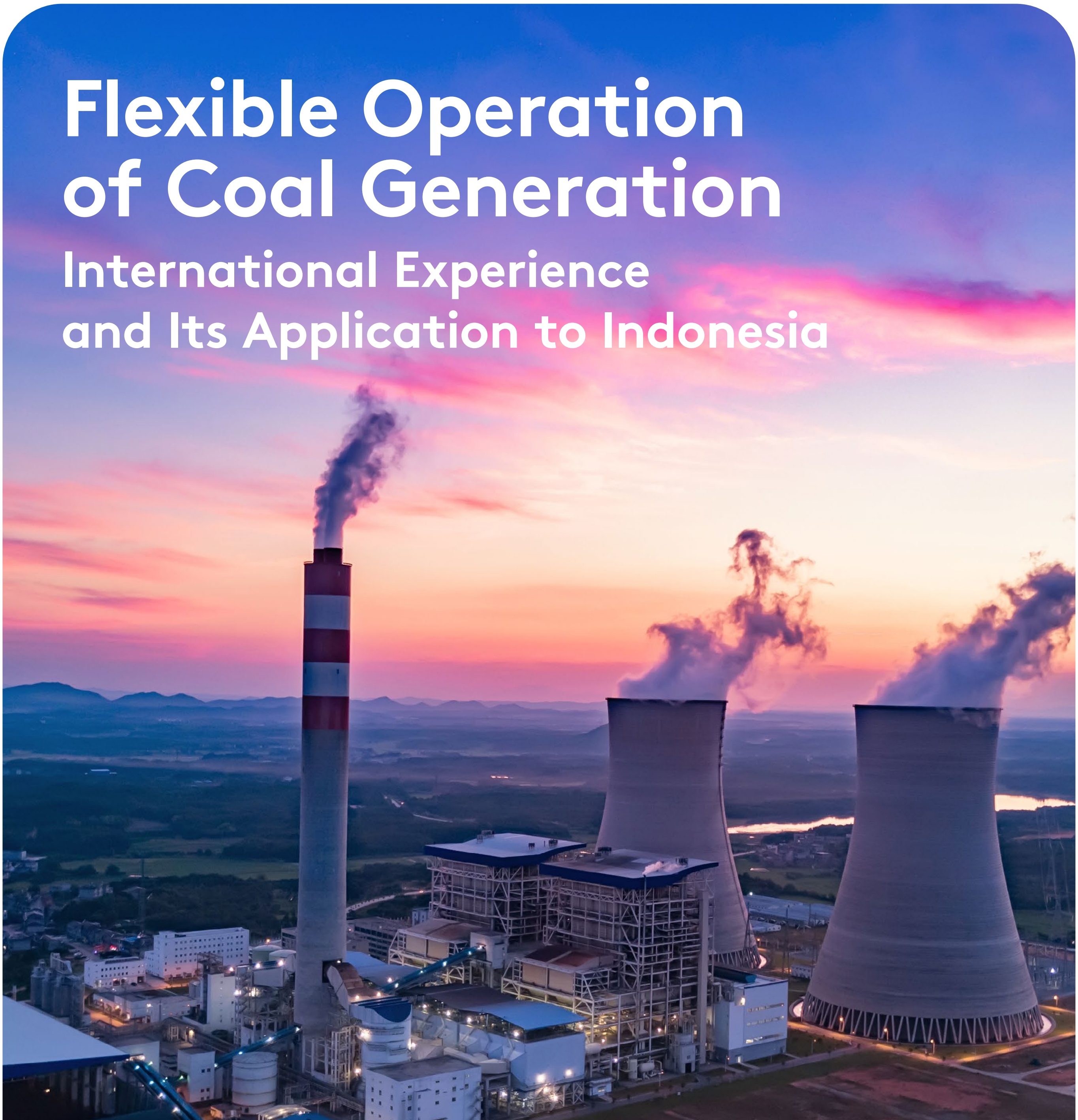
Partnership between

British Embassy
Jakarta

mentari
A UK-Indonesia Low Carbon Energy Partnership

Flexible Operation of Coal Generation

International Experience and Its Application to Indonesia



www.mentari.info

Powered by
Palladium
MAKE IT POSSIBLE

In consortium with
castlerock consulting
ECA
Hivos people unlimited

FLEXIBLE OPERATION OF COAL GENERATION

International Experience
and Its Application to Indonesia

About MENTARI

The MENTARI programme, led by the British Embassy Jakarta and its partners, aims to deliver inclusive economic growth and poverty reduction in Indonesia by supporting the uptake of low carbon energy. The programme focuses on developing the low carbon energy sector to best support disadvantaged communities and specifically those in eastern Indonesia. MENTARI is a four-year programme, running from 2020 to 2023.

Flexible Operation of Coal Generation
International Experience and Its Application to Indonesia

Authors

Will Wright, ECA
William Derbyshire, ECA

Editor

Margo Bedingfield

Reviewers/Contributors

Bagus Mudiantoro, Castlerock Consulting
Nadhilah Shani, Castlerock Consulting
Aloysius Damar Pranadi, Castlerock Consulting

Support Team

Nova Doloksaribu
Vincentius Reno Agusta

Design

Isman Nasrah

Acknowledgements

The authors of this report would like to thank the UK Foreign, Commonwealth and Development Office (FCDO) and the Ministry of Energy and Mineral Resources (MEMR) of Republic of Indonesia for their support. This report is one of the UK-Indonesia MENTARI programme result in providing comprehensive assistance and support to MEMR in accelerating energy transition. MENTARI programme is funded by the UK FCDO through British Embassy Jakarta, implemented by Palladium International in consortium with Castlerock Consulting, Yayasan Humanis dan Inovasi Sosial (Hivos), and Economic Consulting Associates (ECA).

Contents

List of Tables

List of Figures

List of acronyms and abbreviations

EU	European Union
EUR	Euros
FCDO	UK Foreign, Commonwealth and Development Office
GW	gigawatt (one thousand megawatts, one billion watts)
IPP	independent power producer
LCOE	levelised cost of electricity
MW	megawatt (one million watts)
O&M	operations and maintenance
PLN	Indonesia's national power utility (Perusahaan Listrik Negara)
PPA	power purchase agreement
SRMC	short-run marginal cost
UK	United Kingdom
US	United States
USD	United States dollars

1. INTRODUCTION

Seeking an orderly exit for coal

In many energy systems, variable renewable energy generation is displacing coal. While this transition was initially due to the supportive policy and regulatory environments for variable renewables, the switch is now being driven by market forces. This is because in many systems where power is purchased and sold on competitive markets, the levelised cost of renewables has fallen below the cost of coal. In these markets, coal asset owners face dual problems of lower production volumes and lower average power prices, making it difficult to cover their fixed costs and creating a risk of 'stranding'. This gives them the incentive to exit the market. While this coal exit is the aim from an emissions perspeceive, stranding these assets ahead of the planned retirement dates can lead to concerns about security of supply. As variable renewable energy penetrates the market further and levels of intermittency increase, security of supply services become vital and therefore gain in value. Providing these services by shifting to low-use but high-value operations represents an option for owners of dispatchable but high-emissions assets. This means they do not retire their assets too early and thus maintain system reliability. Meanwhile, the limited use of the assets also means emissions are minimised.

In electricity systems where power is not purchased and sold on competitive markets, coal assets are protected from stranding. For example, in Indonesia, coal assets are either owned by PLN, the state electricity company, and so are regulated or they are owned by independent power producers who have long-term power purchase agreements that include minimum offtake requirements. These assets are therefore not at risk of an early exit driven by market forces but customers will not benefit from the potential savings from low-cost renewables and the electricity system will have the problem of 'carbon lock-in' (ECA, 2015). In this context, we need to develop incentives to support the transition from coal to renewables. Mechanisms used in market-based systems that promote flexibility and allow coal assets to pivot to support security of supply provide insights into how to achieve the switch to low-use, high-value operations.

This report reviews international mechanisms used or proposed to incentivise owners of fossil fuel assets at risk of stranding to pivot to support security of supply. The examples are drawn from Germany, Australia and United Kingdom. In Indonesia, the relative economics of new-build renewable energy and existing coal does not yet create significant cost pressure to force the switch to renewable energy and the large reserve margin implies that these concepts will only be relevant in the future. Nevertheless, this report provides food for thought on planning for an orderly transition from coal to renewable energy.

An orderly exit for coal will depend on forward planning that anticipates any issues likely to arise, ensuring that timely solutions can be managed efficiently. This planning is critical in the context of the Indonesian government's recent policy changes and announcements on retiring coal assets and accelerating the use of renewable energy, including:

- Announcement of a net-zero emissions target for 2060;
- Announcement of a target to phase out coal by 2055–2060 or earlier in the 2040s if sufficient international support is forthcoming;
- Issuance of Presidential Regulation No 112 of 2022 on Renewable Energy Development that addresses many of the barriers to renewable energy expansion, prohibits new coal-fired power plants being developed (with limited exceptions) and requires the Ministry of Energy and Mineral Resources to prepare a roadmap to accelerate the retirement of coal power.

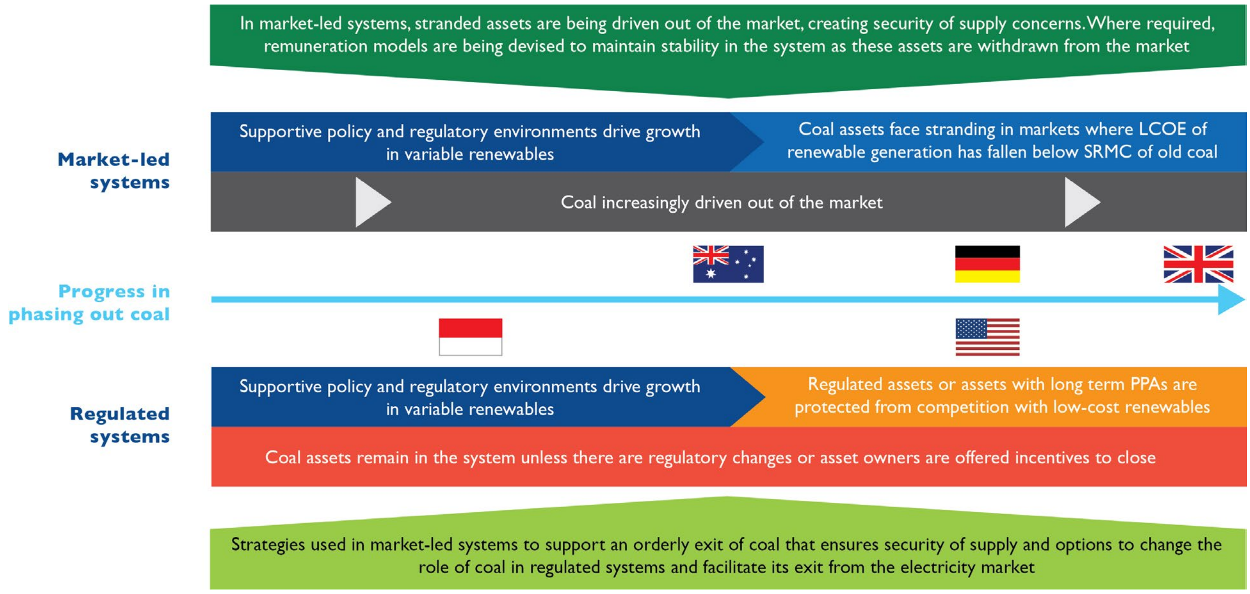
In addition to these announcements, the Ministry of Energy and Mineral Resources has published a roadmap outlining its stretegy to achieve a net-zero energy system in Indonesia by 2060. This roadmap forsees accelerated growth in renewable energy generation capacity in both the near and long term.

