# Just Transition Finance Challenges & Opportunities for the Early Retirement of Indonesia's Coal-Fired Power Plants

**SGFIN Industry Report #2**


**Yannis Yuan | Weina Zhang | Luluk K. Aini | Kirine F. Budianto | Maura F. Winayo**
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[1] National University of Singapore
[2] CGS International

*SGFIN Industry Report #2*

**October 2024**

## Abstract

This report presents an analysis of the financing gap for the early retirement of coal-fired power plants (CFPPs) in Indonesia. By investigating the incremental cash flows for the two coal plants involved in the JETP Indonesia programme, this report breaks down the financial impacts of coal plant phase-out into forgone operating profits, carbon savings and offsets, and the installation and operation of replacement energy capacity. We highlight the affordability of renewable energy (e.g., solar and wind) production and storage is the major bottleneck for accelerating energy transition across Indonesia. This is because the country's levelized cost of energy (LCOE) for renewables is substantially higher than that for coal. We show that the financing gap for the early decommissioning of CFPPs can be filled when Indonesia's solar LCOE can be reduced from >US$150/MWh to <US$50/MWh, which has already been achieved in major economies in the world. Moreover, we also estimate the environmental and social impacts of coal plant early retirement on all stakeholders in financial terms to quantify the benefits of energy transition to society.

**Keywords**: Energy Transition, Early Retirement, Indonesia, Blended Finance, Social Impact, Environmental Impact

**JEL Classification:** G23, Q21, Q51, Q53.

Email addresses: yyuan@nus.edu.sg (Yannis Yuan), weina@nus.edu.sg (Weina Zhang).

***Author Details:***
**Yannis Yuan** is the research associate at SGFIN.
**Weina Zhang** is the deputy director of SGFIN.
**Luluk K. Aini, Kirine F. Budianto, Maura F. Winayo, and Yan Jie** were students who completed the Masters in Sustainable and Green Finance program at the National University of Singapore.
**Johan Sulaeman** is the director of SGFIN.
**Kevin W.F. Lee** is Group Head of Sustainability with CGS International Securities. He also heads the ASEAN Institute of Carbon Neutrality based out of CGS International Securities headquartered in Singapore.
**Jacquelin Hamdani** is a Research Analyst with CGS International Securities, Indonesia (PT CGS International Sekuritas Indonesia)

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The ASEAN Institute of Carbon Neutrality (AICN) is a thought-leadership institute established under the umbrella of CGS International Securities. AICN's aspiration is to motivate capital markets into mobilizing finance for climate change action in the ASEAN region. This is done through the creation and sharing of knowledge along decarbonisation themes aimed at educating and engaging the business and financial community on climate change.

**Cover image acknowledgement**

The cover image for this report is generated by Adobe Firefly.

***Acknowledgments***

We gratefully acknowledge the contribution from our students from M.Sc. in Sustainable and Green Finance Programme for their groundwork in their capstone project. In addition, we appreciate the feedback from the CGS Sustainability Team, including Nathania Giovanna, Daryl Ware and Tabitha Hui.

**Recommended citation**

Yuan, Y., Zhang, W., Aini, L.K., Budianto, K.F., Winayo, M.F., Jie, Y., Sulaeman, J., Lee, K.W.F., and J. Hamdani (2024). Just Transition Finance Challenges & Opportunities for the Early Retirement of Indonesia's Coal-Fired Power Plants, *SGFIN Industry Report* #2, National University of Singapore.

Editorial Correspondence should be addressed to SGFIN@nus.edu.sg.

## Executive Summary

Making up nearly 87% of the world's total GHG emissions in 2023, the energy consumption is a critical part of net-zero transition (Energy Institute, 2024). While fossil fuels remain dominant in the global energy portfolio, the share of renewable energy has been climbing steadily over the past decade, driven by a substantial cost reduction in wind and solar installation due to China's expansion in newly commissioned projects (IRENA, 2023). By 2028, renewables are expected to make up more than 40% of the global power generation, led by solar, wind and hydropower (IEA, 2024). Meanwhile, coal plant phaseout is an imperative across Asia Pacific. In 2023, China, India, Japan and Indonesia combined about 70% of coal power production worldwide (Global Energy Monitor, 2024), while the average age of existing coal plants in China, India and Southeast Asia are lower by more than half compared to their European and American counterparts (IEA, 2021), making it more costly for the phaseout in these regions.

Indonesia stands at a pivotal moment in its journey toward sustainable economic development. As one of Southeast Asia's largest economies, the nation is committed to meeting its climate goals while ensuring energy security and economic stability. The **Just Energy Transition Partnership (JETP)** reflects Indonesia's determination to balance growth with sustainability by focusing on the early retirement of coal-fired power plants (CFPPs) and transitioning toward a greener, more resilient energy sector. To support the energy transition across Asia Pacific, multilateral development banks (MDBs) and international climate and transition funds have joined forces with the nation's government in this initiative by providing both concessional and non-concessional finance, with large amounts of capital dedicated for coal plant phase-out projects. As an importance source of blended finance, these investment funds are meant to address the financing needs for the retirement of CFPPs as well as the installation and operation of renewable power facilities as the replacement energy source.

