

From coal to clean

Expediting Asia's transition
to renewable energy

Invested in meaningful outcomes

Foreword



The energy sector is at a critical juncture – transitioning from climate and community damaging fossil fuels to low carbon sources. On top of this, there's the challenge of meeting increasing energy demands and achieving decarbonisation goals, while maintaining economic growth, minimising stakeholder and environmental impacts and ensuring affordability. Achieving the collective goal of limiting global warming to 1.5°C heavily relies on the energy transition needing a viable and feasible path forward.

Coal power remains the single biggest contributor to climate change and generated 35 percent of global electricity in 2023¹. According to the International Energy Agency's net zero emissions scenario, OECD (Organisation for Economic Co-operation and Development) countries need to reduce the share of coal in the power mix down to 14 percent by 2030, and the rest of the world must stop burning coal by 2040². The latest IPCC models reinforce this timing.

Forward-thinking energy companies are realising the growth opportunities from retiring and transitioning coal-fired power assets. While the countries are different, many of the challenges faced in closing and repurposing energy assets in Australia and Asia are the same. However, to achieve long-term ambition and near-term goals, organisations need a tried and tested plan that can be adapted in-region.

No one organisation can achieve the energy transition alone. The urgency of the challenge demands the pooling of learnings, knowledge and strategies. Positively, over the last 12 months in Australia, progress in the coal to clean transition is being made at the scale required to make the changes we desperately need to see.

GHD has been working with multi-billion dollar, publicly listed and government operated energy companies on their planning, provisioning and repurposing considerations across more than 12 gigawatts (GW) of coal-fire power generation closures.

This paper highlights the key areas that we have observed and define as an effective energy transition strategy, serving to inform other organisations currently considering their pathways and options. For purposes of knowledge sharing, we apply learnings from our involvement in planning, development, operation of repurposed sites and renewable batteries, hydro-electric, wind, and solar assets, as well as important considerations in energy supply firming.

The top three takeaways? While every project requires bespoke strategy and planning, the need for secure and stable technical solutions that optimise and define low carbon energy options is critical. Secondly, every project must minimise impacts and maximise sustainable stakeholder and environmental benefits. And finally, asset energy transitions must have a strong business case that de-risks the commercial imperative and solution.

Ultimately, decarbonisation and energy transition success arrives from thorough stakeholder engagement, technical definition, sequencing and timeframes, understanding of true costs, and capability and capacity of supporting infrastructure all of which inform de-risking of planning, approval and delivery alongside government and financial support. These are all important elements of devising a transition plan for assets while laying out a vision that is clear, achievable and reasonable.

Today we are armed with more information, best practices and principles to apply to the energy transition challenge however, there are generally no financial incentives to drive decarbonisation at the required cadence. More effort is needed in developing a financing strategy that leverages a mix of loans, grants and technical assistance from special funds, not as subsidies to level the playing field. We believe we cannot successfully transition if low carbon solutions are a penalised alternative to fossil fuels in a world that does not price carbon. We largely have what it takes to make the necessary and urgent moves in the right direction.



Coal to clean transition drivers

Decarbonising the Asia region is key to worldwide carbon reduction. Heightened by economic growth and increasing energy demand, carbon emissions in developing Asia now account for more than half of the world's emissions³. The obstacles of industrial structures, social contexts, geographical factors, as well as the stage and rate of development, all vary from country to country – demanding various pathways, scenarios and options.

The phase-out of unabated coal power is crucial for meeting climate agreements in coal-dependent economies such as Indonesia and Vietnam. Southeast Asia had about 106 GW of active coal fired power capacity and another 40 GW in the pipeline as of July 2023. This was behind only China, India and the United States⁴. The Asia region has a particularly young coal power fleet, with an average plant age of about 13 years as of 2023⁵, meaning closure and asset retirement is not aligned with meeting decarbonisation targets.

According to the World Economic Forum⁶, larger scale policy programs have the potential to accelerate the retirement of plants in a more efficient manner than looking at a case-by-case basis. Governments and private funding sources will need to broaden their appraisal processes and lending capacities to put it into practice. Favourable economics for renewables on their own, will often not be enough to secure rapid coal transitions. There is more than USD 1 trillion of capital yet to be recovered from today's coal plants⁷, which creates a potentially powerful constituency in favour of their continued operation.

