# Financing a Paris-Aligned Coal Exit in South Korea

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Solutions for Our Climate (SFOC) is a nonprofit organization established in 2016 for more effective climate action and energy transition based in Seoul, South Korea. SFOC is led by legal, economic, financial, and environmental experts with experience in energy and climate policy and works closely with domestic and international players.

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# Executive Summary

South Korea must rapidly retire coal-fired power generation to address the climate crisis and Korea Electric Power Corporation (KEPCO)'s financial crisis. Nevertheless, the country has yet to bring forward its 2050 coal phaseout year to 2030, a global consensus to meet Paris Agreement; the government instead plans to add two new private coal-fired power plants. Financing the transition of coal power assets can facilitate their early retirement by addressing the remaining financial interests and thus minimizing power generation companies' opposition. To that end, transition finance is increasingly being implemented worldwide. This report aims to estimate the remaining value of shareholders' and investors' assets on the assumption that the entire coal fleet in South Korea is retired by 2030 and 2035, respectively. The findings indicate that South Korea can achieve a Paris-aligned 2030 phaseout with an investment of USD 5 billion[1] total (KRW 6.6 trillion) and a 2035 exit with USD 1.4 billion (KRW 1.8 trillion).

**[Financing Needed for an Early Coal Retirement]**

| Status | Power Plant unit | Coal Exit by 2035 | Coal Exit by 2030 |
|---|---|---|---|
| In Operation* | Yeongheung 5 & 6 | - | - |
| | Samcheok Green Power 1 & 2 | - | - |
| | Dangjin 9 & 10 | 5,532 | 10,472 |
| | Taean 9 & 10 | - | - |
| | Shin Boryeong 1 & 2 | - | 3,951 |
| | Yeosu 1 | - | - |
| | Shin Seocheon 1 | - | 3,397 |
| | Goseong Hai 1 & 2 | - | 10,956 |
| | Bukpyeong Thermal Power 1 & 2 | - | - |
| Under Construction | Gangneung Anin 1 & 2 | - | 12,375 |
| | Samcheok Thermal Power 1 & 2 | 12,797 | 24,794 |
| Total | | 18,329 | 65,945 |

Unit: KRW 100 Mn
*Units that become 20 years or older by 2030 are not considered.

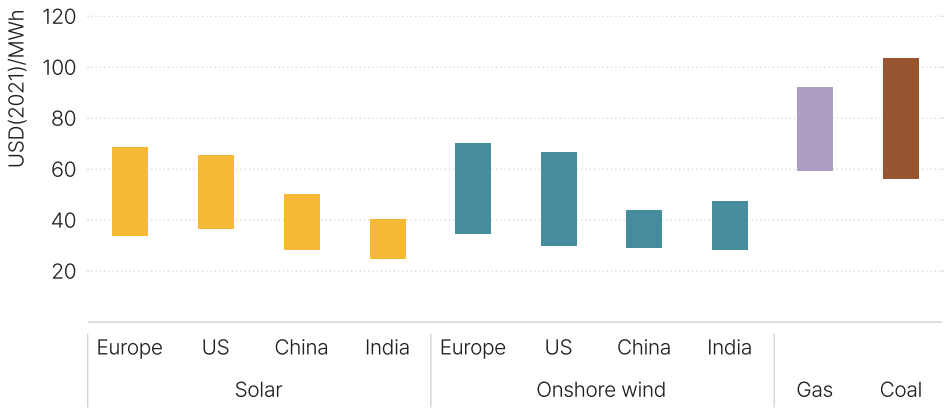
The Korean government can induce the transition of the coal power assets and business restructuring by providing financing to public financial institutions on the condition that they must be used only for the purposes of transition into renewable energy assets and for a just transition. Beyond the scope of this report, further research is needed to estimate the size of the financing required for just transition, the transition of power systems and grid, etc.

1 The USD/KRW exchange rate as of April 3, 2023, was 1,320.66 South Korean Won to 1 US Dollar. This exchange rate is applied hereinafter.

# 1. Introduction

The Russian invasion of Ukraine and the post-COVID-19 economic recovery have precipitated changes in the global energy supply chain that sent the coal and gas prices soaring. The price surges are significantly contributing to the deficit of Korea Electric Power Company (hereinafter "KEPCO"), which is heavily dependent on fossil fuels. In the first half of 2022 alone, the majority-state-owned utility posted an operating loss of USD 10.8 billion (KRW 14.3 trillion) (KEPCO, 2022b), and the deficit was projected to reach USD 22.8 billion (KRW 30 trillion) by the end of 2022 (Hana Securities Co., Ltd. (formerly Hana Financial Investment), 2022). In response, KEPCO announced a series of emergency austerity measures to address the financial crisis by selling or reorganizing non-essential stock holdings, real estate, and businesses, including the sale of all overseas coal-fired power plants that the utility operates or is constructing. The impact of these measures, however, is expected to add up only to USD 4.6 billion (KRW 6 trillion) at most (KEPCO, 2022a), significantly insufficient to cover the deficits that the company is estimated to incur in the tens of trillion of Korean won every year. According to Hana Securities Co., Ltd. (2022), the major driver to the crisis is the skyrocketing coal and gas prices[2] . The problem is that the energy crisis triggered by Russia's invasion of Ukraine is expected to last for an extended period (BloombergNEF, 2022). The war has prompted many European countries to cut down on their dependence on fossil fuels, especially those from Russia. On the other hand, over the same period, the levelized cost of energy (LCOE) of renewable energy has become cheaper than fossil fuel prices globally.