This report assesses the financial and impact implications of retiring two key CFPPs—**Cirebon-1** and **Pelabuhan Ratu**. It underscores the need for strategic financial planning, leveraging both public and private capital through mechanisms such as the **Energy Transition Mechanism (ETM)**, and the potential role of carbon credits in bridging the funding gaps. We also evaluate the environmental, social, and governance (ESG) impacts, recognising that the energy transition must be inclusive, addressing both economic and social challenges while creating new opportunities in the renewable energy sector. We hope that our findings can provide valuable insights for policymakers, investors, and stakeholders on how to align Indonesia's energy transition with its broader economic and sustainability objectives. The road ahead will not be easy, but with coordinated efforts and innovative financing mechanisms, Indonesia can serve as a model for other emerging economies seeking to pursue climate action without compromising growth and development.

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# 1 Introduction

Indonesia's economy is forecast to grow at a rate of 4.9% between 2024 and 2026. The steady growth is powered by an industrial expansion, with manufacturing alone contributing to about 20% of Indonesia's GDP (World Bank, 2023). In 2022, Indonesia was responsible for about 692 Mt $CO_2$ emissions. It accounted for 1.8% of the world's total $CO_2$ emissions that year, exceeding the country's share of world's total GDP at 1.3% (European Commission, 2023). To address the ongoing imperative of decarbonising its economy, the Indonesian government is committed to reduce GHG emissions by 31.89% on its own or 43.2% with international support by 2030, as outlined in its enhanced Nationally Determined Contribution (NDC) published in September 2022 (UNDP, 2024).

Energy transition is a critical part of Indonesia's path towards net zero. The energy sector has been the second-largest contributor to Indonesia's national GHG emissions behind food and land use (FOLU), making up about 35% of total emissions (UNFCCC, 2021). Currently, the country's electricity generation remains heavily dependent on coal, which accounted for 61.5% of its total electricity mix in 2022 (IEA, 2022). To meet the enhanced NDC targets while maintaining high economic growth, the Indonesian government devised the National Electricity Plan (RUKN) with four scenario pathways towards net zero. Guided by this master plan, the country's state utility (PLN) developed the latest edition of its 10-year electricity plan (RUPTL) that targeted to add 21 GW renewable power capacity by 2030, around 52% of the total additions during the period (Ember, 2024). Unfortunately, renewable energy remains critically under-invested in Indonesia, with merely US$1.6 billion realised investments in 2022, compared to US$28.5 billion needed annually to achieve net zero emissions by 2060 (MEMR, 2022).

The international development finance institutions have joined forces with the Indonesian government to support the country's energy transition through **blended finance**. In particular, the Asian Development Bank (ADB) has been an active player in financing the early retirement of coal-fired power plant (CFPP) projects in developing countries across Asia Pacific. During COP28, ADB reached a new agreement with the Indonesian government to early retire Cirebon-1, a coal plant in West Java, 7 years ahead of the scheduled cessation date under the Energy Transition Mechanism (ETS) framework (ADB, 2023b). In this framework, a special purpose vehicle (SPV) is formed to acquire capital of the CFPP and pay special dividend to its owners to cover their expected loss from early retirement. Apart from covering financial needs to decommission power plants, the concessional capital is used to finance the repurposing of the plants and reskilling of employees.

On 16 November 2022, the Government of Indonesia and the International Partners Group (IPG) launched the Just Energy Transition Partnership Indonesia (JETP Indonesia). At an initial commitment of US$20 billion, of which US$10 billion in IPG funding was pledged to catalyse US$10 billion of private financing from Glasgow Financial Alliance for Net Zero (GFANZ), US$20 billion over the next several years as initial catalytic financing and accelerated retirement of CFPPs. The ADB is the lead development partner of JETP Indonesia, providing technical assistance with the programme (ADB, 2023a). On 21 November 2023, Indonesia launched its JETP Comprehensive Investment and Policy Plan (CIPP). The plan outlined five investment focus areas, requiring a total funding of US$97 billion. It aims to cap the country's peaking power sector emissions by 2030 at 290 MtCO2 and achieve net zero in the power sector by 2050. Moreover, it targets to achieve 44% renewable energy shares by 2030 (JETP Indonesia, 2023).

In this report, we examine the second investment focus area (IFA2) of the JETP programme, which involves CFPP early retirement and managed phaseout. Specifically, we estimate the **financing gap** and **the energy gap** that need to be filled for the early retirement of Cirebon-1 and Pelabuhan Ratu plants and assess the **environmental** and **social impacts** during the transition.

# 2 Financial Valuation

The five JETP investment areas require more than US$97.3 billion investments committed between 2023 and 2030, while the IFA2 makes up at least US$2.4 billion of the total investments. The two featured priority projects under IFA2, namely PLTU Cirebon-1 and PLTU Pelabuhan Ratu, combined a total capacity of 1,710 MW and an aggregate investment need of approximately US$1,130 million (see **Table 1** for a breakdown of Cirebon-1 and Pelabuhan Ratu early retirement funding, and **Figure 1** for the funding structure of the early retirement of the two power plants). Cirebon-1 started operating in 2012 and the JETP plans to retire the plant in 2035, 7 years ahead of its natural retirement date. Pelabuhan Ratu is projected to early retire in 2037, 8 years in advance (JETP Indonesia, 2023).

The Cirebon-1 power plant is owned by a consortium known as Cirebon Electric Power (CEP), which is a joint venture consisting of several international and local entities including Marubeni (Japan), KOMIPO (Korea), Samtan (Korea), Indika (Indonesia) and JERA (Japan). Under a private CFPP early retirement programme, the independent power plant (IPP) receives a portion of concessional financing from the Accelerating Coal Transition Investment Programme (ACT) administered by the Climate Investment Funds (CIF) together with commercial financing from ADB Private. The loan proceeds from the concessional financiers and commercial lenders are intended for (a) the prepayment of existing borrowings; (b) special dividend payments to the IPP shareholders; and (c) repayment of outstanding loans from these early retirement financiers.