This chapter outlines the market structures in the countries we discuss as well as the physical and financial challenges that their mechanisms are designed to overcome. The second chapter describes mechanisms used internationally and outlines how the concepts might be transferred to the Indonesian context.

Comparing market structures

In this report, we separate power markets into two groups: 'market-led' systems where power is purchased and sold on competitive markets, and coal power plants are potentially exposed to stranding; and 'regulated systems' where coal power stations are either part of a monopolistic utility's regulated asset base or they have secure power purchase agreements with monopolistic distribution and supply utilities. Within each kind of market, various drivers lead to differing levels of renewable energy penetration. In market-led systems, high renewable energy penetration leads to less use of coal power and lower average power prices, and therefore assets can be threatened by stranding. In regulated systems, coal assets are protected and this hinders the growth of renewable energy as coal continues to occupy space within the generation mix despite being economically inefficient. Figure 1 shows the relative positions of the three example markets (Germany, Australia and United Kingdom) and Indonesia on each of these axes.

Figure 1: Comparing market-led and regulated systems: implications for coal assets being stranded



Notes: LCOE = levelised cost of electricity; SRMC = short-run marginal costs; PPA = power purchase agreement

In Germany, electricity is sold though long-term contracts (months to years in advance of delivery) from generators to large consumers and retailers, as well as through short-term (days to hours in advance of delivery) exchanges and spot markets. The growing capacity of renewable energy generation, its falling costs as well as preferential access to the grid all mean that its market share is growing and this is driving down average prices. These factors reduce the revenues from coal power plants and create a risk that asset owners will not be able to service their debt payments and therefore the assets could become stranded.

In Australia we focus on the National Electricity Market (DCCEEW, 2022) that covers the entire east coast of Australia but excludes Western Australia and Northern Territory. The National Electricity Market is a competitive wholesale market that facilitates the exchange of electricity between generators and retailers based on a common pool. The wholesale market determines a spot price for electricity based on physical supply and demand. As well as the wholesale exchange, generators and retailers can enter long-term bilateral contracts at an agreed fixed price.

Similar to Germany, most electricity in the United Kingdom (UK) is sold through long-term contracts between generators and retailers, with shorter-term energy trading taking place through exchanges. Real-time supply and demand are matched using the 'balancing mechanism' where generators 'offer' to increase generation or 'bid' to reduce generation according to the needs of the system operator. For 'offers' either generators can increase generation or consumers reduce demand. For 'bids' either generators can reduce generation or consumers increase demand. The spot price for electricity revealed on exchanges is increasingly being set by 'contracts for difference' for subsidised renewables since their marginal costs are lower. These renewable energy assets are providing a growing share of total energy supplied as well as driving down the average price on the spot market.

Indonesia's power system is dominated by the state-owned vertically-integrated electricity company, PLN , the major player in generating electricity and the sole purchaser of other electricity injected into the grid through power purchase agreements. Coal generation is either owned by PLN and included in its regulated asset base or sold to PLN by independent power producers through secure long-term power purchase agreements. PLN cannot prematurely retire assets in its regulated asset base because of strict laws against any actions that will devalue the balance sheet of state enterprises. The power purchase agreements are long term and made up of three components: fixed payments to recover investment costs; an energy payment to cover fuel costs; and an energy payment to cover variable operation and maintenance costs (O&M). This market structure protects coal assets from the market forces created by the falling costs of renewables that would otherwise put these assets at risk of stranding. Nevertheless, Indonesia still faces the same situation as countries with market-led systems in that the economics of new-build renewable energy generation is improving relative to existing coal and managing system stability as renewable energy penetration grows presents a challenge. We can therefore gain insights from other countries into how Indonesia can achieve cost savings (and emission reductions) by developing variable renewable energy and managing the associated practical challenges of intermittency.

An orderly coal exit: managing the risks of stranded coal assets and the threat to security of supply

Many countries are pursuing coal exit as part of their strategy to reduce emissions but this exit needs to be carefully planned to ensure sufficient firm capacity is available in the system throughout the energy transition process. Therefore when countries create mechanisms to retire coal assets in market-led systems, they need to address two key challenges simultaneously:

- The stranding risk for coal assets created by low-cost renewables;
- The physical risk to system stability caused by the growing capacity of variable renewable energy and the accelerated retirement of firm fossil-fuel generation.

In this section we explore these concepts in more detail. First, we describe how the risks associated with these concepts translate across to the Indonesian context. This then frames the discussion on how we can draw on mechanisms developed in market-led systems to inform the effective management of the coal exit in Indonesia going forward.

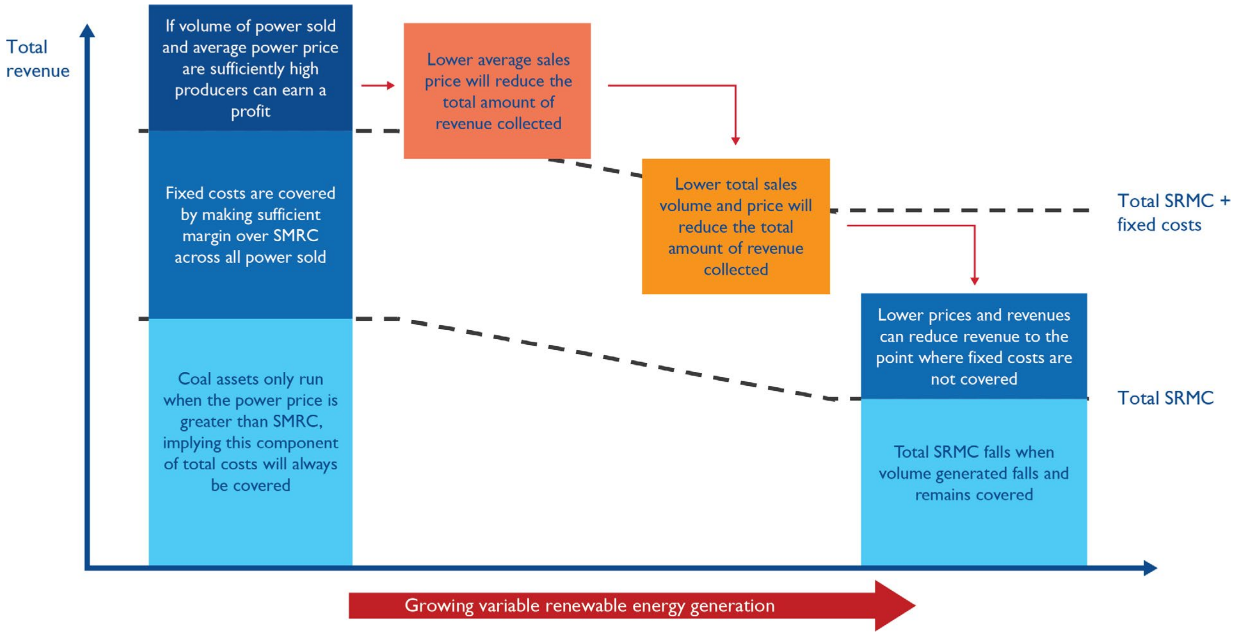
As low-cost renewables displace fossil-fuel assets in generating power for the base load, these assets are at risk of becoming stranded

As the global rollout of variable renewable energy technologies grows, economies of scale and increasing 'returns to adoption' result in the levelised cost of these technologies falling rapidly, making them cost competitive with coal generation. In some markets, the falling costs are complemented by supportive policy and regulatory regimes, including: renewable subsidies; preferential grid access; renewable capacity targets; carbon prices applied to fossil fuels; and coal phase out targets. As a result, variable renewable energy is taking up a large and growing share of power generation that was traditionally provided by coal and other fossil fuels. In market-based power systems, this means that low marginal cost variable renewable energy is increasingly setting the wholesale market price, leading to a drop in the average price of power. These impacts on markets mean that the growth of variable renewable energy is eroding the revenues of coal generators in two ways:

- Reducing the volume of energy that coal generators are selling;
- Reducing the average price of energy that coal generators are selling.

In a market-based system with merit-order dispatch, coal operators sell power when the wholesale price is above the short-run marginal cost (SRMC) of generation (fuel plus variable operations and maintenance costs). To cover capital costs and fixed operations cost, they need to sell sufficient volume of power at prices above the short-run marginal cost. However, with lower sales volumes and prices, many coal asset owners cannot collect sufficient net revenue to cover their fixed costs and this creates a risk of stranding.

Figure 2: Illustrative example: the impact on coal asset revenues in systems with merit-order dispatch and growing penetration of variable renewable energy



In non-market-based systems, coal assets are protected from stranding by being state-owned regulated assets or by long-term power purchase agreements with independent power producers. However, these systems face two issues: high-emission coal assets lock-in; and customers with no access to potential cost savings as new-build variable renewable energy costs fall below existing coal generation on a levelised basis.

For both market-led and non-market-led systems, one solution to these financial issues is to use potentially-stranded coal assets to provide essential services where they still have a comparative advantage and to structure remuneration mechanisms to incentivise this option. The comparative advantage is being able to provide flexibility services to manage any security of supply issues associated with high variable renewable energy penetration.