**[Graph 1] LCOE by Energy Source**






Source: International Energy Agency, 2022

However, in Korea, renewables are still considered more expensive than fossil fuels and nuclear. Such a distortion comes in part from the power market structure that links the prices of renewable energy to that of fossil fuel generation, putting higher price tags on renewables than their actual costs. Moreover, expensive permits and other administrative costs to build and operate renewable energy power plants further exacerbate the distortion.

The phase-out of fossil fuel reliance and transition to renewable energy is the most urgently needed step toward addressing the climate crisis. Advanced economies including South Korea must retire all coal-fired power generation by 2030 to reduce emissions in line with the effort to limit the long-term rise in average global temperature to 1.5°C, the objective of the Paris Agreement (International Energy Agency, 2021).

2. Analysis by Solutions for Our Climate (SFO°C) indicates that KEPCO settlement increased by USD 2.2 billion (KRW 2.9 trillion) for coal power generation and USD 4.5 billion (KRW 5.9 trillion) for gas power generation in the first quarter of 2022 than in the same period of 2021, while its settlement for renewable energy remaining nearly the same during the same period (Han & Choi, 2021).

Given that KEPCO's financial crisis and climate crisis are likely to continue, the Korean government must rapidly scale down coal power in its electricity mix by, for example, deploying public finance. Countries around the world, including the United States, Germany, and South Africa, have already put in place, or are expected to put in place, early coal phase-out policies utilizing public and/or private finance depending on their own political and socioeconomic environments. In this report, we (1) present existing mechanisms that deploy public finance or private finance for the early shutdown of coal-fired power plants and (2) estimate the size of financing needed to close all South Korean coal power plants by 2030 and 2035, respectively. Furthermore, we propose that the financing be utilized for transitioning the coal power assets into renewable energy assets.

We do not intend this report to be construed as providing any legal, political, or economic basis to support the coal asset holders' demands for compensation. Rather, Solutions for Our Climate regards that the utilities have made risky investments despite the rising economic and environmental risks from coal power generation and thus have significantly contributed to a serious drag on KEPCO's finances and the South Korean economy. Therefore, the legally acceptable level of financial assistance likely would be less than the amount estimated in this report. For the purposes of facilitating the coal phase out discussions, this report nonetheless presents an estimate that coal asset owners would commercially expect.

# 2. Existing Coal Transition Finance Mechanisms

Although the global consensus and trends of accelerated coal phaseout is growing stronger, there remain cases where enhanced environmental regulations and market mechanisms alone cannot induce early coal retirement due to barriers such as long-term financial contracts and power purchasing agreements (PPA). Therefore, in cases where it is difficult to expect utilities to voluntarily close their plants, institutional reform and/or financial mechanisms can help accelerate the transition (Calhoun et al., 2021).

**[Table 1] Types of Coal Transition Mechanism**

| Country | Transition Method | Type of Financing | Characteristics |
|---|---|---|---|
| Germany | Enacted the 2038 coal exit by law [3] and defined retirement capacities and schedule accordingly. Hold reverse auctions for power plant owners and provide just transition funds to assist in the restructuring of regional economies. | Compensation | The government sets ceilings on compensation per MW and **minimizes** the **costs** by inducing competition among the bidders. To encourage active participation, the provisions allow **compulsory closures** without compensation from the fifth round of tender in the case of under subscription (Scott et al., 2022). |
| United States | Issue bonds at low interest rates to enable the securitization of coal assets. Power plants can recover investment costs and use the recouped funds for new renewable energy projects and just transitions. | Refinance | Public utility commissions (PUCs) can participate in the management and supervision. Implemented in states such as New Mexico and Colorado. The Inflation Reduction Act of 2022 is expected to further facilitate this method |
| Republic of South Africa | Seek a reduction in national GHG emissions through early shutdown of coal plants and provide funds to bail out the state-owned utility, Eskom HID SOC Ltd (hereinafter "Eskom"). The transition of coal mining regions is also considered. | Concessional loans[4] , grants, etc. | The Just Energy Transition Partnership (JETP) was launched with financing from France, Germany, the UK, the US, and the EU (COP26, 2022). Additional projects modeled on this partnership are planned to be implemented in Indonesia, Vietnam[5] , India, Senegal, etc. (G7, 2022). |
| Asian Development Bank | Acquire coal power assets and/or provide loans with the aim of retiring the coal plants early and replacing them with renewable energy projects | Blended finance | **Public financial institutions** such as the Asian Development Bank (ADB) build the mechanism and mobilize **private-sector investments.** Pilot projects are underway in the Philippines, Indonesia, and Vietnam, with the goal of scaling up to more countries (ADB, 2021). |

Source: Reorganized based on RMI data (Calhoun et al., 2021)

Germany introduced a reverse auction system where utilities submit bids and receive compensation in the order from lowest to highest bids. The first round of auction was held in September 2020, and the successful bids ranged from about EUR 6,000 per MW to EUR 150,000 per MW. In this auction, RWE AG submitted bids totaling about EUR 216 million to close two coal plants with a combined capacity of 1,560 MW by the end of 2020 (one of the units started operation in 2014) and indicated that the amount represented "adequate compensation for the loss of the future value" of the power plants (RWE, 2020). The German auction has been criticized for providing overly large compensation for the closure of loss-making, economically non-viable power plants (Brown, 2020). This shows that

3 The Act to Reduce and End Coal-Fired Power Generation (Gesetz zur Reduzierung und zur Beendigung der Kohleverstromung) was enacted in August 2020.