The Pelabuhan Ratu power plant, also located in West Java, is fully owned and operated by PT PLN (Persero), a dominant state-owned utility provider in Indonesia that serves the Java-Bali electricity grid. The plant consists of three units, each with a capacity of 350 MW. Funding from ADB, CIF-ACT, Government of Indonesia and other commercial lenders will be blended and managed as a trust fund within PT Sarana Multi Infrastruktur (SMI). In turn, PT SMI will invest into a special purpose vehicle (SPV) that owns the PLN assets, which are repurposed as independent power plants (IPPs).

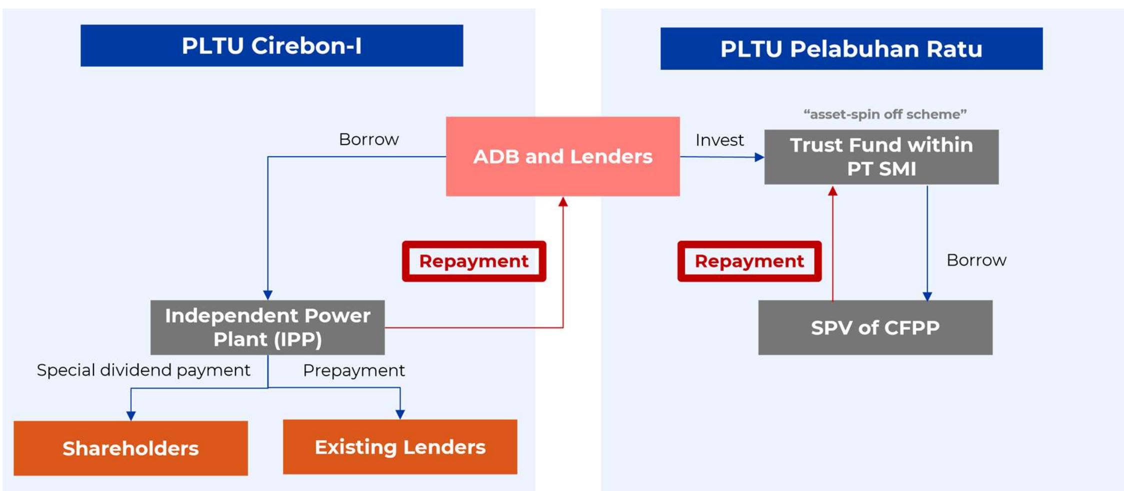
**Table 1:**
Funding Sources for Cirebon-1 & Pelabuhan Ratu

| PLTU Cirebon-1 | | | PLTU Pelabuhan Ratu | | |
|---|---|---|---|---|---|
| **Funding Source** | **Type** | **Amount ($mil)** | **Funding Source** | **Type** | **Amount ($mil)** |
| ***Currently Available Funding*** | | | | | |
| ADB (Private) | Non-Concessional Loan | 250 | ADB | Concessional Loan | 102 |
| CIF-ACT | Concessional Loan | 50 | CIF-ACT | Concessional Loan | 98 |

| | | | | | |
|---|---|---|---|---|---|
| | | | | Grant | 1 |
| **Subtotal** | | **300** | **Subtotal** | | **201** |
| ***Future Funding Plans*** | | | | | |
| | | | Commercial Financing | | 150 |
| | | | Government | | 500 |
| **Subtotal** | | **-** | **Subtotal** | | **650** |
| **Total Funding** | | **300** | **Total Funding** | | **851** |

Data Source: JETP Comprehensive Investment and Policy Plan (2023)

**Figure 1:**
Funding Structure for Cirebon-1 & Pelabuhan Ratu




Source: Authors generated.

## 2.1 *Financial Cost & Benefit Analysis*

In this report, we consider two transition scenarios: (a) a max retirement scenario, which assumes the decommissioning of both coal plants takes place immediately this year; and (b) an early retirement scenario, which assumes the decommissioning of Cirebon-1 and Pelabuhan Ratu take place in 2035 and 2047 respectively. The financial implications of energy transition generally include the unearned operating profit due to early retirement of the coal plant, incremental cost/benefit from the sales of replacement energy, as well as cost avoidance due to reduced emissions. This subsection breaks down the incremental cost and benefit from each value driver.

### A. Forgone P&L due to Early Retirement

The primary source of revenue of a power plant is from the sales of electricity under power purchase agreements (PPAs). It can therefore be calculated with

$$Annual\ Revenue = Annual\ Electricity\ Generation \times PPA\ Tariff\ Price$$

where the unit cost of electricity supply, also known as the electricity tariff, is currently priced at about US$63 per megawatt hour (MWh). The amount of electricity generated from a CFPP per annum can be estimated based on its total installed capacity and a capacity factor, which measures the effective usage rate of the plant relative to its maximum capacity. A coal plant typically has a higher capacity factor compared to renewable energy sources due to the ability to consistently generate power regardless of weather conditions. The capacity factor is about 65% - 75% for a coal plant, 16% for solar photovoltaic (PV) and 30% for an onshore wind power generator in Indonesia (TransitionZero, 2024).