Intermittency creates security of supply issues in systems with a high share of variable renewable energy

Variable renewable energy generation is intermittent and this creates a range of physical challenges that electricity systems need to manage. Systems need a combination of generation, storage and demand-side responses to provide flexibility in their services and ensure a stable and reliable grid. While the existing coal assets cannot provide the quick response and rapid ramping that the system needs to manage supply and demand on a daily basis and to overcome any mismatch, coal can provide back-up capacity to cover times when renewable generation is persistently low while demand is high.

This situation has arisen in the United Kingdom during the winter, for example, when very cold temperatures create high demand for electricity for heating that coincides with low wind speeds and thus low wind generation output. In this scenario, otherwise closed or unused coal assets could fill the gap between supply and demand. However, if coal assets become stranded and close, they cannot deliver this service when required.

In principle, in an energy-only market (where generators are only repaid through energy sales), such events lead to high prices and potential profits that make it viable for otherwise unused coal power plants to remain available. In practice, the uncertainty over whether, when and for how long such events will occur, and the risk of prices being capped or kept low through other means, make it unrealistic for coal asset owners to depend on such events.

Rethinking how existing coal assets are remunerated could address two issues: avoiding stranded asset-level costs; and providing security of supply for the grid. The fundamental benefit that coal and other potentially stranded fossil fuel generation assets can bring to current and future high variable renewable energy power systems is firm capacity. We need to structure the markets to value this essential support role and enable generators to cover their fixed costs despite the limited use of their assets.

How do these issues apply to the Indonesian context?

Coal assets in Indonesia cannot be forced out of the system by market forces but we can still learn from how market-led systems transform ageing fossil-fuel assets into high-value security of supply services. These services are essential for all systems that aim to have a high share of variable renewable energy. While Indonesia's coal plant assets are protected from becoming stranded, this creates equally tough challenges for the system of carbon lock-in and barriers to replacing coal with low-cost renewables.

Table 1 summarises how these issues relate to the Indonesian situation, including: the risks of stranded assets exiting the market; the high-cost coal lock-in keeping out low-cost renewables; and the need to ensure security of supply as renewable energy penetration grows.

Table 1: Summary of how issues and risks in the transition to variable renewable energy apply in the Indonesian context

Issue	Risk (High/Low)	Reason
1. Risk of assets needed for security of supply prematurely exiting the market due to being stranded	Low	Coal assets are either part of regulated assets or have long-term power purchase agreements (PPAs) that protect them from stranding which means that these assets will only shut early if they are offered direct incentives
2. High-cost coal keeps low-cost renewables from developing and prevents possible cost savings Coal assets not retiring creates carbon lock-in and inhibits Indonesia's decarbonisation ambitions	High	Because they are either regulated assets or have long-term PPAs, coal assets will remain in the system and prevent the switch to lower-cost renewable energy
3. Challenges of managing intermittency as variable renewable energy penetration grows	High	Indonesia has growing ambition to install renewable energy generation – and solar in particular – which has significant seasonal variability under Indonesian conditions

Issues 1 and 2 in Table 1 are inverse problems. Either countries' coal assets are exposed to the falling costs of renewable energy that increase the risk of early retirement and raise security of supply concerns; or countries are protected from coal assets being stranded and retiring when they are still required but they cannot benefit from the lower costs of renewable energy and associated drop in emissions. However, from a physical system perspective, the core problem is the same, regardless of how the market is set up: how to access cost savings from the falling levelised cost of electricity for renewables (and reduce carbon emissions) while simultaneously managing the physical transition to a system dominated by variable renewable energy generation.

This means that the lessons from market-led systems that are the first to face and manage these problems can be learned and applied to regulated systems, like in Indonesia. Thus, shifting coal plants to lower use with an emphasis on supporting security of supply could offer options and incentivise independent power producers to reduce output from their coal assets and provide the dual benefits of lower costs and lower emissions.

The high risk associated with issues 2 and 3 in Table 1 suggests two fundamental reasons to lower coal power plant use while keeping the capacity of these plants available:

- Reducing coal power plant use will create headroom for new-build renewable energy to enter the generation mix. In parallel, renewable energy capacity will need to increase in the the near term as the PLN network currently has excess generation capacity.
- However, we need to ensure the system still has sufficient overall generation capacity to maintain security of supply. In the case of coal, these assets can provide vital back-up services for periods when renewable energy generation is persistently low. For example, coal generation might be reserved for December when there is more cloud cover and this negatively affects solar generation. During this time there is a risk of insufficient supply to meet demand in a system with high solar capacity.

These two drivers justify the quest for ways to limit the operation of coal power stations that can be informed by how market-led systems manage this low use of firm generation.

2. INTERNATIONAL EXPERIENCES

A new role for fossil fuel assets: providing flexibility and security of supply services

Fossil fuel assets that shift to providing flexibility have to fundamentally change how they are paid. As electricity suppliers, most of their revenue came from delivering energy but, as support services, their revenue will be determined by the available capacity. Market-based systems have had to confront this issue because these assets risk being stranded and this in turn raises concerns about security of supply. While countries aim to accelerate the exit of coal in dispatchable generation, the exit ineeds to be orderly and pose no threat to the reliability of the electricity services. The solutions that countries have adopted so far fall into three broad categories:

- **Strategic reserves** – a bridge solution between early closure and flexible operation. Fossil fuel assets are paid to sit outside the market but be ready to come online in the event of a security of supply emergency.
- **A decentralised capacity obligation** – load-serving entities that supply electricity to consumers are given responsibility for ensuring they can cover their share of any peak demand forecast.
- **Centralised capacity markets** – the central service directly procures capacity to ensure there is sufficient to cover peak demand.

In this section we use the following example countries and outline how they are currently using these solutions to manage coal phase out and increase renewable penetration:

- **Germany** is using a competitively procured strategic reserve to provide security of supply while phasing out coal and nuclear generation;
- **Australia**, like Indonesia, is a major coal producer and coal dominates its generation fleet but it is currently investigating a decentralised capacity obligation to manage the increasing risk of stranding as the variable renewable energy capacity grows;
- **United Kingdom** has an established and competitively-procured capacity market that aligns with a firm target for the phase out of coal.

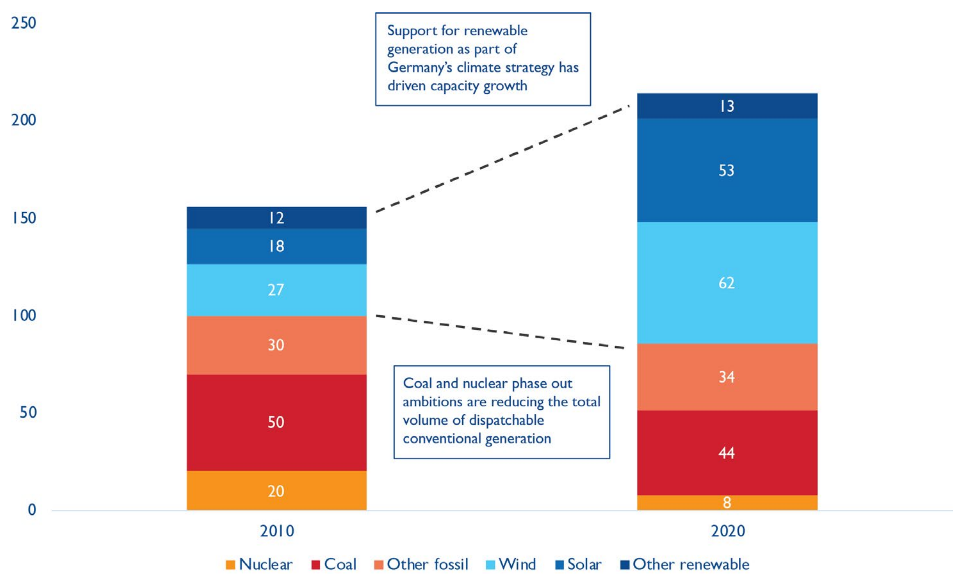
While the electricity systems in the example countries all differ from Indonesia in being market-based, the concepts behind their mechanisms to compensate and incentivise generation assets can be transferred to any context.

Germany's strategic reserve

A strategic reserve is a mechanism whereby certain generation is ringfenced outside the electricity market and can only be used in case of an emergency. Under the reserve, fossil fuel generation assets are compensated (according to their capacity) for remaining available but not operating except when needed over a period of two years, after which they are closed permanently. Restricting the assets to only operating in emergencies differentiates the strategic reserve from the normal capacity market where assets operate freely. The European Union (EU) has approved the short-term use of strategic reserves in Germany to ensure security of supply while the country undertakes a major electricity market reform including phasing out nuclear and coal power(EU, 2018).

Germany needs a strategic reserve due to the growing penetration of renewables in the context of the nuclear and coal phase out that has created a risk for the security of supply. Growing variable renewable energy penetration has created issues typically associated with the intermittency of renewable generation, including a mismatch between periods of peak demand and generation. Nuclear and coal phase out has exacerbated this mismatch by reducing the firm capacity available in the system to fill these gaps.

Figure 3: Changes in the available capacity on the German electricity grid (GW)



Source: Appunn, Haas and Wettengel (2022)

The growing share of renewable electricity production is reducing the profitability of firm fossil-fuel generation and, together with the coal phase-out target and the subsidy scheme to incentivise coal closure, these factors are driving the early retirement of coal plants. While this is in line with Germany's phase-out plan, when combined with the nuclear phase out, the volume of dispatchable generation available in the market has reduced to the point of a tangible risk to security of supply.

Germany's strategic reserve compensates ringfenced generation assets that, despite negative market price signals, remain on standby in case of a shortfall in capacity(Federal Ministry for Economic Affairs and Climate Action, 2018). Placing these assets outside the market means that closing the fossil fuel plants can be done in stages and delivers two outcomes:

- Reduces costs of prematurely closing potentially-stranded dispatchable fossil fuel generation assets;
- Provides low-probability, high-value flexibility services that the energy markets would not normally provide.

