy Solutions (C2ES). It accelerates corporate investment in clean energy systems in emerging economies through the creation and sale of high-integrity energy transition credits. The initiative supports companies in making advance purchase commitments, providing catalytic capital that supports early coal plant retirement, renewables deployment, grid improvements and just-transition measures – while receiving verified emissions reduction credits for their value chains. Initial pilot countries are the Philippines, Chile and the Dominican Republic. The coalition includes over 20 corporate partners such as Amazon, Meta, Mastercard, Netflix, PepsiCo and Schneider Electric.
5. **Climate Investment Fund’s (CIF) Accelerating Coal Transition (ACT) Programme:** CIF-ACT is a multilateral initiative that works with national governments and regional multilateral development banks to help coal-dependent countries transition towards clean energy in a just and sustainable manner by providing concessional finance and technical assistance to accelerate the early retirement or repurposing of coal power assets, while supporting economic diversification and social protection for affected workers and communities. ACT was launched in 2021 as part of the broader Climate Investment Funds portfolio and aims to mobilise blended public and private capital to drive change in power sectors heavily reliant on coal. The programme currently supports pilot investments in the Dominican Republic, Indonesia, North Macedonia, Philippines and South Africa.
6. **Energy Transition Accelerator (ETA):** The ETA is a carbon finance platform backed by the US Department of State, Bezos Earth Fund and Rockefeller Foundation to catalyze finance for the clean energy transition in developing economies. ETA aims to connect governments, utilities and private stakeholders to create sector-wide decarbonisation through the creation and sales of high-integrity, sector-scale carbon credits.
7. **Indonesia Just Energy Transition Partnership (JETP):** Indonesia’s JETP commits \$20 billion in blended public and private financing to accelerate the country’s decarbonisation, with a focus on retiring coal plants, expanding renewables, strengthening transmission and supporting just transition priorities. The JETP’s Comprehensive Investment and Policy Plan (CIPP) has highlighted two early coal retirement pilots, Cirebon-1 (in partnership with ADB ETM and CIF ACT) and Pelabuhan Ratu.
8. **Monetary Authority of Singapore’s (MAS) Transition Credits Coalition (TRACTION):** TRACTION aims to use high-integrity carbon credits to scale the early retirement of coal plants in Asia. The coalition brings together nearly 30 partners across finance, energy and policy to define standards for integrity, demonstrate pilot transactions and build market demand. Workstreams focus on developing credit methodologies, ensuring transaction viability and replicability, and driving confidence among buyers for both compliance and voluntary markets. Early pilots are expected in the Philippines, with wider applicability across Southeast Asia.
9. **North Macedonia Just Energy Transition Investment Plan (JETIP):** North Macedonia’s JETIP, supported through the Climate Investment Funds’ (CIF) Accelerating Coal Transition (ACT) programme, provides a country-level investment framework for phasing out coal and scaling clean energy. The plan is backed by US\$85 million in concessional CIF funding, which is expected to catalyse around €3 billion (US\$3.4 billion) in total investment by 2030. Funding will support early coal retirement, just transition measures for workers and communities, and investments in renewable energy and grid modernisation. It represents one of the first JETIPs in Eastern Europe, highlighting how CIF-ACT financing can be tailored to coal-dependent economies beyond Asia and Africa.