On the other hand, the operating and maintenance costs of a coal-fired power plant (CFPP) can be calculated by aggregating several major cost components, expressed as

$$Operating\ Cost = Fuel\ Price + Carbon\ Cost + VOM\ Cost + FOM\ Cost$$

where the fuel price, VOM cost and FOM cost can be expressed as US$/MWh, whereas the carbon cost, also known as the financial cost of carbon, is charged based on the amount of $CO_2$ emissions. Currently, Indonesia's intensity-based emissions trading scheme (ETS) targets all CFPPs with an output of 25 MW or above. For non-mine mouth CFPPs with a capacity above 400 MW, the allocated emission allowance is capped at 0.918 $tCO_2$/MWh (World Bank, 2021, p. 66). Pelabuhan Ratu coal plant has an average carbon intensity above the cap at 0.94 $tCO_2$/MWh, while Cirebon-1 coal plant has a carbon intensity below the cap at 0.86 $tCO_2$/MWh (TransitionZero, 2024). As a result, Pelabuhan Ratu will need to pay a carbon tax or offset their emissions through the Indonesian Carbon Exchange (IDXCarbon) officially launched in September 2023. Cirebon-1 can instead trade away their emissions with other corporate entities. In 2023, the average auction price of carbon was IDR 10,000 (or US$0.64) per tonne $CO_2$ and the average market price of carbon was US$4.45/$tCO_2$ (ICAP, 2024).

In addition to the four regular operating costs, the owners of the CFPPs will need to pay a lump-sum decommissioning cost at the time of plant retirement. The decommissioning cost is proportional to the power plant capacity, and it is estimated to be US$58,110/MW for any Indonesian CFPP (TransitionZero, 2024).

### B. Transition P&L due to Renewable Installation

To fill the energy and financial gap due to early retirement of coal plants, renewable energy facilities (e.g., solar and wind) will need to be installed to generate replacement energy and cash flows to plant owners. The amount of clean electricity generated from replacement energy facilities should be able to fully cover the energy gap created in the phase-out of coal plants. Taking into account the difference in capacity factors for coal and renewable energy generation, the renewable capacity of replacement solar or wind facilities needs to be significantly higher. For example, the Cirebon-1 power plant has a capacity of 660 MW and a capacity factor of about 75%. If fully replaced by solar energy with a capacity factor of 16%, the required capacity to be installed is approximately 3,094 MW. If instead replaced by onshore wind with a capacity factor of 30%, the required capacity to be installed becomes 1,650 MW.

The annual profit from replacement energy can be calculated with

$$Annual\ Renewable\ Profit = Annual\ Electricity\ Generation \times [PPA\ Tariff\ Price - LCOE]$$

where the levelized cost of energy (LCOE) measures the net present cost of replacement energy production and storage, expressed in \$/MWh. Despite the significant global decline in solar and wind LCOE over the past decade, powered by China's expansion in renewable projects, the LCOEs for solar and onshore wind in Indonesia are among the highest in the world, standing at about US\$158/MWh and US\$190/MWh respectively (TransitionZero, 2024). As is the case with the current electricity tariff, sales of electricity generated from renewable energy facilities result in negative profits. However, large-scale investments in renewable energy infrastructure in Indonesia are expected to reduce the cost of renewable energy generation and storage, making it a more affordable replacement option.

Another important source of cash flows is the sales of carbon offset, created from carbon avoidance due to CFPP early retirement. The revenue from sales of carbon offset can be calculated with

$$Annual\ Carbon\ Credit\ Profit = Annual\ Electricity\ Generation \times Carbon\ Intensity \times Carbon\ Credit\ Price$$

where carbon intensity measures the carbon emissions for per unit amount of electricity generated, expressed in $tCO_2/MWh$. The carbon credit price is the secondary market financial cost of carbon currently traded at US\$4.45/$tCO_2$ (ICAP, 2024). TransitionZero (2024) assumes a carbon offset value of US\$10/$tCO_2$ in their energy transition toolkit.

## 2.2 *Free Cash Flow to Equity Holders Analysis*

The financing gap for the early retirement of CFPPs can be evaluated with a discounted cash flow (DCF) model. Assuming that the energy gap is filled in the year of coal plant decommissioning, the incremental cash flows from 2024 till the end year of coal plants' designed useful life (2042 for Cirebon-1 and 2045 for Pelabuhan Ratu) are discounted by the weighted average cost of capital (WACC) to arrive at the present value at the beginning of 2024. In this study, we assume a 9% cost of capital given the country characteristics and return expectations (MAS, 2023), and an inflation rate of 2.51% based on the country's five-year inflation economic outlook (Statista, 2024).

This subsection analyses the impacts of the early retirement of CFPPs on the cash flows to coal plant asset owners, thereby estimating the net financing gap that needs to be filled with transition investment capital. In particular, we consider a max retirement scenario where coal plants are decommissioned immediately, and an early retirement scenario where coal plants are decommissioned in the early retirement year specified in the JETP Comprehensive Investment and Policy Plan (2023).The max retirement scenario accelerates the energy transition and reduces the largest cumulative carbon emissions, while the early retirement scenario is more cost-efficient and more feasible for coordinated capital mobilisation to finance the transition.

In the max retirement scenario, both coal plants will be decommissioned in 2024 and the net present value (NPV) of forgone profit from selling electricity (after a 22% corporate income tax) is estimated to be about US$910 million and US$1,242 million for Cirebon-1 and Pelabuhan Ratu respectively. Unfortunately, as renewable energy generation and storage remains unaffordable, the installation and operation of the renewable facilities further enlarge the financing gap. We use solar as an example and estimate the net financing gap for energy transition to be approximately US$3 billion for Cirebon-1 and US$4.3 billion for Pelabuhan Ratu (see **Table 2** for the PV contribution from each value driver for Cirebon-1 and Pelabuhan Ratu early retirement). The total funding for the early retirement of both coal plants shown in **Table 1** is far below the required financing amount, making immediate decommissioning a financially infeasible option.