Many coal plants are shielded from market competition, in some cases because they are owned by incumbent utilities, in others because private owners are protected by inflexible power purchase agreements. In Vietnam, for example, such agreements govern the operation of around half the fleet. Innovative financing mechanisms have an important role in accelerating the pace of change. Outside China, where low-cost financing is the norm, the weighted average cost of capital for coal plant owners and operators is around seven percent. Bringing this down by three percentage points through refinancing would accelerate the point at which owners recoup their initial investment, clearing a path for one-third of the global coal fleet to be retired or repurposed within ten years.



“ Half of the 100 financial institutions that have supported coal-related projects since 2010 have not made any commitments to restrict such financing, and a further 20 percent have made only relatively weak pledges. Stepping up policy and financial support for cost-competitive clean sources of generation, including international climate finance, is essential to close off avenues for continued growth in coal-fired capacity.”

- International Energy Agency

GHD Advisory: From coal to clean

A tried and tested, future-ready strategic approach for energy leaders

While the world desperately needs a rapid scale up of clean energy generation and infrastructure, a considered transition with proper planning and execution is critical. The approach must interconnect closure strategy and future energy transition ambitions using a framework that ensures consistent information and assumptions – paving the way to consider alternative scenarios and the impact of repurposing, and value-add plays.

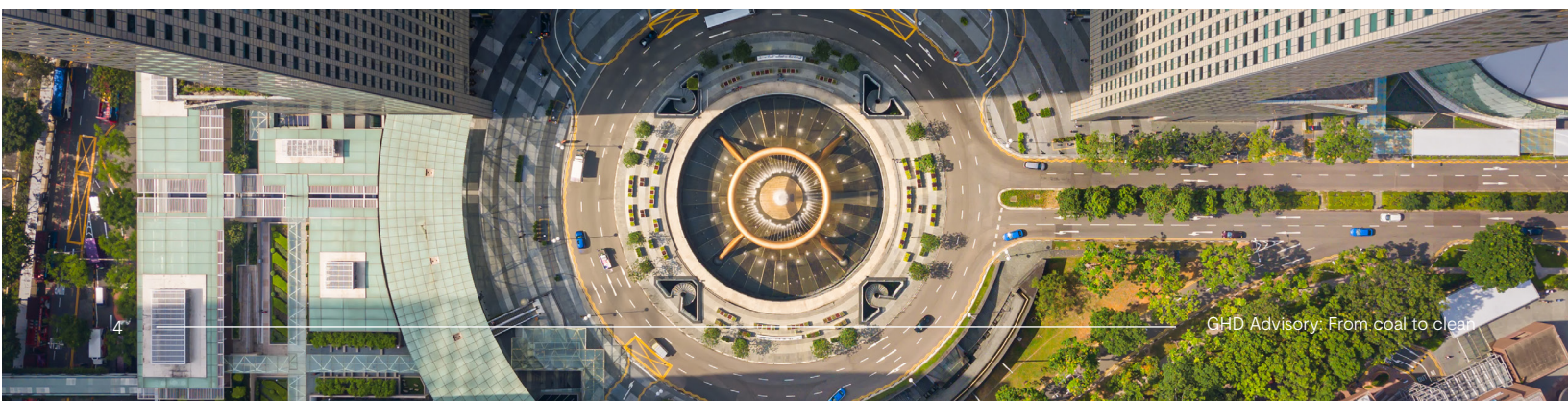
Strategy: Future state planning creates an informed context for scenario modelling, blending quantitative and qualitative analyses. As part of this first step, market trends, comparative benchmarking (provincially, nationally and internationally), techno-economic modelling and gameplay simulation are a few additional techniques to consider. Review the financial capital expenditure, operational costs and potential revenue streams. Develop a funding strategy that leverages government grants, public-private partnerships and other financing options. The cost to replace energy is an important and often overlooked factor. The time to achieve a “firmed supply of the replacement energy” is evolving as a critical influence, especially for emerging economies (or non-OECD) jurisdictions.

Technology and partnerships: Harnessing emerging technologies such as battery storage, carbon capture, and hydrogen complements renewable energy solutions, and future-proofs replacement assets. This includes exploring and investing in alternative technologies or solutions to reduce the risks associated with the main technology being used or developed. Once you have determined your most likely energy mix scenario, establish a partnership ecosystem to accelerate project development, lower risk profiles and facilitate knowledge transfer. Building renewable energy infrastructure requires the mobilisation of new materials and repurposed equipment. And in some cases, securing access to what's needed to facilitate asset transition projects is delayed by long lead times and supply chain challenges. Additionally, price fluctuations and shortages can be cause for concern.