10. **Regulatory Energy Transition Accelerator (RETA):** RETA is a global initiative aimed at strengthening the regulatory foundations needed to accelerate energy transitions. Convened by the International Energy Agency (IEA), the International Renewable Energy Agency (IRENA), and other partners, RETA works with national regulators to modernise frameworks that govern electricity markets, grid integration and investment conditions. By providing technical assistance, peer learning and best practices, RETA seeks to ensure that regulatory systems enable coal retirement, clean energy integration and investment mobilisation.
11. **South Africa Just Energy Transition Partnership (JETP):** South Africa's JETP, announced at COP26, commits \$8.5 billion from a coalition of international partners to support the country's decarbonisation goals. Funding is directed toward accelerating the decommissioning of coal plants, deploying renewable energy at scale, strengthening grid infrastructure, and ensuring just transition support for affected workers and communities. The JETP is structured around South Africa's Just Energy Transition Investment Plan (JET-IP), which prioritises around 15 GW of coal retirements by 2030 and associated clean energy replacements.
12. **World Economic Forum's (WEF) Coal to Renewables:** The WEF's Coal to Renewables initiative convenes global stakeholders across finance, utilities and governments to identify scalable models for early retirement and replacement of coal assets with clean energy sources. By combining policy dialogue, private-sector engagement and knowledge sharing, the initiative aims to accelerate investment in coal-to-clean transitions, with a focus on creating bankable pathways that align utility incentives with early retirement. The platform emphasises collaboration across regions to replicate successful models and mobilise blended finance for coal-to-renewables projects globally.
13. **Energy Transition Council (ETC) — Rapid Response Facility (RRF):** The RRF, launched under the COP26 Energy Transition Council, provides fast-track technical assistance to developing countries to support energy transitions. Backed by donor governments, international institutions and philanthropies, the RRF prioritises areas such as integrated energy planning, utility-scale renewables, coal and fossil fuel transition, investment policies, green grids, energy efficiency, distributed renewables and just transition. Delivery partners provide expertise to help countries overcome transition obstacles and mobilise larger-scale finance.
14. **Southeast Asia Energy Transition Partnership (ETP):** The ETP is a five-year, multi-donor initiative hosted by UNOPS and supported by governments and philanthropies, working to accelerate sustainable energy transitions across Southeast Asia. Established in 2020, it helps partner countries align energy policies with Paris Agreement and SDG goals, mobilising coordinated technical and financial assistance for renewable energy deployment, energy efficiency improvements, coal phasedown support and resilient infrastructure. The ETP supports four strategic outcomes: aligning climate policy, de-risking investments, strengthening governance and regulation, and building regional capacity.
15. **Clean Energy Bridge:** Clean Energy Bridge is a decarbonisation development company focused on accelerating coal-to-clean transactions in emerging markets. Supported by philanthropic grants and working in partnership with the Coal Asset Transition Accelerator (CATA), CEB originates projects, structures bankable transactions and manages stakeholder relationships to ensure successful outcomes. Its model leverages concessional capital, carbon markets and PPAs to de-risk investments and attract large-scale private finance.
16. **Reviva:** Reviva is an Abu Dhabi-based initiative that supports coal asset owners in commercially viable decarbonisation efforts through active ownership and strategic investment. Reviva's vision is to place coal assets under stewardship for early retirement and transition to renewables. Its approach combines equity investment with tailored asset management strategies, allowing returns to be recycled into further decarbonisation. Reviva leverages a global ecosystem of utilities, financiers, technical experts and developers to deploy solutions ranging from early plant decommissioning to hybridisation and repurposing.

A.3: Data analysis methodology for global coal fleet analysis

Objective and scope

The objective of the analysis is to identify assets that may be suitable for early retirement using specific coal transition mechanisms (CTMs). The analysis screens the global, grid-connected coal-fired power fleet against key country- and asset-level factors to assess whether a coal asset may be suitable for using different CTMs. The scope of the analysis was global and focused on operating coal plants, with the exception of coal plants in the following countries:

- China, India and the United States were not screened given both their substantial coal fleets and the importance of subnational factors in determining the suitability and enabling conditions for different CTMs. Screening of assets in these markets would require additional data and analytical granularity.
- North Korea and Russia were not screened due to potential challenges in mobilising public and private finance, particularly international finance, to support CTMs in these markets.

The following table maps the discrete coal transition mechanism considered in the analysis, as well as their stage of implementation:

Mechanism category	Stage of implementation		
	Existing + Implemented	In piloting	Conceptual
Optimising CoC	Relevering, Refinancing, Asset sale/change of ownership		Aggregation of a diverse portfolio, Extending loan tenor, Bad Bank model, Debt Forgiveness
Contractual solutions	Sustainability-linked or performance-based instruments	Coal-to-clean PPA, Contract Renewal for Retirement	
Additional Revenue		Transition credits	Jurisdictional credits, Revenue models for coal flexibility, Auctions

The screening approach is two-tiered:

1. **Country-level filters** determine whether enabling conditions exist for each financial mechanism.
2. **Plant-level filters** assess whether specific coal assets are suitable for each mechanism, according to their status, design and typical asset requirements.

The outcome is a plant-by-plant match of assets to mechanisms, that is then aggregated by stage (implemented, in piloting or conceptual), type (Optimising Cost of Capital, Contractual Solutions, or Additional Revenue Models), or region.

Country-level screening

The first step of the analysis was a screening at the country-level focused on assessing the enabling conditions for existing coal transition mechanisms to be deployed. Country-level factors included:

- Power system composition and renewable energy trends: share of coal in capacity and generation, renewable penetration and national renewable targets, the presence of energy storage to support balancing and grid flexibility
- Governance and policy factors: overall market structure, concentration of coal asset ownership, or existence of coal moratoria or phase-out commitments
- Financing environment, such as sovereign credit ratings.

These conditions were assessed using 2023 data from Ember (coal and renewables), BloombergNEF (storage), S&P/Fitch/Moody's (credit ratings), GEM Global Coal Plant Tracker (ownership and asset characteristics), GEM Coal Project Finance Tracker (project finance status) and World Bank/IEA (market structure and coal commitments).