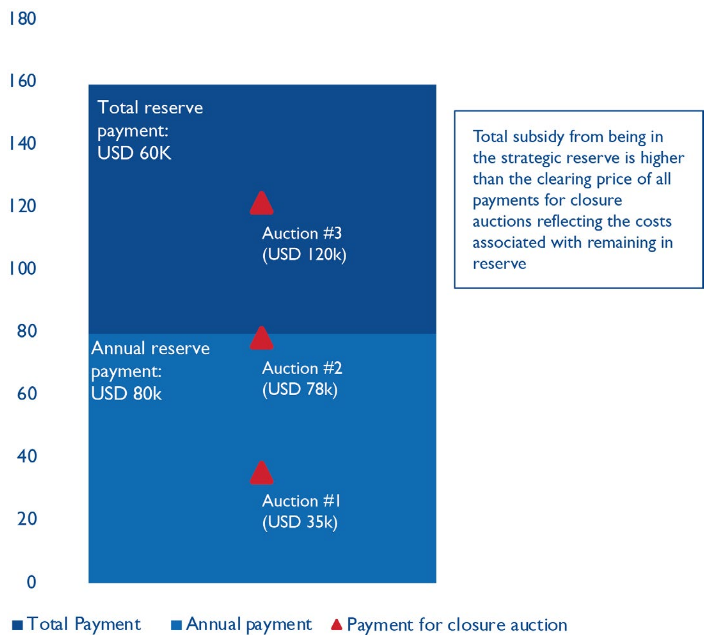
In 2015, Germany put eight lignite coal plants into a strategic reserve through a non-competitive process but this reserve was contested by other EU members who felt it represented an unfair application of EU state aid rules (Simon, 2018). The EU subsequently approved a new competitive tender scheme for a strategic reserve on the grounds that it would be temporary, competitively-procured and address a clearly-defined and quantified security of supply risk (European Commission, 2018).

The new reserve was approved for three periods of two years, with up to 2GW of strategic reserve capacity to be procured in competitive auctions (Clean Energy Wire, 2018). Auctions are run collaboratively by the four German transmission system operators, typically at the start of a year with delivery from October of the same year. The mechanism is distinct to the ongoing coal payment-for-closure auctions that take place annually to incentivise the shut down of hard coal assets. In these auctions, assets that transmission system operators considered essential to security of supply were handicapped to prevent them from winning contracts in the auctions (Federal Network Agency, 2021).

The first procurement for the strategic reserve concluded in February 2020 with 1,056MW of capacity contracted at an average price of USD79,587 per MW. This was below the maximum stipulated of USD117,040 per MW, despite the auction being undersubscribed for the 2,000GW target.

All 1,056MW winning contracts were natural gas assets, reflecting the relative costs of operating gas and coal assets in reserve. Over the two years of the reserve contract, the auction price provides a total subsidy of USD159,174. This total subsidy is higher than those achieved in the payment-for-closure auctions. However, a larger subsidy will not necessarily incentivise assets to enter the reserve rather than the closure auctions. The strategic reserve payments must cover the costs of mothballing incurred over the two-year reserve period, as well as compensate for closure and cover closure costs. Running the payment-for-closure and strategic reserve auctions simultaneously would effectively sort the assets into those best suited for immediate closure and those best suited for the strategic reserve.

Figure 4: Comparing the first strategic reserve procurement results with payment-for-closure auctions (USD thousands)



Sources: Federal Network Agency (2022); Reuters (2020)

Indonesia could use a strategic reserve to incentivise would-be stranded assets that are protected by power purchase agreements to switch from supplying bulk power to providing security of supply services at the tail end of their operational lives.

Indonesia currently has a high reserve margin and is unlikely to require a strategic reserve in the near term (before 2030). However, as renewable energy capacity grows and coal assets begin to close, the need for a strategic reserve is likely to emerge. In the interim, a conceptually similar solution to a strategic reserve might be appropriate where, rather than paying independent power producers to remain in reserve, government reduces their guaranteed offtake and only allows additional generation in a security of supply emergency.

Indonesian assets are not exposed to the kind of market forces that are driving German assets to early closure. However, as long as the net savings from replacing coal with cheaper renewable energy[1] exceed the net cost of the subsidy payments, then PLN will benefit from shifting an asset into the strategic reserve.[2] The saved environmental cost of emissions

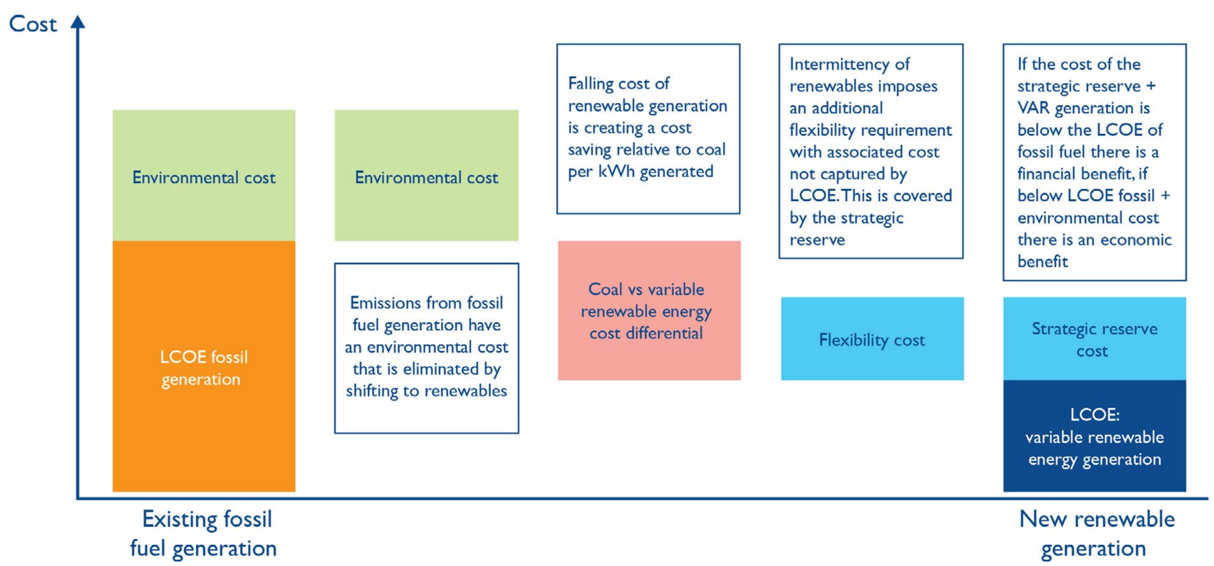
1 Domestic levelised cost of electricity for renewables has reached parity with coal but is not yet creating would-be stranded assets. However, increasing renewable ambition and growing international pressure to decarbonise in the future are likely to stimulate renewable development and drive future cost reductions (IESR, 2019).

2 Expected net savings from introducing a strategic reserve can be estimated using system forecasting software ,such as PLEXOS. Expected net savings guide the financially-viable level of subsidies and can be compared with the expected willingness of coal owners to accept payment to assess the overall viability of the programme.

delivers additional economic benefit for Indonesia and internationally. Figure 55 breaks down the potential cost savings of implementing a strategic reserve. Considering the typical structure of an Indoneisan coal power purchase agreement, independent power producers should be willing to forgo guaranteed energy payments as long as they are priced to cover only the marginal cost of generation because this would not impact on returns. The cost of the strategic reserve should therefore be the cost of outstanding investment recovery repayments plus the extra cost for the assets to remain in reserve.

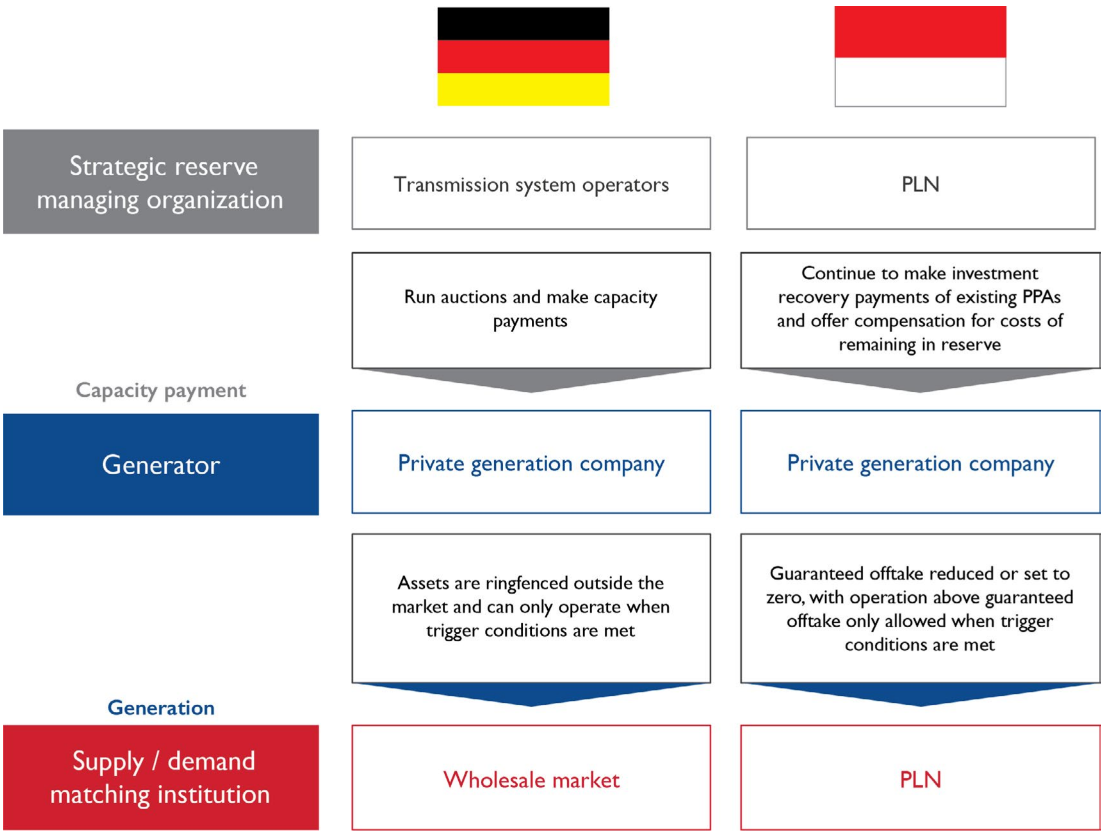
In Germany's first strategic reserve auction, the contracts were all won by gas assets. For a strategic reserve targeting coal, as in Indonesia, coal would need to have the advantage in providing security of supply services. The strategic reserve would be established with the express purpose of correcting imbalances in supply and demand in the medium to long term. For example, when solar generation in Indonesia is relatively low in December, a high-solar generation mix may not provide enough to meet demand.