**Table 2:**
Present Value of Key Transition Value Drivers for Cirebon-1 & Pelabuhan Ratu

| | PLTU Cirebon-1 | | PLTU Pelabuhan Ratu | |
|---|---|---|---|---|
| **Value Driver** | **Max Retirement ($mil)** | **Early Retirement ($mil)** | **Max Retirement ($mil)** | **Early Retirement ($mil)** |
| ***Forgone P&L due to Early Retirement*** | | | | |
| Sales of Coal PPA | (910) | (257) | (1,242) | (308) |
| **Subtotal** | **(910)** | **(257)** | **(1,242)** | **(308)** |
| ***Financial P&L due to Transition Externalities*** | | | | |
| Sales of Solar Energy | (2,449) | (477) | (3,484) | (549) |
| Sales of Carbon Offset | 316 | 91 | 507 | 131 |
| **Subtotal** | **(2,160)** | **(396)** | **(3,020)** | **(433)** |
| **Total Financing Gap** | **(3,070)** | **(653)** | **(4,262)** | **(740)** |

Source: Authors generated.

In the early retirement scenario, Cirebon-1 and Pelabuhan Ratu will be decommissioned in 2035 and 2037 respectively. The delayed phase-out compared to the max retirement scenario lowers both the financing gap and the carbon avoidance. The forgone profit from coal plant operations is reduced to US$257 million and US$308 million for Cirebon-1 and Pelabuhan Ratu respectively, and the ultimate financing gap is shrunk to US$653 million and US$740 million respectively. The committed investments in the early retirement of Cirebon-1 still fall short of the required funding, while financing for the early retirement of Pelabuhan Ratu is sufficient under this scenario. In the following subsection, we analyse how a potential change in key economic variables such as interest rate and inflation rate as well as energy-related variables such as fuel cost and renewable LCOE may alter this outcome.

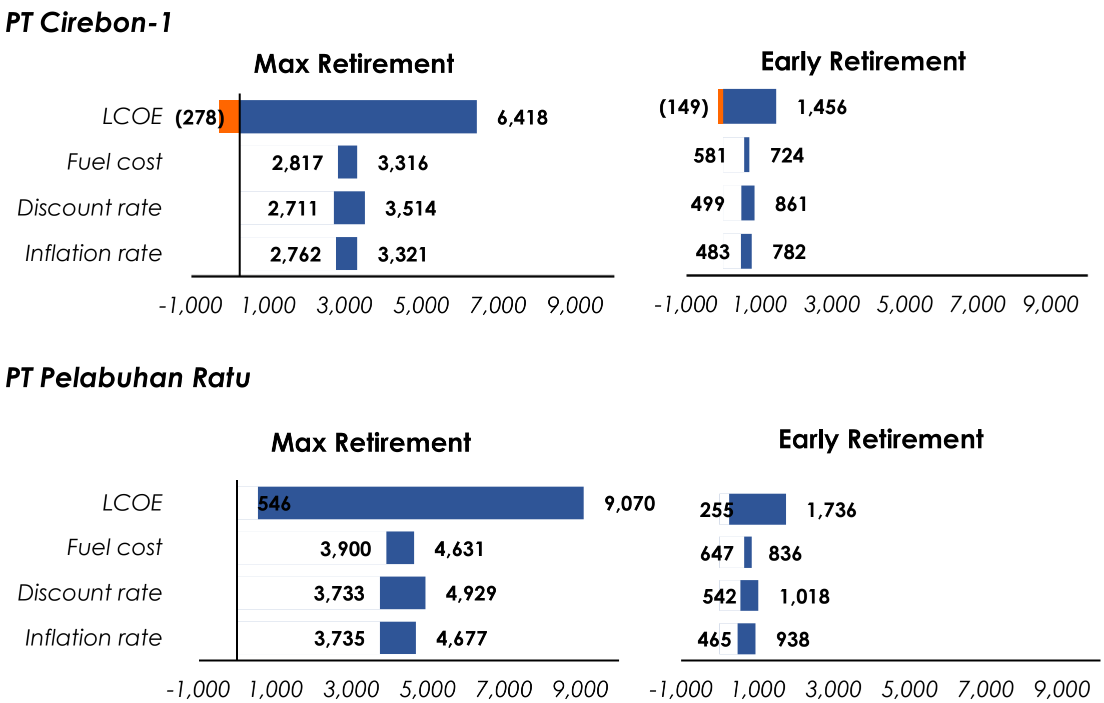
## *2.3 Sensitivity Analysis*

The cash flow analysis presented above may be sensitive to macroeconomic variables and changes in energy prices. This subsection delves into how these variables affect the net present value of the total financing gap for the early retirement of the two coal plants. The sensitivity analysis is performed by varying an increment of one parameter while fixing the values of the other parameters to estimate the marginal contribution of the varied parameter to the outcome variable.

The upside and downside values of these parameters should reflect their plausible variation corresponding to the changing economic conditions. In the baseline scenario, we use an average inflation rate of 2.51% and an effective long-term discount rate of 9%. The discount rate is in the denominator of the DCF analysis and an increase in discount rate reduces the financing gap as a result. We investigate the effect of a 2% change in the discount rate on the NPV of financing gap for the two coal plants, with a best-case scenario at 11% and a worst-case scenario at 7%. On the other hand, changes in the inflation rate affects multiple price quantities including the PPA tariff price, the fuel cost, the variable and fixed operating and maintenance costs and the carbon credit price. The net effect of an increase in the inflation rate is a reduction in financing gap. Similar to the analysis of discount rate, we examine the effect of a 2% change in the inflation rate with a best-case scenario at 4.51% and a worst-case scenario at 0.51%.