4 Concessional loans are often provided to developing countries at a zero rate of interest or lower-than-market interest rates and with long repayment periods to lessen their debt burdens.

5 The projects in Indonesia and Vietnam are the size of USD 20 billion (The White House, 2022) and USD 15.5 billion (European Commission, 2022), respectively.

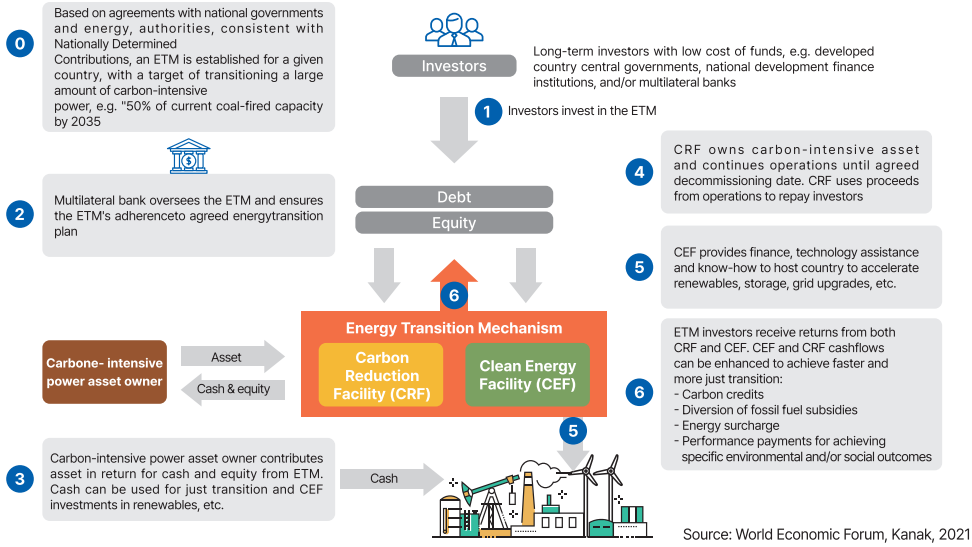
financing mechanisms should be designed with safeguards to prevent excessive compensation.

Several states in the U.S. employ securitization, a type of refinancing. Coal power assets are used to establish special purpose vehicles (SPV) and issue corporate bonds at interest rates that are lower than the original capital cost of the power generation companies. The securities are issued to secure funds needed to transition the coal assets into renewable assets. Although additional costs incurred in the process are charged to consumers, in the long run, increasing the proportion of renewable energy and accelerating the depreciation of coal plant assets can lead to a lower energy bill. For this to be possible, the price of renewable energy must be cheaper than coal. In the U.S., renewable energy prices are already lower than coal power, as the country has been rapidly expanding renewables for about 15 years through measures such as tax benefits. This case shows that rapid energy transition requires investment in renewable energy expansion as well as coal retirement (Calhoun et al., 2021).

The Republic of South Africa will be receiving financial support from G7 countries to expedite coal exit and bail out Eskom, which is on the verge of bankruptcy (Burkhardt & Cohen, 2019; Winning & Acharya, 2022)[6] . According to Winkler et al. (2021), the enormous costs of the construction of two coal power plants (Global Energy Monitor, n.d.) [7]was a major driver of the company's financial crisis. With an estimated cost of USD 98 billion projected over the next 20 years for South Africa to complete its energy transition, the Just Energy Transition Partnership (JETP) was announced at the 26th UN Climate Change Conference of the Parties (COP 26, 2022) to support the process. Concessional loans and grants totaling USD 8.5 billion for the period of 2023-2027 have been committed, and mechanisms to mobilize private financial investments are being designed.

The Asian Development Bank established the Energy Transition Mechanism (ETM), where ADB acquires ownership of coal power plants for the purposes of early retirement and recovers the acquisition costs by operating the plants for a period shorter than their original expected lifetimes. The ETM is a collaborative initiative by which public financial institutions take advantage of their lower costs of capital than that of the utilities to accelerate the full repayment of loans and mobilize private-sector investment. Profits from coal power generation are used to expand renewable assets, thereby expediting the recovery of investments further. This mechanism emphasizes the role of public financial institutions, which have the responsibility to serve public benefits and have better risk management capacity than the private sector does (Asian Development Bank, 2021).