Figure 5: Illustration of potential cost savings from implementing a strategic reserve



Indonesia could allocate strategic reserve contracts in competitive auctions like they do in Germany but PLN can also negotiate bilateral contracts directly with the independent power producers concerned. Figure 6 outlines how the key components of the strategic reserve in Germany might transfer to an equivalent mechanism in Indonesia. While the nature of the organizations delivering the components of the mechanism would differ across the market, the central concept remains of coal assets that only run when security of supply is threatened.

Figure 6: Comparing Germany's strategic reserve and an equivalent mechanism in Indonesia

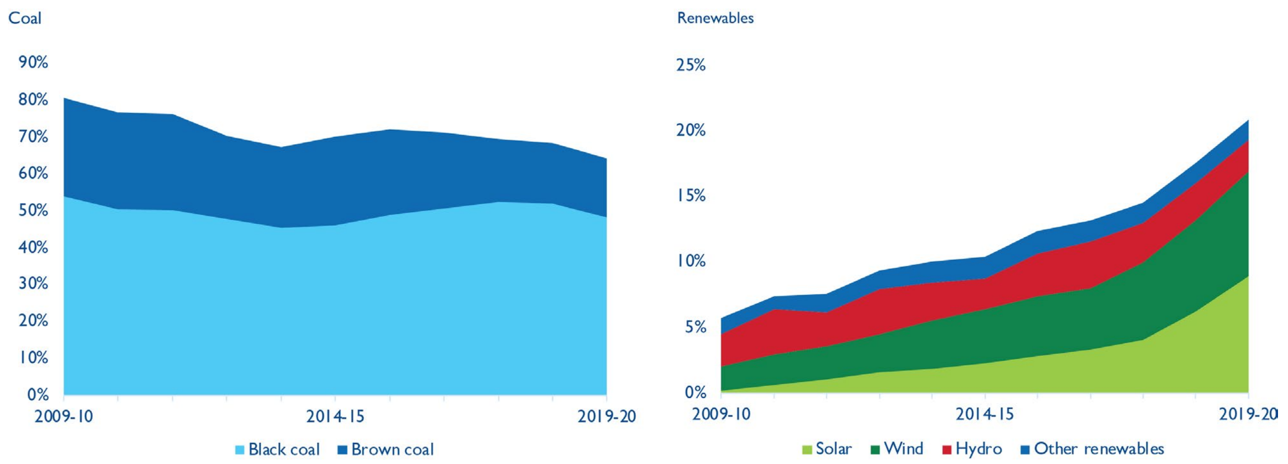


Australia's proposed decentralised capacity mechanism

Coal has traditionally dominated the electricity generation mix in the Australian National Energy Market[3] and, despite growing renewable penetration, it still provides the largest share. However, the economics of renewables have become competitive relative to coal, driving growth in renewable generation that surpassed 20 per cent of the total supply for the first time in 2020 (Department of Industry, Science, Energy and Resources, 2021). On a levelised costs basis, new-build standalone wind and solar are already cheaper than new coal and further cost reductions are expected to improve the relative economics of renewables even further (CSIRO, 2020). The market is driving the replacement of coal by renewables despite the lack of a coal phase-out policy and no carbon price being imposed on coal.

3 The National Electricity Market is Australia's largest energy market and includes Queensland, New South Wales, Australian Capital Territory, Victoria, Tasmania and South Australia. Western Australia and Northern Territory operate separate systems. This paper focused on proposed solutions for the National Electricity Market.

Figure 7: Changing electricity generation mix: Australia, 2009–2020



Source: Department of Industry, Science, Energy and Resources (2021)

Wind and solar are making up a growing share of generation, creating a stranding risk for Australian coal assets. In Australia's current electricity market structure, fossil fuel generators get most of their revenue from the wholesale energy market, with their fixed costs covered when prices are high and exceed their short-run marginal costs (SRMC). The falling levelised cost of electricity (LCOE) and growing capacity of renewables will impact on revenues for fossil fuel generators in two ways (Edis and Bowyer, 2021):

- Reducing the total volume of power that fossil assets sell;
- Reducing the average wholesale price of electricity.

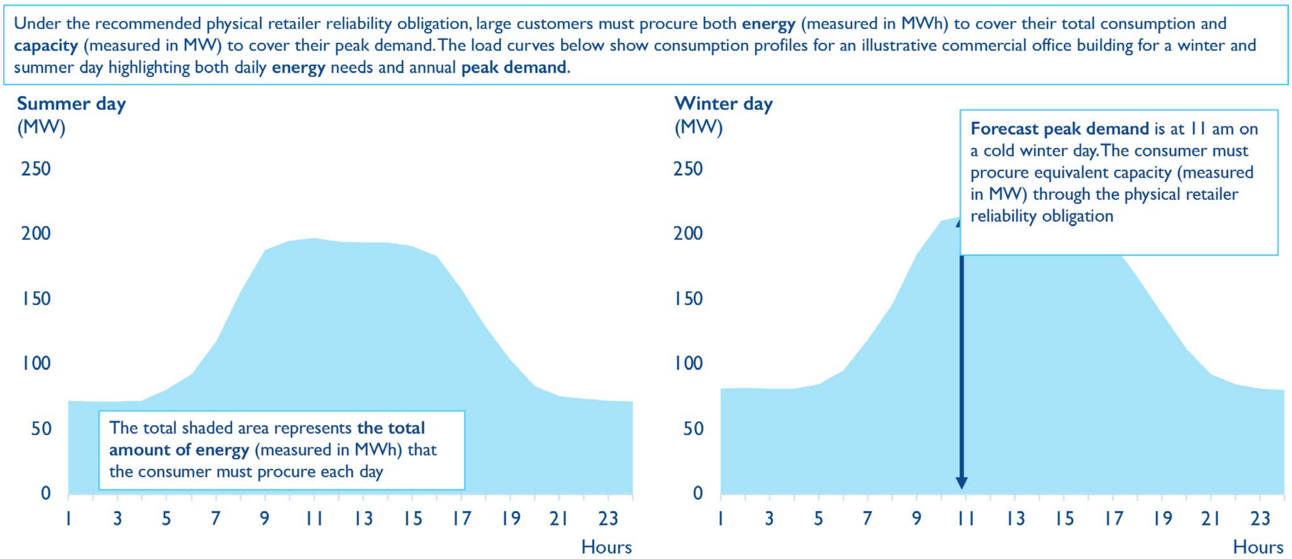
These factors will affect the coal generators' ability to cover their fixed cost, with several assets expected to become unprofitable by 2025.

Growing variable renewable penetration creates the physical challenge of increased intermittency and the system needs dispatchable generation with appropriate ramping capabilities to manage this challenge. While existing coal assets are not the ideal option to deliver fast ramping services, Australia needs to ensure an orderly exit of existing fossil fuel capacity to avoid any security of supply risks during the transition to renewables (Energy Security Board, 2020a). Additionally, it will need to incentivise new firm dispatchable generation to meet the growing requirement for ramping. While current market arrangements are sufficient to meet the country's needs in the short run, the Australian electricity industry is currently debating how to ensure these needs are met in the medium to long term. The Energy Security Board has recommended that they develop a mechanism that explicitly values capacity.

The Energy Security Board has suggested a solution for valuing capacity in the form of a physical retailer reliability obligation that places the onus on electricity purchasers (suppliers and large customers) to procure sufficient capacity to meet their share of peak demand (Energy Security Board, 2020b). The way this obligation would work is as follows:

- The Australian Energy Market Operator assesses generation assets and certifies them as providing a 'firm capacity' – the megawatt (MW) amount that they can deliver at any point. Generators are given tradable certificates that can then be procured by suppliers and large customers.
- Suppliers and large customers must forecast their own contribution to peak demand (in MW) and then procure a sufficient number of certificates to cover that contribution (see Figure 8 for an example of total energy consumption and peak demand for a large customer).
- Suppliers and large customers continue to trade for energy on the wholesale market.
- The sale of certificates effectively provides generators with a fixed payment directly tied to the availalable capacity of their assets. This gives the assets a fixed revenue stream to contribute towards fixed costs, including investment costs.

Figure 8: Example of a large customer's daily energy and capacity requirements in summer and winter



Note: The example uses data for an average commercial office building in Great Britain in 2012. The concepts illustrated are applicable to any similar customer, including large commercial customers in Australia.

Source: ofgem (2012)

Australia's National Cabinet has reviewed the proposed physical retailer reliability obligation concept and recommended that the mechanism be developed to the detailed design phase (Department of Industry, Science, Energy and Resources, 2021). There is ongoing debate on whether coal should participate under the mechanism at all, since some stakeholders regard this as prolonging the life of high-emission assets (Varrath, 2021). Under the current design of the mechanism, each state can determine which technologies will be allowed in the scheme within their jurisdiction (Department of Industry, Science, Energy and Resources, 2021).

Indonesia could use capacity certficates similar to those suggested in the physical retailer reliability obligation in a competitive process that allows PLN to switch the role of some independent power producer coal assets to providing flexibility and security of supply services.

The capacity certificates (or any form of capacity payment) are intended to cover the same portion of asset costs as the investment cost element in Indonesian power purchase agreements – thus they cover the fixed costs associated with the capital investment.