Workforce: Assess the workforce requirements for implementing your plan, including the need for skilled labour, training programs for your current workforce and workforce transition plans for employees affected by the phasing out of existing generation plants. Collaborative policy action is essential for developing skills in harnessing transformation for the renewable energy workforce. The private sector can adapt recruitment strategies for emerging renewable energy technologies and governments can implement policies to support renewable energy education and training to address the skills mismatches.

Customer and markets: Electricity demand forecasting forms part of this consideration. Refine your demand forecasting models to account for factors such as population growth, industrial expansion and the electrification of transportation and heating and cooling. Ensure that your supply plan aligns with projected demand trends. As well as correctly provisioning for risk-adjusted asset closure costs, work to understand the constraints and opportunities around the existing asset base, leading to opportunities for repurposing and leveraging shared infrastructure.

Community and stakeholders: Building consensus among stakeholders through transparent dialogue and incorporating community and environmental considerations into planning processes. Gathering insights on community and workforce sentiment to support organisations in understanding critical issues and key opinions, while derisking complexity.



Global best practices to apply

① Asset closure and decommissioning:

The future state of an existing asset, considers the need for how to manage its closure. Conversations around repurposing the asset should include risk analysis within planning and estimating, future state options evaluation, liability management and resource budgeting. The most successful asset transition projects are nested within a broader transition context, including portfolio and strategic alignment, workforce transition, market analysis, technology integration and developing the right partnerships.

② Build a central source of truth:

Develop a closure model with consistent information/assumptions and the ability to consider alternative scenarios. The model should be built with appropriate levels of materiality and the ability to support regulatory disclosures, internal and external reporting. Outputs should also be used to support active community and stakeholder engagement.

③ Bring people on the journey:

Any change or transition works best when organisation and community values are aligned to the effort. Success comes from thorough education and awareness programs, as well as government approval that drives engagement across the all-stakeholder groups. Ensuring consistent messaging will drive trust and help to overcome resistance. Workforce and community buy-in will shape the path forward and ensure the transition is met with acceptance and support – critical for successful change implementation.

④ Testing delivery and contractor models early:

Early contractor and consultant involvement is key to understanding skill requirements, likely costs, being able to execute new hire strategies early and securing what will be highly sought after skills. Consider different delivery model approaches in the context of desired risk transfer and consideration of outsourcing versus self-performance activities. Examine how financial models should be integrated with contractor delivery models to provide access to existing infrastructure. Ensuring closure planning involves people from senior management, accounting, HR and on the ground operators from all sub-assets will minimise the potential to underestimate owners' costs.

⑤ Limit stagnation in execution:

Considering the breadth and depth of the challenge ahead can lead to an over-focus on planning and paralysis in execution, missing out on incremental progress that aligns with the long-term goal. Your transition plan should detail options and scenarios to avoid stagnation. This requires clearly identifying the actionable solutions that can be taken in the nearer term that align with the interests of the broader stakeholder community and contribute towards the long-term vision. Key to this is stakeholder engagement and confidence in decision-making. Drive a collaborative process, combined with modelling and evaluation of scenarios.

⑥ Consider the potential:

The energy asset presents unique attributes that can be leveraged for future uses that create value. In evaluating these options, it is important to explore a diversified energy portfolio that balances a mix of renewable sources, including solar, wind, hydro, and emerging technologies like tidal and geothermal energy. Recognising the intermittent nature of renewables, it is also necessary to embrace storage innovations that bridge the gap between energy demand and renewable generation, with the potential for such technologies to enhance the flexibility and resilience of the energy system.

⑦ Integrating intermittent renewables and storage:

Demands a reimagination of grid architecture and sophisticated grid management solutions. The development of smart grids equipped with real-time monitoring, demand response capabilities and advanced analytics that has demonstrated their critical role in enhancing grid stability and efficiency. By adopting such smart grid technologies, including integrating networked microgrids, you can not only improve the reliability of its energy supply, but also empower consumers to play an active role in energy management, fostering a more dynamic and responsive energy ecosystem.

⑧ Sustainable energy systems:

GHD's work on energy projects points to the potential of decentralised energy systems and the role of inter-industry planning in facilitating energy transition. Integrating renewable energy generation and storage solutions within urban infrastructure, farms, forestry and mining sites allows these players to become active participants in the energy landscape. Beyond this, consideration needs to include maintaining stable energy grid supply during the transition.