## [Diagram 1] The Energy Transition Mechanism of Asian Development Bank




Source: World Economic Forum, Kanak, 2021

6 In the first half of 2022, Eskom's liabilities reached about USD 24 billion. Declaring the situation a "national crisis", the South African minister of finance announced that the government will actively seek solutions.

7 The Kusile power station and the Medupi power station each have a capacity of 4.8 GW.

# 3. Valuation Methodology for South Korean Coal Power Assets

In this chapter, we estimate how much the South Korean utilities would expect to receive in compensation for retiring their coal plants ahead of their original expected lifetime.

In South Korea, 58 coal-fired units are currently in operation and two new plants are under construction[8] . We evaluate the remaining financial value of the entire coal fleet in the country, excluding the aging plants that would reach 20 years of their lifetime or more by 2030. The units that went into operation in 2014 or earlier are likely to be fully depreciated by 2030[9] , and thus assumed to be closed without any financing. 20 units (18.7 GW) are considered in our analysis, including 16 units in operation and the two privately funded plants (4 units) under construction in Samcheok and Gangneung.

**[Table 2] List of Coal Power Units Included in the Analysis**

| Company Type | Power Company | Power Plant | Unit | Capacity (MW) | Start Year |
|---|---|---|---|---|---|
| KEPCO GENCO [10] | Korea South-East Power Co., Ltd. | Yeongheung Thermal Power | 5 | 870 | 2014 |
| KEPCO GENCO | Korea South-East Power Co., Ltd. | Yeongheung Thermal Power | 6 | 870 | 2014 |
| KEPCO GENCO | Korea East-West Power Co., Ltd. | Dangjin Thermal Power | 9 | 1020 | 2016 |
| KEPCO GENCO | Korea East-West Power Co., Ltd. | Dangjin Thermal Power | 10 | 1020 | 2016 |
| KEPCO GENCO | Korea Southern Power Co., Ltd. | Samcheok Green Power | 1 | 1000 | 2016 |
| KEPCO GENCO | Korea South-East Power Co., Ltd. | Yeosu Thermal Power | 1 | 340 | 2016 |
| KEPCO GENCO | Korea Western Power Co., Ltd. | Taean Thermal Power | 9 | 1050 | 2016 |
| Private | GS Donghae Electric Power Co., Ltd. | Bukpyeong Thermal Power | 1 | 595 | 2017 |
| Private | GS Donghae Electric Power Co., Ltd. | Bukpyeong Thermal Power | 2 | 595 | 2017 |
| KEPCO GENCO | Korea Southern Power Co., Ltd. | Samcheok Green Power | 2 | 1000 | 2017 |
| KEPCO GENCO | Korea Midland Power Co., Ltd. | Shin Boryeong Thermal Power | 1 | 1000 | 2017 |
| KEPCO GENCO | Korea Midland Power Co., Ltd. | Shin Boryeong Thermal Power | 2 | 1000 | 2017 |
| KEPCO GENCO | Korea Western Power Co., Ltd. | Taean Thermal Power | 10 | 1050 | 2017 |
| Private | Goseong Green Power Co., Ltd. | Goseong Hai Power | 1 | 1040 | 2021 |
| Private | Goseong Green Power Co., Ltd. | Goseong Hai Power | 2 | 1040 | 2021 |
| KEPCO GENCO | Korea Midland Power Co., Ltd. | Shin Seocheon | 1 | 1000 | 2021 |
| Private | Gangneung Eco Power Co., Ltd. | Gangneung Anin | 1 | 1040 | 2022 |
| Private | Gangneung Eco Power Co., Ltd. | Gangneung Anin | 2 | 1040 | 2023 (under construction) |
| Private | Samcheok Blue Power Co., Ltd. | Samcheok Thermal power | 1 | 1050 | 2023 (under construction) |
| Private | Samcheok Blue Power Co., Ltd. | Samcheok Thermal power | 2 | 1050 | 2024 (under construction) |

Our analysis defines the size of compensation for early retirement as the difference between the cash flow under the current policy and the cash flow in the case of early coal phaseout. The two key variables that affect a power plant's cash flow are (1) the capacity factor and (2) the unit cost of power generation. Emissions regulation determines capacity factors and the system marginal price (SMP) set by the Korea Power Exchange (KPX) determines the unit power generation cost. The following section discusses the scenario and assumptions on emissions regulation and SMP used for our analysis.

8 While the construction of Gangneung Anin unit 2 is still ongoing, unit 1 is currently connected to the grid. For the purposes of simplifying the analysis, however, both units are grouped into a single new coal project.

9 The projected financial statements in the Samcheok thermal power plant Information Memorandum expect the repayment of the corporate bonds to be completed in about 18 years.