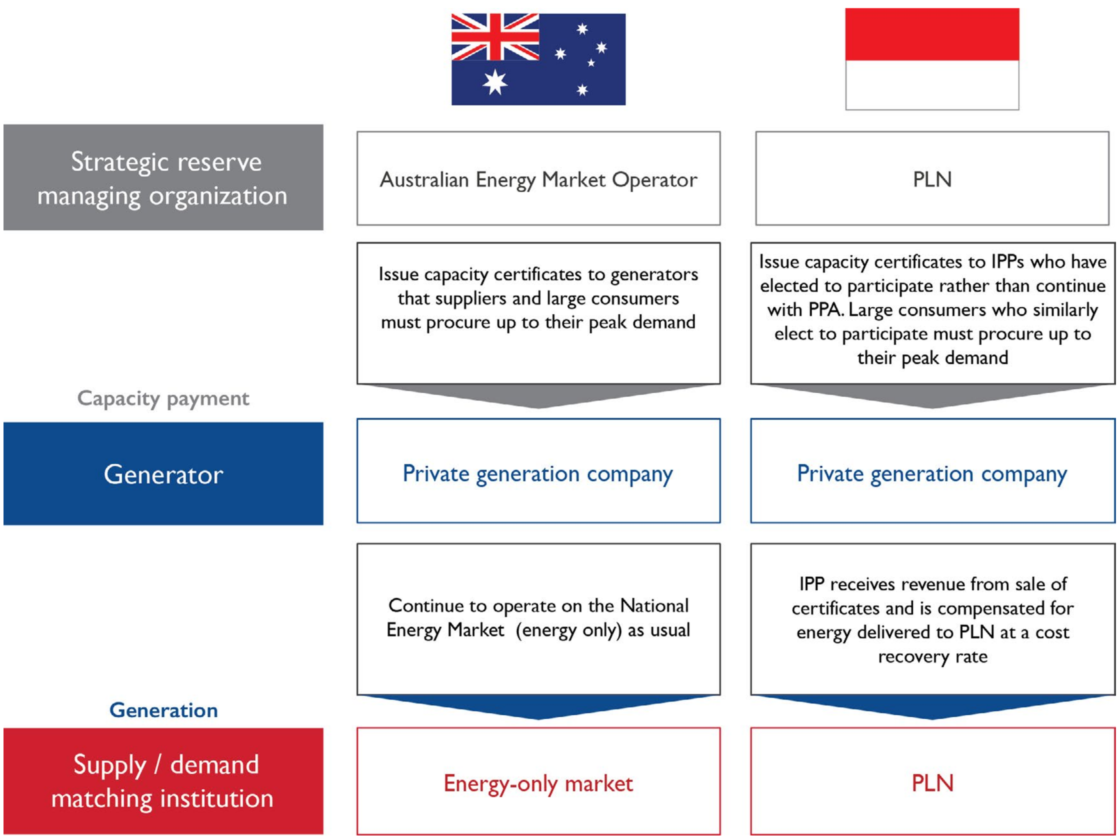
Developing a capacity certification scheme similar to the Australian scheme would involve a more significant change than adopting the principles from Germany's strategic reserve. Since the certificates cover the investment cost element in the power purchase agreement, they are likely to replace these agreements. The certificates would aim to cover the fixed costs of generation and the energy payments linked to the actual energy delivered, thus covering the variable costs of generation.

A capacity certification scheme could therefore be used as an incentive for independent power producer operators to give up their current power purchase agreements. Independent power producers would be attracted by this option if the returns on their investment are likely to be higher than the current returns based on their power purchase agreements. This would require sufficient competitive pressure for the purchase of certificates to push up the sales price. Assuming the energy component in the existing agreements only covers fuel costs, independent power producers should be willing to participate in the new capacity certificate scheme if they can expect higher returns on investment and accept lower levels of use. However, compensation paid for power generated by assets operating under the scheme needs to be at a cost recovery rate that means producers are neutral about the actual levels of use they achieve.

PLN would need to assess all generation assets in the system (the scheme could be designed to include coal or all generation assets depending on the overall objectives) and issue each asset with a certificate corresponding to its rated capacity. PLN could create demand for these certificates by offering its large (industrial) customers the option to switch to a new billing structure. The current billing structure includes a fixed cost plus energy charge but in the new structure, the fixed charge is replaced with a requirement to purchase capacity certificates.

Certificates could be fully tradable between generators and could act as a natural extension to other mechanisms being introduced in the Indonesian power sector, for example, the cap-and-trade emissions trading scheme. Figure 9 compares the proposed Australian physical retailer reliability obligation and a possible Indonesian mechanism using the same principles.

Figure 9: Comparing the proposed Australian physical retailer reliability obligation and a possible Indonesian mechanism



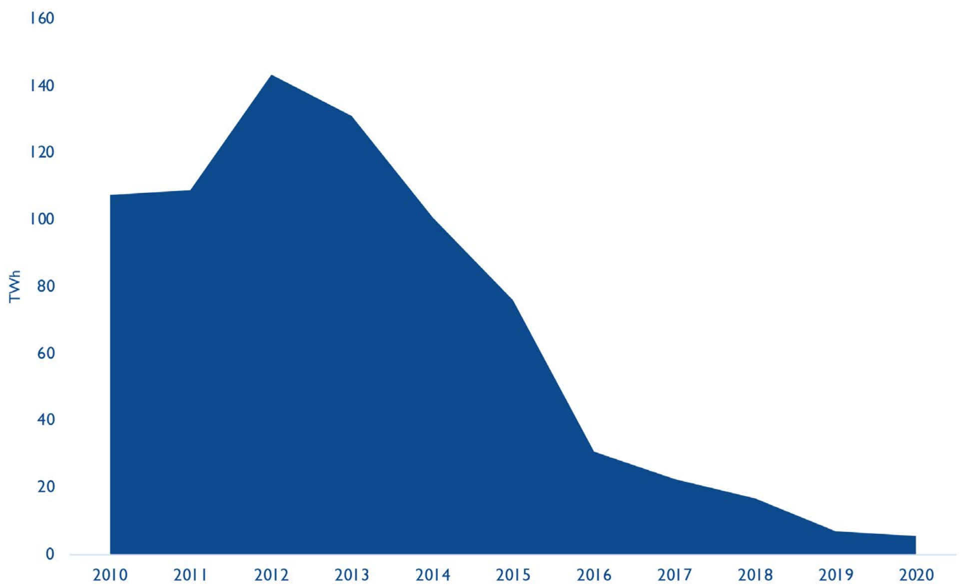
United Kingdom's capacity market

The United Kingdom has a target to eliminate coal in Great Britain by 1 October 2024 (BEIS, 2021).[4] Coal already operates primarily as a reserve and in 2020, with the low demand due to COVID-19 restrictions, the country went 5,000 hours without using coal-fired electricity. On top of the specific coal closure target, several other policies that aim to support renewable targets and lower fossil fuel generation are driving coal out of the market. These include: the previous feed-in tariff and current 'contracts for difference' support mechanisms for renewables; the increasingly ambitious capacity targets for offshore wind generation; carbon pricing raising the cost of fossil generation; and the introduction of a carbon price floor

4 The UK electricity network covers only the island of Great Britain. Northern Ireland is included in the Irish electricity network alongside the Republic of Ireland.

in 2013, after the price of the European Union's Emissions Trading System's emissions units collapsed during the global financial crisis (LSE, 2019). The installed coal capacity and use of the remaining coal assets are both falling as a result of this suite of policies that is leading to levels of coal generation falling rapidly.

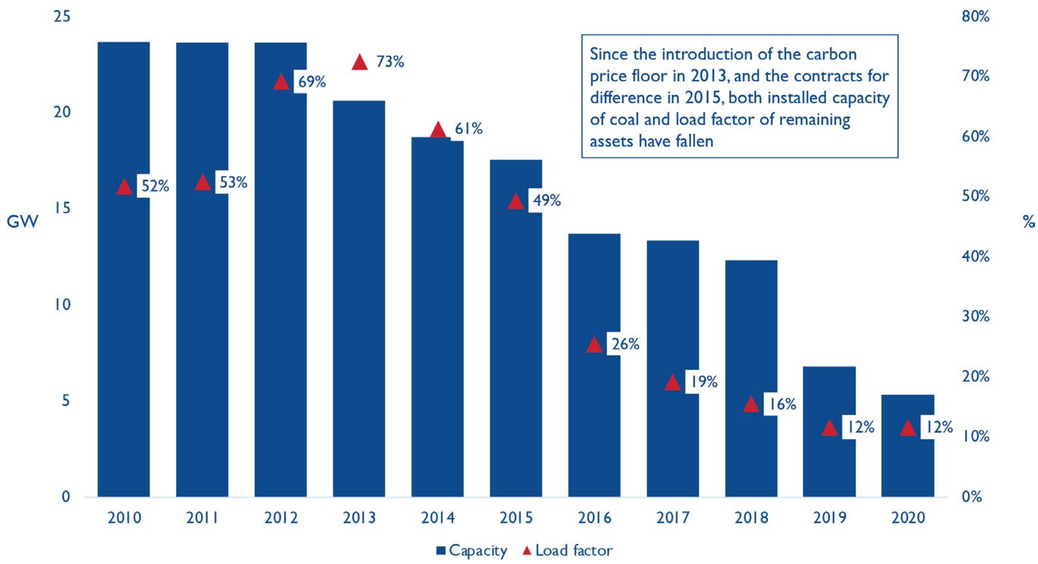
Figure 10: Electricity generated by coal in Great Britain (Terawatt-hours)



Source: UK government (2022)

The UK electricity system has a decentralised market structure that aims to dispatch generation based on the lowest short-run marginal costs (SRMC). Most energy is contracted for bilaterally between generators and suppliers via the wholesale market, with short-term trading taking place on exchanges. The system operator responsible for maintaining system stability is notified of planned generation and uses a balancing mechanism to incentivise generators to increase or decrease generation to match supply and demand (ELEXON, undated). Under this system, dispatchable fossil fuel generators operate whenever the market price is above their short-run marginal costs of generation (fuel plus variable operation and maintenance costs / variable costs), with fixed costs covered by the margin over these costs they achieve when prices are high. When coal assets have a high use rate, they make sufficient margin in periods of high prices to cover fixed costs. However, the support for renewable generation combined with carbon pricing has shifted fossil generation down the merit order, reducing its use rate. With lower use rates, asset owners struggle to cover their fixed costs, resulting in many coal and gas assets becoming uneconomic.

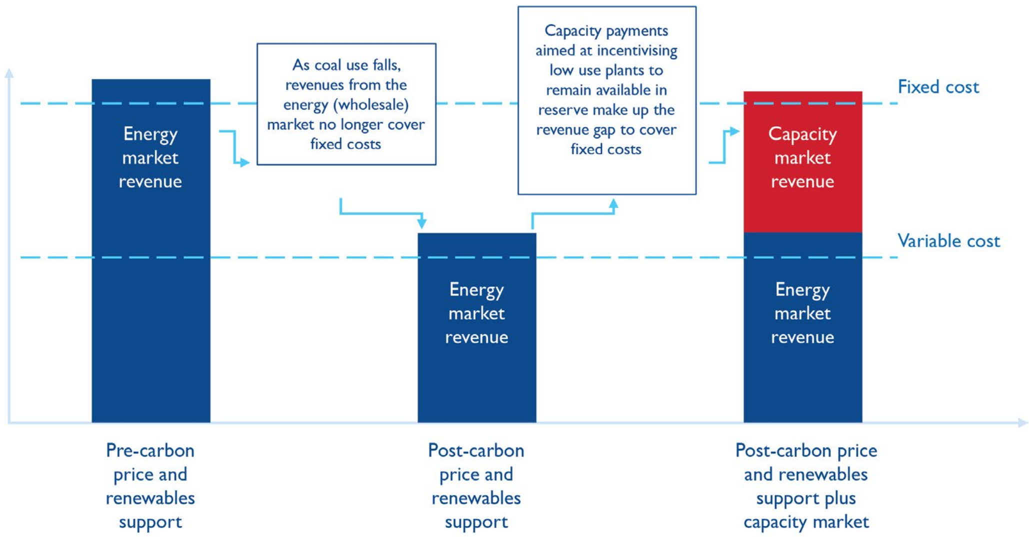
Figure 11: Great Britain: installed coal generation capacity and average load factor



Source: UK government (2021)

UK introduced the Capacity Market in 2015 as a mechanism to ensure security of supply in an environment of low use for dispatchable generation while minimising impacts on the wholesale market. Capacity Market contract holders receive fixed monthly payments proportional to their capacity that cover some or all their fixed costs. They are free to participate in the wholesale market but they must have the capacity they are contracted for available if and when required by the system operator.