Variation in the fuel cost has a direct effect on the size of forgone profit from the sales of PPA generated from the coal plants. We assume a 20% upside/downside from the baseline value of the fuel cost at around US$34/MWh. By comparison, the LCOE for renewables is subject to higher variation. In a plausible best-case scenario, the LCOE for solar can even go below US$50/MWh, as is the case in the United States, France, India and China (IEA, 2020). However, it is equally plausible for the solar LCOE to go well above US$200 in Indonesia, if the investments in solar and transmission infrastructure continues to lag (ReExplorer, 2020). We therefore allow for a 70% upside/downside from the baseline solar LCOE at about US$158/MWh.

**Figure 2:**
Sensitivity Analysis of Financing Gap for Cirebon-1 & Pelabuhan Ratu




Source: Authors generated based on Table 2 and 5.

**Figure 2** presents a football field chart that illustrates the range of financing gap in response to changing inflation rate, discount rate, fuel cost and solar LCOE. While all four parameters can influence the magnitude of the financing gap, the solar LCOE has the most sizable impact on the outcome, with the early retirement of Cirebon-1 creating a negative financing gap (or positive net profit). Although there remains a financing need for Pelabuhan Ratu, the funding requirement is substantially reduced to US$546 million and US$255 million for max retirement and early retirement scenarios respectively, both within the available funding from the JETP programme. This shows that making renewable energy facilities (especially solar and wind) more affordable in Indonesia is key to reducing the financing gap for early retirement of CFPPs and renewable energy transition in the long term.

# 3 Environmental & Social Impact Valuation

The impacts of the early retirement of coal-fired power plants (CFPPs) are manifold and manifest in ways beyond financial accounting and valuation. In this section, we examine the environmental and social externalities of the JETP IFA2 programme and systematically evaluate their impacts in financial terms.

## *3.1 Environmental Impacts*

Early retirement of CFPPs is beneficial for the environment. Its environmental externalities, may or may not be priced in the financial valuation, should be considered in the evaluation of the project, as the impacts on all stakeholders should be incorporated in corporate decision-making. We do not aim at providing an exhaustive list of environmental impacts in this subsection. Instead, we exemplify an impact valuation methodology framework with a few selected environmental impacts.

**A. Carbon Emissions**

In the previous section, the prices of carbon offset and ETS are incorporated into the financial valuation of carbon emissions/savings. Here, we introduce the social cost of carbon (SCC), the shadow price of carbon that measures the economic impacts of emissions using integrated assessment (Bolton, Halem, & Kacperczyk, 2022). Generally speaking, the SCC can be measured by either estimating the marginal damage of future carbon emissions or simulating the societal costs needed to power the economic transition (Stern & Stiglitz, 2021). The SCC varies significantly across the globe and the value for Indonesia is calculated based on net-zero emissions 2050 scenario, estimated to be US$15.04/MWh (TransitionZero, 2024).

Using the DCF model, the present value of the carbon avoidance in the max retirement scenario is estimated to be US$610 million and US$978 million for Cirebon-1 and Pelabuhan Ratu respectively (see **Table 3** for a breakdown of selected environmental and social impact values). By comparison, the early retirement scenario only creates a social value of carbon of US$175 million and US$252 million for Cirebon-1 and Pelabuhan Ratu respectively.

**B. Air Pollution**

The early retirement of the Cirebon-1 and Pelabuhan Ratu CFPPs in Indonesia is projected to bring substantial health benefits primarily driven by avoided air pollution. A study conducted by the Centre for Research on Energy and Clean Air (CREA, 2024) attributes these benefits to the significant reduction in PM2.5 air pollutants. The substance is known for its adverse health effects as these particles can penetrate deep into the lungs and enter the bloodstream, leading to various respiratory and cardiovascular diseases.

Using the AIRPOLIM-ES model developed by the New Climate Institute, the unit social cost of (total) air pollution is estimated to be US$6.55/MWh and US$50.92/MWh for Cirebon-1 and Pelabuhan Ratu respectively (TransitionZero, 2024). As a result, a max retirement of the two coal plants leads to social cost savings of US$308 million and US$3,512 million respectively, and an early retirement as planned in JETP creates social costs savings of US$88 million and US$906 million respectively.

**Table 3:**
Present Value of Environmental & Social Impacts for Cirebon-1 & Pelabuhan Ratu

| | PLTU Cirebon-1 | | PLTU Pelabuhan Ratu | |
|---|---|---|---|---|
| **Impact Value** | **Max Retirement ($mil)** | **Early Retirement ($mil)** | **Max Retirement ($mil)** | **Early Retirement ($mil)** |
| ***Environmental Impacts*** | | | | |
| Carbon Emissions | 610 | 175 | 978 | 252 |
| Air Pollution | 308 | 88 | 3,512 | 906 |
| Water Stress | 56 | 16 | 92 | 24 |
| ***Social Impacts*** | | | | |
| Labour Re-training | (5) | (1) | (8) | (2) |
| Job Creation | 17 | 5 | 29 | 8 |
| **Total Impact Value** | **986** | **283** | **4,603** | **1,187** |

Source: Authors generated.