⑨ Strategic policy and regulatory support:

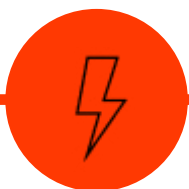
Navigating complex and evolving regulatory environments and advocating for policies that accelerate the energy transition is essential. Embracing stakeholder consultations through to drafting policy recommendations, the importance of a conducive policy framework in unlocking investment, encouraging innovation and ensuring a just energy transition forms a key workstream. Engaging proactively with policymakers, regulators and the community to shape supportive energy policies can significantly enhance the feasibility and success of the transition plan.

⑩ Foster collaboration for innovation:

A recurrent theme in every energy transition project has been the power of collaboration in driving innovation. By fostering partnerships between governments, industry, academia and communities we have seen the development of groundbreaking solutions to energy challenges. You can leverage this approach by cultivating a collaborative ecosystem that encourages knowledge sharing, co-investment in research and development and joint initiatives aimed at achieving shared sustainability goals.

Real-world asset closure and transition deep dive

From GHD's experience in project delivery, the coal to clean transition must be benefit-driven across the following three areas:



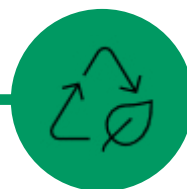
Energy industry

- **Energy infrastructure**
repurposing and enhancement or modernisation.
- **Energy security**
surety and resilience in energy supply.
- **Construction**
decommissioning/demolition as well as building.
- **Manufacture**
equipment fabrication, production repurposing and supply chain issues.



Community

- **Workforce and jobs**
repurposing and workforce upskilling.
- **Community infrastructure**
repurposing and enhancement or modernisation.
- **Community health**
reduced contaminant release and consumption in air, water and food.



Environment

- **Atmospheric**
reduced greenhouse gas/carbon emission, and reductions in other localised pollutants to air. Use of life cycles tools to define overall benefits.
- **Land**
avoidance of coal sourcing and supply, generating asset land contamination, cleaner land use, as well as avoidance in impact to flora and fauna.
- **Water**
avoidance of surface and groundwater contamination and resource depletion, as well as avoidance of impact to fresh and saline water flora and fauna.

GHD observes successful closure and/or repurposing transition outcomes are most influenced by building a very clear understanding of all transition activities, their sequencing/staging and interdependencies/influences.

Presented below are common challenges with corresponding considerations to address them.

Challenge

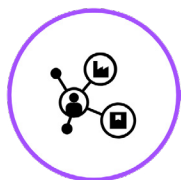
Experience, observations or impacts



Development of detailed transition

Observations show that failure to develop and confirm a clear mandate of the final state asset and any closure, replacement/substitute or repurposing presents a serious impediment to planning and option assessment.

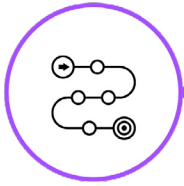
- Approximately half of operators fail to get near this timeline and as such inherit over two years' delay at the start of planning and closure execution, including replacement/substitute or repurposing option. This can add an estimated 20 percent more to costs.
- In about ten to 15 percent of cases this also substantially impacts stakeholder engagement (including permits and approvals) driving delays of over two years and driving up around ten to 20 percent of costs.



Access to key supply chain resources

Energy operators must adequately prepare for access to supply chain (equipment and construction) resources to avoid delays, replacement/substitute or repurposing increased costs.

- Access to new asset supply chain resources adds substantial cost and likely three years delay
- The same applies to access to existing infrastructure and resources.



Development of detailed transition timeline

A lack of developed schedule for closure and transition leads to problems and unexpected execution challenges.

- Challenges in defining key closure, replacement/substitute or repurposing stages and activity sequencing especially in defining overlapping efforts.
 - * Key stages are pre-planning/planning, closure (through to switch off at last megawatt (MW)), decommissioning, demolition, remediation and aftercare activities as well as overlapping replacement/substitute or repurposing activities.
 - * Observations indicate that about three quarters of energy operators underestimate these by:
 - Pre-planning/planning: three to five years (most energy operators are approximately one to two years short).
 - Closure: typically, six to 12 months adds approximately five percent in overall funding for disconnection.
 - Decommissioning: around one to two years (energy operators understated by about 100 percent).
 - Demolition: varies enormously by the level of “scrap” recovery and individual asset characteristics. Direct cost (without recovery) is often understated by 100 percent in funding needed. Typically, this takes two to five years. Actual demolition timing is overstated by around 30 percent. On a comparison scale we see approximately USD50k to 250k per MW (for large coal fired power station depending on specific asset complexities and characteristics).
 - Remediation: often understated on scope. Takes three to five years. Can be about 100 percent in understated funding.
 - Aftercare: allow 15 to 20+ years. This is commonly underestimated. Often twice the time originally considered and needing about 300 percent greater funding.
 - * For more than 80 percent of energy operators, failure to have a detailed transition schedule delays execution by at least one to two years.
 - * Improper consideration of each stage can also lead to poor resource loading and delivery timing inconsistencies. This can result in a 20–40 percent increase in costs to close support resource gaps.
- Resourcing gaps can also lead to broader stakeholder impacts around energy security. For large coal fired power stations there are two project examples which have shown more than two and up to five years potential delay in successful transition.
- Energy security must also consider temporary transitional energy supply (if needed).