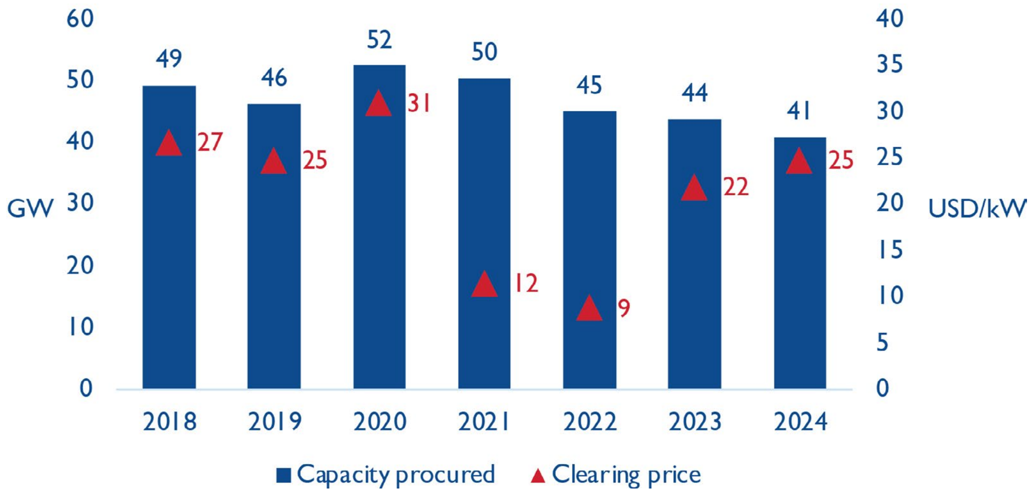
Figure 12: Illustrative example: how the Capacity Market tops up generator revenue to help cover fixed costs



Capacity Market participants compete for contracts in a descending clock auction held four years before the desired delivery date.[5] The auction runs by offering participants a price per MW starting at a predetermined price ceiling. As the auction reduces the price offered, asset owners that are not willing to accept the lower price level withdraw from the auction. The auction closes once a price is reached where the remaining capacity willing to accept the price is equal to the target capacity. This price is known as the 'clearing' price. Contracts are awarded for one year for old assets, three years for refurbished assets and fifteen years for newly-built assets.

Over the seven years that the Capacity Market has been run, the clearing price has ranged between USD9 and USD31. While the capacity of coal assets winning contracts has come down in recent auctions, around 1GW of coal assets hold contracts for the 2022 and 2023 delivery years. Newly-introduced emission limits for those participating in the Capacity Market disqualified coal generation from the four-year ahead Capacity Market auction in 2021 for 2024 delivery (BEIS, 2021). Emissions limits were introduced in 2021 to ensure that coal exits the Capacity Market in align with the 2024 coal phase-out date.

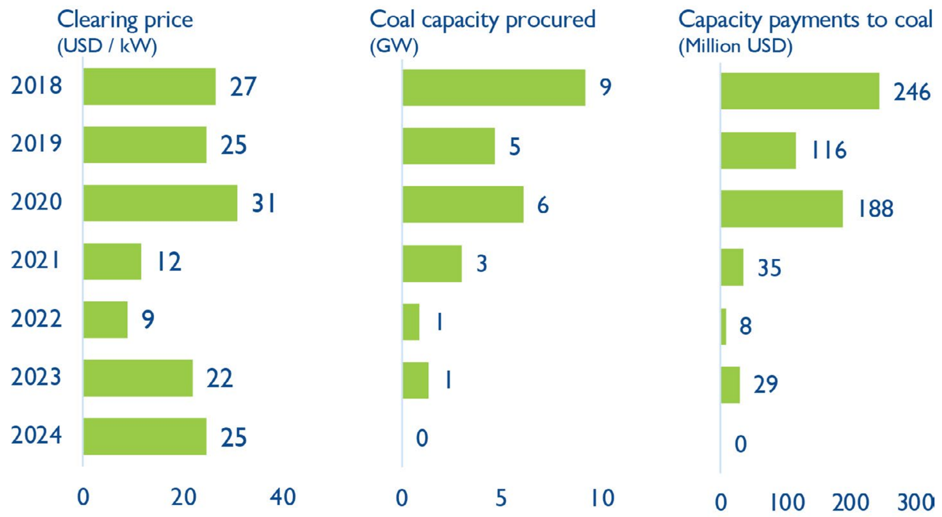
Figure 13: UK Capacity Market auction results by year (all technologies)



Source: National Grid ESO EMR (undated)

5 Additional auctions can also be held a year before delivery if the national grid shows that insufficient capacity was procured in the four years in advance auction.

Figure 14: UK Capacity Market auction results by year (coal)



Source: National Grid ESO EMR (undated)

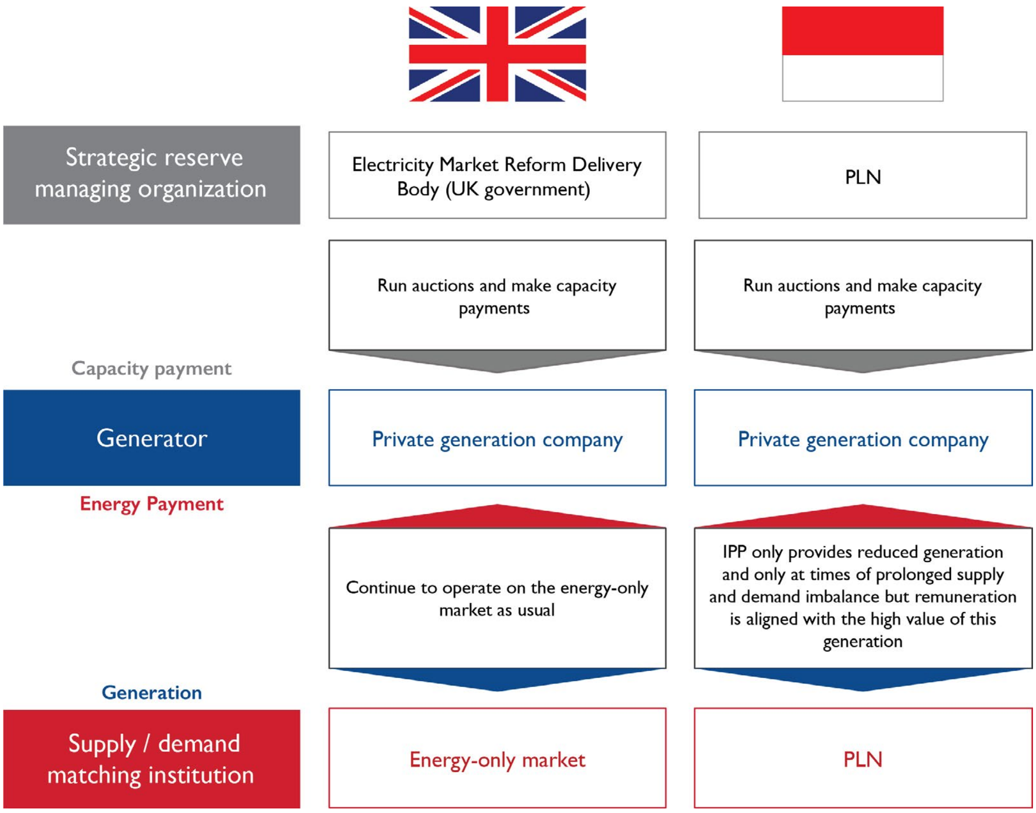
Central capacity procurement as another way of replacing power purchase agreements

Another option to encourage independent power producers to give up their current power purchase agreements would be to set up a centralised capacity procurement mechanism and payment structure. This centralised mechanism would allocate a capacity payment to cover investment costs alongside energy payments for power generated with no minimum offtake agreement. Independent power producers are only likely to participate in this scheme if the combination of these payments is at least as high as the returns they receive from the existing power purchase agreements. One way to ensure this would be for energy payments to reflect the value that the energy delivered provides rather than the cost of generating it. In systems with a high share of renewable energy, coal assets operate to address daily to weekly imbalances in supply and demand (coal assets are not suited to managing imbalances over shorter time scales). These assets deliver power when it is scarce and therefore it has a higher value, especially since it ensures security of supply.

Thus the procurement mechanism needs to allocate capacity payments equal to or higher than the current returns on investment under the power purchase agreements. However, the capacity auctions should aim to deliver this at least cost to PLN. PLN would determine a target volume of coal assets to shift from the power purchase agreements to the central mechanism and hold an auction for the equivalent capacity contracts. All currently operational coal assets would be eligible to participate in the auction, creating competition for scarce contracts and ensuring a competitive price for PLN. Coal asset owners who win contracts in the auction receive the capacity payment as well as a new contract for power delivered. The contract does not guarantee offtake but the compensation offered reflects the high value of delivered power. Figure 15 compares the UK Capacity Market and the possible Indonesian capacity market discussed in this section.

While this option offers a premium payment for energy delivered, the reduced use of coal also creates space in baseload generation for low-cost renewables and offers potential for cost savings. These savings become more significant if we consider economic pricing and compare the cost of renewables with the true cost of coal – without the domestic market obligation cap and with the cost of carbon added.