### C. Water Stress

The closure of CFPPs benefit water in the surrounding areas in two ways: reduced water demand and improved water quality. The impact varies by how water is treated by different power plants. For example, Cirebon-1 has a closed-cycle cooling tower to control the temperature of the wastewater not exceeding 2°C from the initial temperature before it is released back into the sea so that damaging the marine ecosystem can be avoided (Cirebon Power, 2022). Therefore, the impact from thermal reduction might be minimal. In terms of contaminated dust, total suspended solids level around Cirebon-1 has increased by an average of 18.75 mg/L from 1999 to 2014 at Mundu Bay. Changes in water quality also disrupt marine habitats around Mundu Bay and make it difficult for local fishermen to achieve ideal catch yields (Widiawaty, Nurhanifah, Ismail, & Dede, 2020). The termination of CFPPs will halt this type of pollution, leading to improved water quality in the surrounding areas.

The unit social cost of water stress associated with the two coal plants, modelled based on the baseline water stress (BWS) from the World Resources Institute (WRI)'s Aqueduct database, is estimated to be US$1.2/MWh for Cirebon-1 and US$1.33/MWh for Pelabuhan Ratu (TransitionZero, 2024). The total economic impacts on water stress avoided due to the early retirement of Cirebon-1 and Pelabuhan Ratu are estimated to be US$16 million and US$24 million respectively.

### *3.2 Social Impacts*

The phase-out of CFPPs is accompanied with comprehensive social externalities concerning fair distribution of costs and benefits, procedural justice and equal opportunity, some of the most important elements in a just and equitable sustainability transition (EEA, 2024). Among these considerations, labour transformation poses one of the most critical challenges in a renewable energy transition. Upon the decommissioning of a coal power plant, the workers of the plant need to be re-trained to be able to operate the replacement energy facilities. However, if the current workers are unable to pick up the skills, or if there is excess manpower to operate the replacement energy facilities required to match the capacity, the energy transition creates labour displacement with a potentially negative social impact.

In terms of job intensity, coal power plants hire 1.3 workers per MW of capacity, while solar and wind are more labour intensive with 1.95 and 5.24 workers needed respectively for each MW of capacity in Indonesia (TransitionZero, 2024). Based on the US data, it costs between US$6,009 and US$20,863 on average to retrain a worker in transition from a coal plant to operations of a solar PV, approximately 1.75 months of average salary in this industry (Louie & Pearce, 2016). Applying the same conversion, the average cost of labour retraining in Indonesia is estimated to be about US$537 per person. Apart from this social cost, the early retirement of coal plants indirectly helps job creation, a social gain for the labour market. The social value created due to energy transition is estimated based on the increase in job intensity and the average wage in the industry, with a total of US$5 million and US$8 million created during the early retirement of Cirebon-1 and Pelabuhan Ratu respectively (see **Table 3** for a tally of the impact values). Moreover, frictional unemployment is still possible despite net job creation due to a displacement in the labour needs from the decommissioning of the coal plants to the installation, operation and maintenance of the renewable facilities. While the impacts of the labour displacement is challenging to measure with limited data for specific energy transition projects in Indonesia, stakeholders of the coal plants involved in JETP shall incorporate these social responsibility considerations throughout the programme to minimise negative externalities and ensure a just transition.

# 4 Conclusions and Policy Implications

This report examines the financing gap for the early retirement of two coal-fired power plants (CFPPs) involved in the JETP IFA2 programme, located in West Java, Indonesia. By projecting the incremental cash flows due to various financial impact drivers during the coal plant phase-out and the installation of replacement energy capacity, we can estimate the net funding requirements to be met through blended finance. Moreover, we assess the environmental and social impact values that are yet to be fully priced-in but of profound significance to all stakeholders amid the energy transition. With the wealth of scientific and social studies, we provide a systematic approach to investigating how various externalities can be assessed through the lens of financial valuation.

The trade-off between maximum social gains and minimum financing gap is entrenched in the selection of early retirement date, and the JETP programme strikes the balance by targeting a 7-year early retirement for Cirebon-1 and an 8-year early retirement for Pelabuhan Ratu. The owners of the coal plants will have to forgo the operating cash flows from the sales of electricity generated from these assets and fill the **energy gap** with clean energy generation facilities. Consequently, there will be costs associated with the decommissioning of the coal plants, the installation, operating and maintenance of replacement energy facilities and the transformation of their manpower to operate these new facilities. There are financial benefits, too, from the carbon avoidance as a result of energy transition. Through carbon savings under Indonesia's intensity-based emissions trading scheme and trading of carbon credits in the secondary market, the **social value of emissions reduction** can be at least partially rewarded to these asset owners with the country's government committed to accelerating its decarbonisation.

The total funding available for the early retirement of the two coal plants, US$300 million for Cirebon-1 and US$851 million for Pelabuhan Ratu, are insufficient compared to the grand financing needs (US$653 million and US$740 million respectively). The key is to **make renewable energy more affordable**. The levelized cost of energy (LCOE) for solar production and storage is approximately US$158/MWh (TransitionZero, 2024), significantly higher than in most of the world's major economies. If the solar cost can be reduced to below $50/MWh, as is the case in the United States, France, China and India, the financing gap can be fully addressed and the blended finance committed in the JETP programme can be used for short-term refinancing needs without repayment concerns.