GHD analysis reveals that successful coal power station closure and transitions are dependent on a thorough assessment of transition delivery timeframes, such as scenarios with combinations of asset adjustment and development sequencing. There are specific interdependencies for each repurposing, remediation and aftercare. These areas are significantly impacted by equipment supply chain competition, construction and commissioning capacity timing, which range between three to five years. In nearly all cases the capability and capacity of supporting infrastructure is identified as a limitation to energy asset transition. This typically presents itself by potentially delaying the start of the transition or impacting the execution.



Financing the coal to clean energy transition

The IPCC cites finance as one of the critical enablers for accelerating the transition. However, access to finance is fundamentally unequal across countries and, as a result, it can be a barrier to mitigation and adaptation investment. Developing countries and renewable energy sources in particular face high investment risks that are reflected in a high cost of capital for projects. Managing such costs is a key challenge in mobilising private funding for the energy transition in the developing world. Organisations have a role to play in creating solid coal to renewables transition plans will positively position themselves within investor space.

Clear and adequate financial mechanisms have a very broad and impactful influence. Smarter use of public finance will need to come with much more private capital.

Overall support is needed to fund planning, decommissioning/demolition, remediation, asset repurposing and aftercare/operation. Financial instruments to support this are many and bespoke.

Experience shows capital at the beginning and then at the end of the project is most critical. However, thought does need to be given to sequential asset transition need and possible deferred capital sequencing throughout transition.

Energy investments today in emerging and developing economies rely heavily on public sources of finance, but International Energy Agency climate-driven scenarios point to over 70 percent of clean energy investments are privately financed, especially in renewable power and efficiency.



Establishing the middle ground through a just transition

Balancing cost-effectiveness, the environment and provision of stable power is a key question for all energy providers seeking to decarbonise. The impacts of the energy transition are apparent, but are they felt equally among the various sectors and stakeholders involved? That being the case, it becomes imperative that a just transition should have a comprehensive approach that emphasises fairness and equity and minimises adverse effects on communities and workers.

Learning from the past and the present

Lessons from past transitions underscore the importance of proactive planning, engaging with stakeholders and affected communities meaningfully and providing viable alternatives for workers in declining industries. A just transition should then emphasise social inclusion, worker retraining and community support. A just transition also means de-risking investment profiles. Uncertainty creates risk, so setting clear and stable policies can encourage more investments and the timely deployment of projects.

Securing industry buy-in

A just transition has a substantial role at the big-business level, especially in changing the influential players in the economy. If your organisation can transition an extensive system at the heart of this, all big-business supply chains will need to transition to meet their goals. Strategies include incentivising clean-technology adoption, supporting research and development and fostering partnerships between government, industry and academia.

Addressing transition costs and equitable distribution

A just transition ensures that communities are not disenfranchised or excluded from the process because of the cost factor, especially Indigenous and other marginalised groups. The benefits from the new economic base should reach all sectors of the community. Transparency and education campaigns are crucial to explaining necessary investments to the public. Sharing long-term benefits, such as reduced emissions and job creation, can help garner public support. Equitable cost distribution can be achieved through progressive policies, subsidies for vulnerable populations and mechanisms like carbon pricing, ensuring that the burden is shared fairly.