10 GENCOs refer to the 5 power generation subsidiaries in the KEPCO group.

## 3-1) Capacity Factor Projection by Emissions Scenario

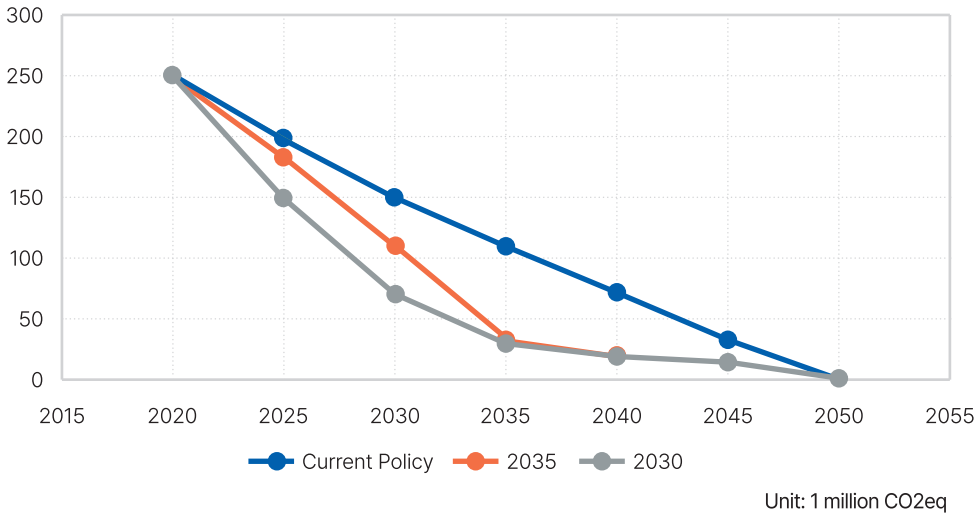
Power plant capacity factors vary depending on the regulation on greenhouse gas emissions from coal power generation (e.g., power sector emissions reduction targets). We develop three emissions regulation scenarios: the current policy scenario, the 2035 coal exit scenario, and the 2030 coal exit scenario.

**[Table 3] Emissions Regulation Scenarios**

| Scenario | Assumptions |
|---|---|
| Current Policy | This scenario assumes that GHG emissions decrease linearly as per the enhanced NDC and the 2050 carbon neutrality targets and estimates how much coal power generation would decline along the reduction pathway. This scenario is the closest to the currently adopted policies. |
| 2035 Coal Exit | This scenario assumes the level of emissions cap needed to phase out coal by 2035. |
| 2030 Coal Exit | This scenario assumes the level of emissions cap needed to phase out coal by 2030. |

The emissions reduction pathways of the respective scenarios are as follows:

**[Graph 2] Emissions Reduction Pathways by Scenario**




The emissions scenarios and their assumptions above are applied to the PLEXOS model[11] to derive the annual capacity factors of each generation unit between 2020 and 2050. In the case of the power plants currently under construction, the initial capacity factors between their start dates (2022 and 2023) and 2024 are set based on their respective Information Memorandums. The unit-by-unit capacity factor projections are as follows:

11 PLEXOS is an optimal energy mix model that can simulate the South Korean power market structure and operation rules as closely as possible. The model employed in the report is the preliminary version of the model developed by the Lawrence Berkeley National Laboratory and the NEXT Group (Park et al., 2023). The hourly dispatch results of each power plant unit between 2020 and 2050 can be obtained based on the emissions scenarios above, and those results can be converted into the individual unit's annual capacity factor.

**[Table 4] Unit-Level Capacity Factor Projection**

| Unit | Scenario | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 | 2038 | 2039 | 2040 | 2041 | 2042 | 2043 | 2044 | 2045 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Yeongheung unit 5 | Current Policy | 75 | 75 | 75 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 2035 | 75 | 75 | 75 | 75 | 75 | 75 | 67.13 | 75 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | |
| | 2030 | 75 | 75 | 75 | 75 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | |
| Yeongheung unit 6 | Current Policy | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 70.38 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 2035 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | |
| | 2030 | 75 | 75 | 75 | 75 | 75 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | |
| Dangjin unit 9 | Current Policy | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 73.03 | 51.21 | 51.31 | 31.81 |
| | 2035 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | |
| | 2030 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | |
| Dangjin unit 10 | Current Policy | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 73.89 | 75 | 75 | 75 | 75 | 57.53 | 51.21 | 34.39 | 23.76 |
| | 2035 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | |
| | 2030 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | |
| Samcheok Green unit 1 | Current Policy | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 2035 | 75 | 75 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | |
| | 2030 | 75 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | |
| Yeosu unit 1 | Current Policy | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 2035 | 75 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | |
| | 2030 | 75 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | |
| Taean unit 9 | Current Policy | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 2035 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | |
| | 2030 | 75 | 75 | 75 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | |
| Bukpyeong unit 1 | Current Policy | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 68.11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 2035 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | |
| | 2030 | 75 | 75 | 75 | 75 | 56.05 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | |
| Bukpyeong unit 2 | Current Policy | 75 | 75 | 75 | 75 | 75 | 75 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 2035 | 75 | 75 | 75 | 75 | 75 | 75 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | |
| | 2030 | 75 | 75 | 75 | 75 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | |
| Samcheok Green unit 2 | Current Policy | 75 | 75 | 75 | 75 | 75 | 75 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 2035 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | |
| | 2030 | 75 | 75 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | |
| Shin Boryeong unit 1 | Current Policy | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 53.63 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 2035 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | |
| | 2030 | 75 | 75 | 75 | 75 | 75 | 75 | 74.2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | |
| Shin Boryeong unit 2 | Current Policy | 75 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 2035 | 75 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | |
| | 2030 | 75 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | |
| Taean unit 10 | Current Policy | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 2035 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | |
| | 2030 | 75 | 75 | 75 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | |
| Goseong Hai unit 1 | Current Policy | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 59.54 | 66.16 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 2035 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | |
| | 2030 | 75 | 75 | 75 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | |
| Shin Seocheon unit 1 | Current Policy | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 2035 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 73.99 | 66.29 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | |
| | 2030 | 75 | 75 | 75 | 75 | 75 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | |
| Goseong Hai unit 2 | Current Policy | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 2035 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | |
| | 2030 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | |
| Gangneung Anin unit 1 | Current Policy | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 64.56 | 75 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 2035 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | |
| | 2030 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | |
| Gangneung Anin unit 2 | Current Policy | 0 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 2035 | 0 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | |
| | 2030 | 0 | 75 | 75 | 75 | 75 | 75 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | |
| Samcheok Thermal Power unit 1 | Current Policy | 0 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 72.69 | 73.03 | 75 | 75 | 75 | 75 | 53.63 | 34.23 | 34.39 | 9.28 |
| | 2035 | 0 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | |
| | 2030 | 0 | 75 | 75 | 75 | 75 | 75 | 75 | 65.1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | |
| Samcheok Thermal Power unit 2 | Current Policy | 0 | 0 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 73.03 | 75 | 75 | 75 | 75 | 53.63 | 39.59 | 23.24 | 9.28 |
| | 2035 | 0 | 0 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | |
| | 2030 | 0 | 0 | 75 | 75 | 75 | 75 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | |

The projections above suggest that even under the Current Policy Scenario, Gangneung Anin would not be able to stay online beyond 2035. In fact, due to the grid saturation and sensitivity issues in the region, it is expected that the power plant would be unable to operate normally upon the completion of its construction unless new transmission lines are built (Yun, 2022).

## 3-2) System Marginal Price

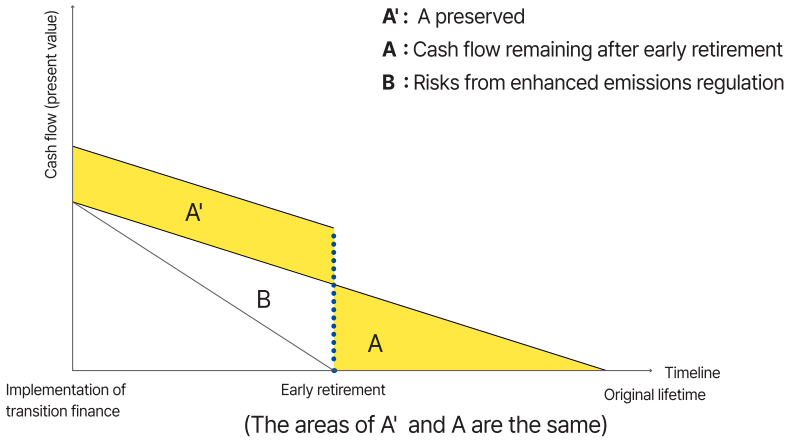
We assume a fixed system marginal price (SMP) of USD 0.076 (KRW 100). This is in consideration of the past five-year average of USD 0.062 (KRW 81.97) and the past ten-year average of USD 0.083 (KRW 109.7). Even though the SMP has recently increased due to the fluctuations in the global energy market and fuel prices, a higher payment for coal power likely would face political backlash as coal's economic viability decline and the case for an accelerated phase-out become clearer. Moreover, since the investors have made investment decisions based on the level of energy prices prior to the Russian invasion of Ukraine, our analysis does not consider the rise in the SMP in the aftermath of the invasion.

## 3-3) Scope of Transition Finance

The size of compensation that coal power plants may receive for their early shutdown (i.e., the transition costs for their coal assets) is estimated based on the capacity factor projections and SMP assumption above. The investment, financial, and operational costs were set in reference to the materials that power producers and financial institutions submitted to the National Assembly of South Korea (e.g., the Samcheok thermal power generation project Information Memorandum drawn up by Korea Development Bank and data disclosed by the Financial Supervisory Service on the business corporations concerned). More details on the methodology can be found in the Appendix and Annex.

The cost of early coal retirement is equivalent to the cash flow that the power plant had expected under the Current Policy Scenario but can no longer receive due to early retirement (A). Financing provided to the asset holders thus cannot exceed the amount of cash flow under the Current Policy Scenario (the scenario that assumes the SMP at KRW 100) under the current emissions regulation). This is illustrated in Graph 3.

**[Graph 3] Scope of Financing**




(The areas of A' and A are the same)

Any declines in cash flow that incur while the plant is still in operation do not qualify for transition finance. Potential financial losses due to a sharper drop in capacity factor caused by enhanced environmental/emissions regulations[12] are a normal risk that entails fossil fuel power generation projects (B). Therefore, losses that take place prior to the early shutdown year must be borne by the asset holders themselves. The decline of Gangneung Anin and

12 The estimates are available in the Annex.

Samcheok's capacity factors should have been particularly foreseeable since the procedures for their environmental impact assessments, licensing and permitting, and financial support started despite the announcement of the Paris Agreement. This means that both the power companies and the government aggressively went ahead with the new coal projects, dismissing the ratchet mechanism within the Paris Agreement that requires Nationally Determined Contributions to continue to progress and prohibits backsliding (Ministry of Foreign Affairs, 2017; UNFCCC, n.d.). Thus, it is deemed that the utilities actively made the decision to take the risks from increasingly rigorous emissions targets.