Figure 15: Comparing stakeholders in the UK Capacity Market and equivalent parties in a potential Indonesian scheme



3. CONCLUSION

Indonesia can renegotiate the compensation for independent power producers that shift from providing baseload power to delivering flexibility and security of supply services. These are essential services for a high variable renewable energy system and they provide a way for Indonesia to break its dependence on coal, create room in the system for large-scale renewable generation and maintain security of supply throughout the transition. A mechanism that can deliver the required flexibility services will have multiple benefits for PLN, its customers and the power purchase agreements by:

- Incentivising coal generators to reduce output and hence their carbon emissions;
- Reducing the potential costs of stranded coal assets compared to a forced shutdown schedule;
- Enabling coal to be replaced with lower-cost variable renewable energy generation;
- Providing security of supply services needed in the transition to a high variable renewable energy system.

The German, Australian and UK models of using coal assets in making the energy transition all share a common principle of using fossil fuel assets to cover essential security of supply services. They create business models to incentivise the delivery of these services and reduce the stranded costs associated with retiring coal assets early. In an Indonesian system with high renewable penetration, the likely role for coal in the transition is to provide firm capacity in prolonged periods of low renewable generation during the rainy season or when forest fires create haze that affects solar generation.

Coal power purchase agreements in Indonesia typically include an availability (or investment recovery) payment, intended to cover the cost of finance, fixed operations and maintenance costs, and energy payments for power generated. This availability payment is similar to the capacity payments discussed in Germany, Australia and the United Kingdom in that it is intended to cover fixed costs. This payment is likely to continue as it is or under a different label as a capacity payment under any model where coal assets shift to providing security of supply.

However, government could adjust the energy component of the power purchase agreement to ensure coal is only used during prolonged periods of low renewable generation. For example, it could allow coal assests to operate only after trigger conditions are met, as in the German approach. Restructuring remuneration for coal-fired assets in this way could achieve three outcomes: (1) encouraging renewable generation and reducing carbon emissions; (2) reducing overall system costs once the levelised cost of electricity of new-build renewables falls below the short-run marginal costs of existing coal; and (3) minimising stranded costs of existing coal assets.

The three options discussed in this paper each offer different advantages and disadvantages. Deciding on an appropriate mechanism will not only need to consider the structure of existing power purchase agreements and the physical needs of the Indonesian system but also the wider social and political feasibility of the different mechanisms. A comparison of the options and some of their relative strengths and weaknesses is presented in Table 2.

Table 2: Comparing potential mechanisms to incentivise coal generators in Indonesia to shift to operating flexibly

	Incentive for IPPs to participate	Reduction in coal use	Transparency	Administrative burden
Strategic reserve	Investment recovery payments are continued and cost of remaining on standby must be recovered – no immediate opportunities for IPPs to increase returns (Undesirable)	Coal only used when absolutely necessary for security of supply (Desirable)	Difficulties can arise in determining what constitutes an 'emergency' (Undesirable)	Shifting assets to reserve is the simplest process for PLN (Desirable)
Tradable permit-based capacity market	Sale of capacity certificates presents an opportunity for IPPs to increase the expected return on investment (Moderately desirable)	Auctioning capacity contracts and 'value-based' energy payments offer IPPs two opportunities to improve financial performance (Moderately desirable; applies to both Tradable permit-based capacity market and Centralised capacity market)	Predetermined certification of assets by PLN and trading of permits between independent entities creates transparency (Desirable)	Certification of assets by PLN is resource-intensive (Undesirable)
Centralised capacity market	Auctioning capacity contracts and 'value-based' energy payments offer IPPs two opportunities to improve financial performance (Desirable)		PLN runs auctions with participants, including IPPs already contracted to PLN, which may create transparency concerns for customers (Moderately desirable)	Running annual capacity auctions is resource-intensive (Undesirable)

Key: Undesirable · Moderately desirable · Desirable

References

Appunn K, Y Haas and J Wettengel (3 August 2022) *Germany's energy consumption and power mix in charts*, including charts sourced from Fraunhofer ISE, Online resource: Clean Energy Wire, Available at: https://www.cleanenergywire.org/factsheets/germanys-energy-consumption-and-power-mix-charts

Department of Climate Change, Energy, the Environment and Water (DCCEEW)(undated) *National electricity market*, Online resource: Australian Government, Available at: https://www.energy.gov.au/government-priorities/energy-markets/national-electricity-market-nem#:~:text=The%20NEM%20is%20a%20wholesale,not%20connected%20to%20the%20NEM.

Clean Energy Wire (8 February 2018) *European Commission approves Germany's electricity capacity mechanism to ensure security of supply, News digest item*, Online resource: Clean Energy Wire, Available at: https://www.cleanenergywire.org/news/coalition-climate-agreement-criticised-eu-approves-capacity-reserve/european-commission-approves-germanys-electricity-capacity-mechanism-ensure-security-supply

CSIRO (11 December 2020) *Renewables still the cheapest new-build power in Australia*, News release, Online resource, Available at: https://www.csiro.au/en/news/news-releases/2020/renewables-still-the-cheapest-new-build-power-in-australia

Department for Business, Energy and Industrial Strategy (BEIS) (30 June 2021) *End to coal power brought forward to October 2024*, Press release, UK government, Available at: https://www.gov.uk/government/news/end-to-coal-power-brought-forward-to-october-2024

Department of Industry, Science, Energy and Resources (2021) *Principles to guide Capacity Mechanism development*, Available at: https://www.energy.gov.au/sites/default/files/2021-10/Principles to guide Capacity Mechanism development.pdf

Department of Industry, Science, Energy and Resources (2021) *Summary of the final reform package and corresponding Energy Security Board recommendations*, Online resource: Australian government, Available at: https://www.energy.gov.au/sites/default/files/2021-10/Summary of the final reform package and corresponding Energy Security Board recommendations0.pdf

Department of Industry, Science, Energy and Resources, Australia (14 September 2021) *Australian energy statistics*, Report, Online resource: Australian government, Available at: https://www.energy.gov.au/publications/australian-energy-update-2021

Department of Industry, Science, Energy, and Resources(2021) *Australian energy statistics 2021*, Australian government database, Available at: https://www.energy.gov.au/publications/australian-energy-statistics-table-o-electricity-generation-fuel-type-2019-20-and-2020

Economic Consulting Associates Limited (ECA)(2015) *Carbon lock-in toolkit February 2015, submitted to the UK Department for International Development*, Available at: https://assets.publishing.service.gov.uk/media/57a08978ed915d622c000223/61516_Carbon_lock-in_toolkit.pdf

Edis T and J Bowyer (February 2021) *Fast erosion of coal plant profits in the National Electricity Market*, Lakewood: Institute for Energy Economics and Financial Analysis, Available at: https://ieefa.org/wp-content/uploads/2021/02/Coal-Plant-Profitability-Is-Eroding_February-2021.pdf

ELEXON (undated) *Where can I find details of wholesale prices of electricity in Great Britain?*, Company database online, London: ELEXON, Available at: https://www.elexon.co.uk/knowledgebase/where-can-i-find-details-of-wholesale-prices-of-electricity-in-great-britain/

Energy Security Board (2020a) *Post 2025 market design options – a paper for consultation: Part A*, Available at: https://esb-post2025-market-design.aemc.gov.au/32572/1619564199-part-a-p2025-march-paper-esb-final-for-publication-30-april-2021.pdf

Energy Security Board (2020b) *Post 2025 market design. Final advice to energy ministers: Part C*, Available at: https://esb-post2025-market-design.aemc.gov.au/32572/1629945838-post-2025-market-design-final-advice-to-energy-ministers-part-c.pdf

European Commission (7 February 2018) *State aid: Commission approves six electricity capacity mechanisms to ensure security of supply in Belgium, France, Germany, Greece, Italy, Poland*, Press release, Available at: https://ec.europa.eu/commission/presscorner/detail/en/IP_18_682

Federal Ministry for Economic Affairs and Climate Action, Germany (7 February 2018) *European Commission approves reserve to ensure the stability of the electricity market*, Press release, Available at: https://www.bmwk.de/

Federal Network Agency (April 2021) *Results of second coal phase-out tendering process*, Press release, Available at: https://www.bundesnetzagentur.de/

Institute for Essential Services Reform (IESR) (2019), *Levelized cost of electricity in Indonesia, Jakarta: Institute for Essential Services Reform*, Available at: https://iesr.or.id/wp-content/uploads/2020/01/LCOE-Full-Report-ENG.pdf

London School of Economics and Political Science (LSE) and Grantham Research Institute on Climate Change and the Environment (November 2019) *What is a carbon price and why do we need one?*, London: LSE, Available at: https://www.lse.ac.uk/granthaminstitute/explainers/what-is-a-carbon-price-and-why-do-we-need-one/

National Grid Electricity System Operator Electricity Market Reform Delivery Body (ESO EMR) (undated) *Capacity auction information*, Online database, Available at: https://www.emrdeliverybody.com/CM/Capacity Auction Information.aspx

Office of Gas and Electricity, United Kingdom (ofgem) (2012) Electricity demand profiles in the markets database, Available at: https://www.ofgem.gov.uk/publications/demand-side-response-non-domestic-sector

Simon F (7 September 2018) ‘Germany's “strategic reserves” for coal under fire In EU council’, *EURACTIV*, Available at: https://www.euractiv.com/section/electricity/news/germanys-strategic-reserves-for-coal-under-fire-in-eu-council

UK government (2021) *National statistics: Digest of UK energy statistics (DUKES) 2021, Online energy database*, Available at: https://www.gov.uk/government/statistics/digest-of-uk-energy-statistics-dukes-2021

UK government (2022) *UK energy in brief, online energy database*, Available at: https://www.gov.uk/government/collections/uk-energy-in-brief

Vorrath S (1 November 2021) *No ‘big bang’ as ESB confirms rethink on CoalKeeper design, Online news site: Renew Economy*, Available at: https://reneweconomy.com.au/no-big-bang-as-esb-confirms-rethink-on-coalkeeper-design/

Williams G (2022) *Profiling the capacity market debate*, Sydney: Australian Energy Market Commission, Available at: https://www.aemc.gov.au/news-centre/perspectives/economists-corner-profiling-capacity-market-debate

mentari

A UK-Indonesia Low Carbon Energy Partnership

Program MENTARI (Menuju Transisi Energi Rendah Karbon Indonesia)

Ratu Plaza Office Tower, 19th Floor
Jl. Jend. Sudirman Kav. 9
Jakarta 10270, Indonesia
contact@mentari.info

www.mentari.info

For more information and access
to our knowledge database,
visit our website:

Powered by Palladium MAKE IT POSSIBLE

In consortium with castlerock consulting, ECA, Hivos people unlimited