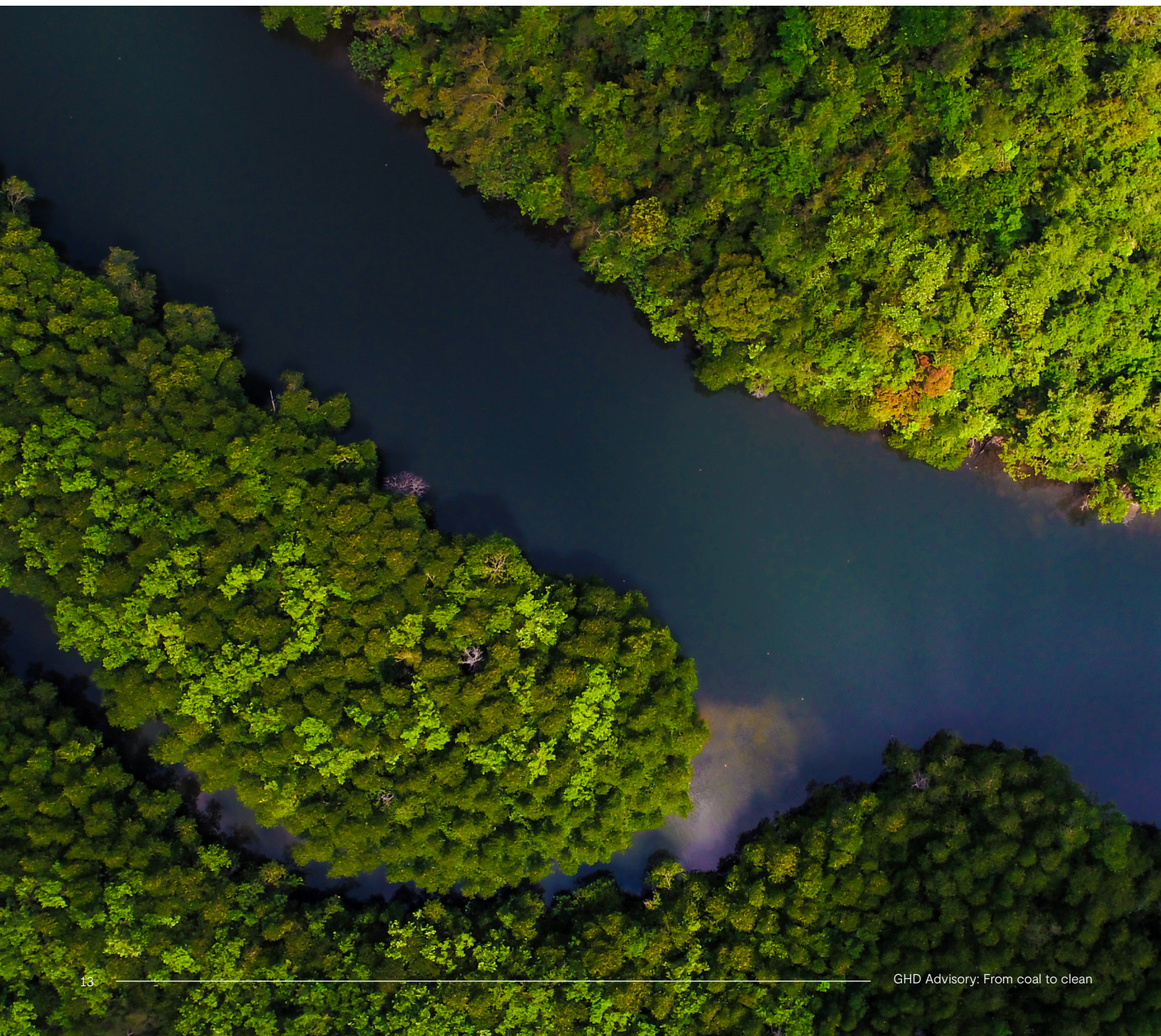


Conclusion

The transition from coal to clean energy in Asia is not just a necessity but an urgent necessity. The path forward is clear: we must leverage our collective knowledge, innovative financing mechanisms, and strategic planning to expedite this transition. The challenges are significant, but so are the opportunities. By embracing a collaborative approach, harnessing emerging technologies, and ensuring robust stakeholder engagement, we can achieve our decarbonisation goals while fostering economic growth and minimising environmental and community impact. The time to act is now, and with the right strategies and support, we can pave the way for a cleaner and greener future for Asia and the world.

Annex

1. [Global Electricity Review 2024](#)
2. [Net Zero Roadmap, International Energy Agency, 2023 update](#)
3. [CO2 Emissions in 2023, IAE](#)
4. [Phasing out coal power in two major Southeast Asian thermal coal economies: Indonesia and Vietnam](#)
5. [Phasing out coal power in two major Southeast Asian thermal coal economies: Indonesia and Vietnam](#)
6. [The case for closing coal plants at scale, World Economic Forum](#)
7. [Executive summary, a steep decline in coal emissions is essential to reach our climate goals, IAE](#)



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