Each country was assessed against threshold conditions for these indicators. Where indicators were not binary conditions, thresholds for comparison were derived from international benchmarks, structural definitions or policy-specific logic, as defined by the following table:

Metric	Comparison Logic
Coal Capacity	Countries with high coal dependency are those whose % of coal capacity is above the weighted global average % of coal capacity = 24.7%, based on Ember 2023 data
Coal Generation	Countries with high coal dependency are those whose % of coal generation exceeds the weighted global average share of generation from coal = 35.4%, based on Ember 2023 data
Fleet-wide utilisation factor	Assumed that lower than 40% fleet-wide utilisation signals more seasonal or flexible coal usage, while higher than 60% signals a more prevalent role in basic resource adequacy.
2030 RE Target – Generation %	Average growth rate of the share of RE to 2030 should exceed historical demand growth (based on past 10 years of demand data)
Credit rating	Credit ratings are considered investable if it's ▪ Above BBB-/Baa3 or ▪ In the B range with a positive outlook
Asset Owner Concentration (Herfindahl-Hirschman Index or 'HHI')	If HHI is larger than 2500, the # of asset owners are considered low. HHI = Sum of (each owner's share of total coal capacity) ²
Market Structure	Based on the World Bank power sector classification, countries in categories 1a and 1b are classified as Vertically Integrated (VI). Countries in 2a and 2b are classified based on the share of Independent Power Producers (IPPs): If IPPs ≤ 40%, the market is considered effectively VI. If IPPs > 40%, the market is considered a Single Buyer model. Countries in 3a, 3b, 4a and 4b are considered deregulated

The output of this stage was to sort countries into two categories: 1) countries with enabling conditions that could support implementation of an existing CTM, and 2) countries that today lack enabling conditions to deploy any of the existing CTMs. Countries were then aggregated into regions, according to the following groupings:

Regional grouping	Countries
Latin America & Caribbean	Argentina, Brazil, Chile, Colombia, Dominican Republic, Guatemala, Mexico
North America	Canada
Oceania	Australia, New Caledonia, New Zealand
Europe	Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Italy, Kosovo, Netherlands, North Macedonia, Poland, Romania, Serbia, Slovakia, Slovenia, Spain, Ukraine
Sub-Saharan Africa	Botswana, Mauritius, Namibia, Senegal, South Africa, Zambia, Zimbabwe
MENAT	Israel, Morocco, Türkiye
South Asia	Bangladesh, Pakistan, Sri Lanka
ASEAN	Cambodia, Indonesia, Laos, Malaysia, Philippines, Thailand, Vietnam
East Asia	Hong Kong, Japan, Mongolia, South Korea, Taiwan
Central Asia	Kazakhstan, Kyrgyzstan, Tajikistan, Uzbekistan

For example, for an asset sale or change of ownership model to work, there are the enabling conditions that a country must exhibit:

- A deregulated or single-buyer market structure that does not set regulatory limitations for ownership changes of IPP assets
- A coal phase-out commitment OR a coal moratorium that sets a clear deadline for retirement after the sale of the asset
- Enough estimated clean energy capacity in the pipeline by 2030 for the replacement resources to be feasible
- A stable economic landscape with an investable environment that attracts new investors

A country that meets criteria a) through d) above by using the thresholds in the previous table is ruled in as having the enabling conditions to support implementation of an asset sale/change of ownership model. A similar logic was followed for each existing and implemented CTM at a country level. For instance, auctions and portfolio aggregators require a diversified market, so the HHI index was used as criteria; or a relieving mechanism is more feasible with medium to high utilisation factors to ensure there's enough market share to repay new incoming debt. Coal capacity and generation percentages were used to assess the market potential of portfolio-based approaches or for exclusively sovereign-level mechanisms (auctions, portfolio aggregation, debt forgiveness, etc.), but for the remainder of mechanisms these were only used to parse out coal-dependent economies and their most promising solutions.

Plant-level screening

The second stage evaluated each operating, non-captive coal plant against specific plant-level criteria that are usually required for a certain coal transition mechanism to be effective. Unit-level information was consolidated into plant-level profiles by combining installed capacity with weighted averages for age and heat rate, and composite ownership and financing characteristics.

The remaining set was analysed using indicators such as age, capacity (absolute and relative to national fleet), efficiency (heat rate), ownership type and financing profile. These indicators were selected to reflect both technical performance and financial readiness for transition, as follows:

Metric	Description	Level of comparison	Threshold for a low value	Threshold for a medium value	Threshold for a high value
Age	Years since commissioning	Global fleet	Lower than the midpoint between the average and the lowest value	Higher than the midpoint between the average and the lowest value, but lower than the average	Higher than the average
Absolute Size (MW)	Installed nameplate capacity	Global fleet	Lower than the midpoint between the average and the lowest value	Higher than the midpoint between the average and the lowest value, but lower than the average	Higher than the average
Relative Size (%)	Share of total national coal capacity = capacity of plant/total installed capacity of the country	Country's fleet	Lower than the midpoint between the average and the lowest value	Higher than the midpoint between the average and the lowest value, but lower than the average	Higher than the average
Heat Rate (Btu/kWh)	Proxy for plant efficiency	Country's fleet	Lower than the midpoint between the average and the lowest value	Higher than the midpoint between the average and the lowest value, but lower than the average	Higher than the average
Ownership	IPP or state-owned	NA			
Use of Project Finance	Based on whether the asset is included in the GEM Project Finance tracker	NA			
Repaid Loan Boolean	For project financed assets, whether the project-level loans are fully repaid	NA			
% Loan	Share of loan in the total financing	Global fleet	Less than 50%	50-60%	More than 60%
Planned retirement	Planned retirement year per public system-level plans	NA			

Project finance data, including repayment status and loan share, were incorporated to analyse mechanisms where refinancing or debt restructuring would be relevant. Plants not present in GEM Project Finance Tracker were assumed to have not used any form of financing at a project level, which could overall create a bias towards the analysis missing opportunities for refinancing or leveraging. Metrics were assessed both on absolute terms and in relation to the national fleet, ensuring comparability across contexts.

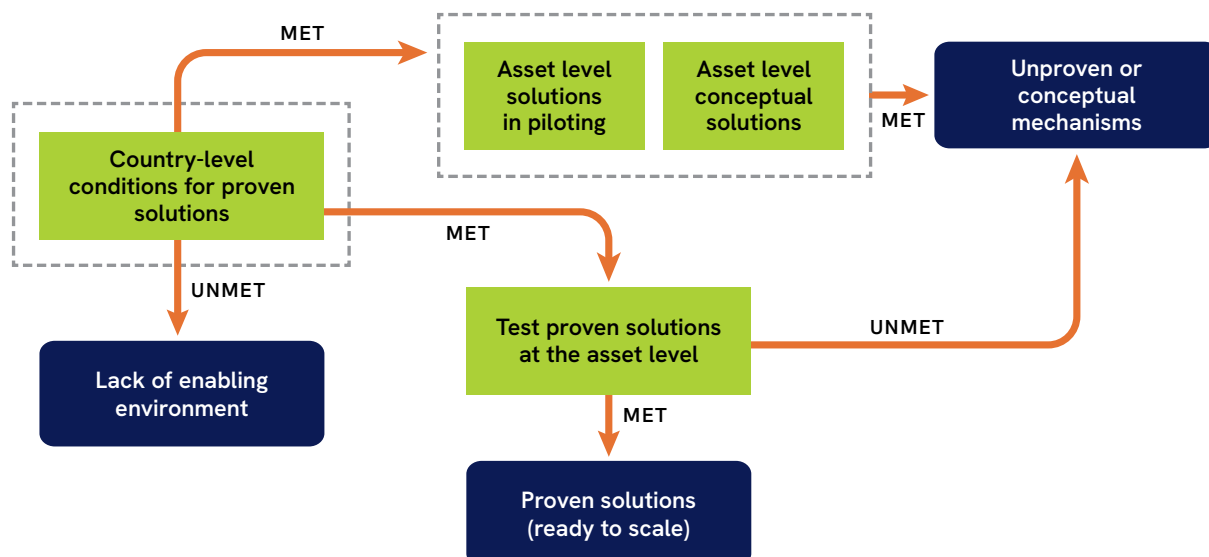
To continue the example for an asset sale or change of ownership model to work at the plant level, the characteristics that an asset must have to be compatible with such CTM include:

- At least middle-aged, but if the asset is old it should meet a low heat rate as an indication of continued profitability
- Not a state-owned asset
- The plant should not be signalled for retirement in system-level plans earlier than four years from now

An asset that meets criteria a) through c) above by using the thresholds in the previous table is considered compatible with an asset sale/change of ownership model. A similar logic was followed for each existing and implemented CTM at a plant level. For instance, a criteria for refinancing is that the original amount of loan in a project finance needs to be high for the refinancing to have enough capital cost reduction to be effective.

Results framework

The country-level and asset-level screening methods outlined above were combined to bucket countries and their coal assets within the categories showcased in the results according to the following chart:



Contact

For further details and questions on this methodology, please contact RMI by emailing tmatsuo@rmi.org and dangel@rmi.org.

About the Coal Transition Commission

The Coal Transition Commission brings together governments, financial institutions, industry, international organisations, and experts to identify practical solutions to help countries overcome the challenges and access the benefits of the coal-to-clean transition. It is co-chaired by the French and Indonesian Governments and supported by the Powering Past Coal Alliance.

For more information, please visit
[poweringpastcoal.org/strands-of-work/
coal-transition-commission](https://poweringpastcoal.org/strands-of-work/coal-transition-commission)