**[Table 5] Timeline of the New Coal Plants' Planning and Licensing**

| | Basic Plan of Long-Term Electricity Supply and Demand (BPLE) | Issuance of Business License | Registered for Environmental Impact Assessment (EIA) | Completion of EIA | Approval of Implementation Plan | Approval of Construction Plan |
|---|---|---|---|---|---|---|
| Gangneung Anin | The 6th | April, 2013 | Aug. 2018 | Nov. 2019 | Oct. 2015 | Feb. 2016 |
| Samcheok | | July 2013 | Aug. 2015 | Dec. 2017 | Jan. 2018 | Jan. 2018 |

(Korea Power Exchange, 2022, Environmental Impact Assessment Reports)

# 4. Results: Financing Needed for An Accelerated Coal Transition

Table 6 shows the costs of transition estimated [13] based on the yearly cash flow forecasts where coal power plants retire either in 2035 or in 2030. More detailed results for each power plant can be found in the Annex.

### [Table 6] Financing Needed for Early Retirement

| Status | Power Plant Unit | Coal Exit by 2035 | Coal Exit by 2030 |
|---|---|---|---|
| In Operation | Yeongheung 5 & 6 | - | - |
| | Samcheok Green Power 1 & 2 | - | - |
| | Dangjin 9 & 10 | 5,532 | 10,472 |
| | Taean 9 & 10 | - | - |
| | Shin Boryeong 1 & 2 | - | 3,951 |
| | Yeosu 1 | - | - |
| | Shin Seocheon 1 | - | 3,397 |
| | Goseong Hai 1 & 2 | - | 10,956 |
| | Bukpyeong Thermal Power 1 & 2 | - | - |
| Under Construction | Gangneung Anin 1 & 2 | - | 12,375 |
| | Samcheok Thermal Power 1 & 2 | 12,797 | 24,794 |
| Total | | 18,329 | 65,945 |

Unit: KRW 100 Mn

We found that most South Korean coal power units do not require any financing under the 2035 Coal Exit scenario. Among the units that are in operation, only Dangjin 9 and 10 are estimated to have a remaining cashflow of USD 420 million (KRW 553 billion) due to their extended role in the grid[14] , and the costs of retiring the new power plants in Gangneung Anin and Samcheok are estimated at zero (0) and USD 970 million (KRW 1.3 trillion), respectively. In total, coal exit by 2035 would cost about USD 1.4 billion (KRW 1.8 trillion). Under the 2030 Coal Exit scenario, the total costs are estimated to be USD 5 billion (KRW 6.6 trillion). Of this total, new power plants currently under construction account for about USD 2.8 billion (KRW 3.7 trillion).

Financing can be provided either in a lump sum or in annual installments over a fixed period. It should be noted, however, that the longer the period of financial support, the greater the inequity issue of passing the burden on to the next generation. A more rapid transition would also help minimize uncertainty for power companies and ensure greater impact and efficiency (Popp & de Pous, 2021).

13 The capacity factor forecasts may vary depending on the regulation on GHG emissions from coal power generation (e.g., the power sector emissions reduction targets), and the SMP may change contingent upon the fluctuations in energy prices, etc. In other words, the assumptions and scenarios affect the transition cost estimation.

14 See Table 4. Unit-Level Capacity Factor Projections.

# 5. Implication and Policy Proposal

- Financing mechanisms can be an effective tool to accelerate the transition of fossil fuel assets and achieve climate goals. Our analysis estimates that all coal power assets, including the new plants under construction, can be retired by 2035 with an investment of about USD 1.4 billion (KRW 1.8 trillion). This is much lower than the added settlement cost of coal power generation, which was an increase of USD 2.2 billion (KRW 2.9 trillion) in the first quarter of 2022. In other words, transition finance for an early coal exit is a reasonable investment that can help resolve a major cause behind KEPCO's USD 22.8 billion (KRW 30 trillion) deficit in 2022 alone.

- A complete coal phase-out by 2030 in line with the Paris Agreement is achievable with an estimated investment of USD 5 billion (KRW 6.6 trillion).

- To ensure that an early coal retirement mechanism does in fact contribute to GHG emissions reductions, all financing must be provided with a condition that prohibits the proceeds from being invested in other fossil fuels assets (such as ammonia co-firing and gas) and limits the usage to renewables (solar, wind, storage, etc.) only. In addition, we advise against recognizing the emissions reductions from early coal retirement as carbon offset credits. For instance, Germany explicitly prohibits emissions reductions from coal phaseout from being included in the EU Emissions Trading System (Herz et al., 2021).

- Public financial institutions[15] can be a viable candidate for serving the role of managing transition finance. The Korean government can consider commissioning development financial institutions that are experienced in industrial restructurings, such as the Korea Development Bank, with the management of such financing and the design of mechanisms to cut down on costs.