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# Appendix – Technical Inputs for the Financial Valuation of JETP Coal Plants

**Table 4:**
Cash Flow Analysis Assumptions for Cirebon-1 & Pelabuhan Ratu

| | PLTU Cirebon-1 | PLTU Pelabuhan Ratu | Description |
|---|---|---|---|
| ***Timing Assumptions*** | | | |
| Model Start Year | 2024 | 2024 | Beginning of the year. |
| Model End Year | 2042 | 2045 | End year determined by natural asset life. |
| Early Retirement Year | 2035 | 2037 | As announced in JETP. |
| ***Macroeconomic Variable Assumptions*** | | | |
| Indonesia Inflation Rate (%) | 2.51% | | 10-year forward inflation rate outlook. |
| Weighted Average Cost of Capital (%) | 9% | | Assumption made by MAS. |
| Effective Corporate Income Tax Rate (%) | 22% | | 2024 Indonesia corporate income tax rate. |
| ***Capacity Assumptions*** | | | |
| Coal Power Stations | 1 | 3 | |
| Total Installed Capacity (MW) | 660 | 1,050 | Max power generation possible. |
| Annual Energy Generation (MWh) | 4,329,056 | 5,893,654 | Average of past 3 years annual generation. |
| Capacity Factor – Coal (%) | 75.92% | 64.97% | Average ratio of (past 3 years) electricity generation to max possible based on full capacity. |
| Capacity Factor – Solar (%) | 16% | 16% | Assumption made by TransitionZero. |
| Capacity Factor – Onshore Wind (%) | 30% | 30% | Assumption made by TransitionZero. |
| Coal Plant Emission Intensity ($tCO_2$/MWh) | 0.86 | 0.94 | Average ratio of (past 3 years) carbon emissions to total power generation. |
| Indonesia ETS CFPP Cap ($tCO_2$/MWh) | 0.918 | 0.918 | |

| | | | |
|---|---|---|---|
| ***Financial Assumptions*** | | | |
| PPA Electricity Tariff (US$/MWh) | 63.55 | 62.92 | Average of past 3 years PPA electricity tariffs. |
| Carbon Offset Value (US$/t$CO_2$) | 10 | 10 | Assumption made by TransitionZero. |
| Average Fuel Cost (US$/MWh) | 33.9 | 34.07 | Coal price for the low-quality coal used in Indonesia's power production. |
| Financial Cost of Carbon (US$/t$CO_2$) | 2.02 | 2.02 | Carbon tax for emission intensities above the cap. |
| Variable Operating Cost (US$/MWh) | 0.12 | 0.13 | Average of past 3 years annual variable operating & maintenance (VOM) cost. |
| Fixed Operating Cost (US$/MWh) | 4.7 | 5.17 | Average of past 3 years annual fixed operating and maintenance (FOM) cost. |
| Annual Labour Cost (US$/capita) | 3,680 | 3,680 | From Indonesian labour market indicators 2022. |
| Decommissioning Cost (US$/MW) | 58,110 | 58,110 | One-time lump sum cost upon decommissioning. |
| ***Replacement Energy and Social Impact Assumptions*** | | | |
| LCOE – Solar Replacement & Storage (US$/MWh) | 158.24 | 158.24 | Estimated by TransitionZero. |
| LCOE – Onshore Wind Replacement & Storage (US$/MWh) | 189.93 | 189.93 | Estimated by TransitionZero. |
| Net-zero Social Cost of Carbon (US$/t$CO_2$) | 15.04 | 15.04 | Estimated based on other emerging economy net-zero emission 2050 scenario implied carbon cost from the IEA's *2021 World Energy Outlook*. |
| Social Cost of Total Air Pollution (US$/MWh) | 6.55 | 50.92 | Estimated using the AIRPOLIM-ES by the New Climate Institute. |
| Social Cost of Water Stress (US$/MWh) | 1.2 | 1.33 | Estimated based on the baseline water stress (BES) from WRI's Aqueduct database. |
| Job Intensity – Coal (#/MW) | 1.3 | 1.3 | Assumption made by TransitionZero. |
| Job Intensity – Solar (#/MW) | 1.95 | 1.95 | Assumption made by TransitionZero. |
| Job Intensity – Onshore Wind (#/MW) | 5.24 | 5.24 | Assumption made by TransitionZero. |
| Labour Re-training Cost (months) | 1.75 | 1.75 | US data based on Louie & Pearce (2016) |

**Table 5:**
Sensitivity Analysis Best-case Scenario and Worst-case Scenario for Selected Parameters

| Parameter | Best Case | Baseline | Worst Case | Description |
|---|---|---|---|---|
| Inflation Rate | 4.51% | 2.51% | 0.51% | Higher inflation rate indicates higher growth rate. As inflation rate here is assumed as the driver for increment in cashflows (numerator). Thus, it will increase the overall profit from the CFPP operation. |
| Discount Rate | 11% | 9% | 7% | By increasing the discount factor, the revenue and expenses occurring every year in the future will be given a lower value compared to costs and benefits that occur right away (as denominator). This will put a higher emphasis on e.g. the capital expenditure. Thus, it will decrease the profit from the CFPP operation from the baseline value. |
| Fuel Cost (US$/MWh) | 40.8 | 34 | 27.2 | Higher fuel cost leads to higher expense and thus lower profit from the CFPP operation. Lower fuel cost leads to lower expense and thus higher profit from the CFPP operation. |
| LCOE – Solar (US$/MWh) | 47.47 | 158.24 | 269.01 | Lower LCOE leads to higher net revenue from replacement renewable energy generation. Higher LCOE leads to higher expenses and thus lower net revenue from replacement renewable energy generation. |

Sustainable and Green Finance Institute (SGFIN)
National University of Singapore
Innovation 4.0, 3 Research Link
#02-02 Singapore 117602