- The scope of this analysis is limited to estimating the costs that early retirement would incur to the power plant shareholders and investors. Further research is needed to examine the size of financing and types of policies needed to support the transition of coal-dependent workers and communities. Most existing mechanisms provide systemic support to assist the transition process along with financing. In Germany, the federal government and the EU committed EUR 40 billion (approx. USD 43 billion[16] ) between 2020 and 2038 for just transition, and the regional governments manage the funds to best serve their local contexts. In particular, Nordrhein-Westfalen (NRW), an industrial region where the coal industry carries heavy weight, will receive about EUR 15 billion (USD 16 billion) (Lee, 2021). In Korea, Chungcheongnam-do (Chungnam) Province established its own just transition fund of USD 7.6 million (KRW 0 billion) (Chungcheongnam-do Province, 2021), but the scale of financing needed to transition the region's coal power-based economy is a much larger problem than a subnational government alone can handle. The national government must step up to the plate to implement actions to facilitate the transition of coal-dependent regions.

- Even though transition finance is a useful policy tool to accelerate early coal retirement, it cannot replace other climate actions. The introduction of financing mechanisms should be complemented with the identification of locked-in assets that genuinely require financial assistance and prompt policy improvements to support renewables expansion. Also required are institutional reform to improve the power market's flexibility and fairness and regulatory reform to facilitate renewable energy siting and licensing/permitting. Most importantly, South Korea must enhance the national emissions reduction targets and move up the current coal exit year to 2030 in alignment with the Paris Agreement.

15 For example, Korea Asset Management Corporation (KAMCO) and other institutions are already performing similar tasks such as the acquisition of non-performing loans (NPL), liquidation and business restructuring, provision of support for the financially vulnerable, and management and sale of state-owned property and properties confiscated from tax arrears (KAMCO, n.d.).

16 The EUR/USD exchange rate as of April 3, 2023, was 1.08 Euro to 1 US Dollar.

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# Appendix
## (Valuation Methodology and Assumptions)

## 1. Net Present Value Assessment Model

### 1) Valuation Methodologies

The amounts of financing provided to the shareholders and creditors of the private coal plants are calculated based on the net present value of the future cash flow that they are expected to receive, respectively. This study employs the discounted cash flow method (DCF; hereinafter the "DCF method") to determine the net present value (NPV), which discounts estimated future cash flows to their value as of a reference date for valuation.

### 2) NPV Assessment for Shareholders and Creditors

As shown in the table below, there are two ways to assess shareholders' net present value: *The free cash flow to equity* (hereinafter the "FCFE") method, where FCFE is calculated by subtracting the principal and interest repayments from the *free cash flow to the firm* (FCFF), and the *dividend discount model* (hereinafter the "DDM"), which forecasts future dividend cash flows for the shareholders. The FCFE method assumes that the FCFF minus the principal and interest repayments of the year entirely goes to the shareholders, whereas the DDM additionally considers dividend limitations and other factors to estimate the actual expected dividend cash flow for the shareholders. Both FCFE and DDM methods use the cost of equity as the discount rate. Theoretically, the total dividend cash flow is identical between the two methods. Under the DDM, however, the expected dividend cash flow is carried over to be paid out later than under the FCFE method, and thus the cash flow and the NPV after consideration of the discount rate are lower under the DDM than under the FCFE. This report employs the DDM.

For the creditors' NPV assessment, this study uses the cost of debt (i.e., the interest rate), which equals the principal and interest repayments that the creditors receive, as the discount rate and also considers the possibility of default triggered by a cash shortage.

**Appendix Table 1. Methods of Shareholder NPV Assessment: FCFE vs. DDM**

| Methods | Formula | Details |
|---|---|---|
| FCFE<br>(Free Cash-Flow to Equity) | FCFE = FCFF (cash inflow – cash outflow, excluding principal and interest) – principal and interest | - The principal and interest are paid out of the FCFF, and then the remainder (cash flow available for dividends) goes to the shareholders.<br>- The cost of equity is used to discount shareholder's cash flow. |
| DDM<br>(Dividend Discount Model) | Expected dividends to shareholders (limitations on dividends are considered) | - The analysis focuses on the expected dividends to be received.<br>- The cost of equity is used to discount shareholders' cash flow. |

## 2. Investment Costs

The total investment cost of a coal power project comprises the construction costs (including the direct construction costs, indirect construction costs, and land acquisition costs) and financing costs (including the interest on the loans for construction and fees/commissions). Investment costs are estimated in reference to the Information Memorandum of each project, the data disclosed by the Financial Supervisory Service on the project, and so forth (see the Annex for more details).

## 3. Power Plant Operating Costs

The power plant operating costs comprise fuel costs and operation and maintenance (O&M) costs. The latter includes salaries, repair/maintenance, expenses to procure limestone, water, and chemicals, taxes and fees, and insurance premiums. Fuel costs are contingent upon a power plant's capacity factor. O&M costs are estimated in reference to the materials disclosed for the individual projects, including the Samcheok thermal power plant Information Memorandum (see the Annex for the details of the input data). The capacity price is assumed to stay fixed.

**Please refer to the Annex for more details on the methodologies and the model.**

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