Quantifying Climate Risk Premium in Coal power plant: A case study of Samchoek Power Plant

PLANiT

Summary

- In February 2026, Samcheok Blue Power's 14th unsecured bond offering, initially sized at 100 billion won, was oversubscribed and upsized to 150 billion won, pricing 41 basis points inside the market curve. This happened even as rating reports explicitly flagged the company's exposure to South Korea's decarbonization policy and chronic transmission constraints along the east coast. The company carries a leverage ratio of roughly 518% and holds an A+ credit rating.

- Credit rating agencies have acknowledged climate-related risks as downside monitoring factors, yet have stopped short of quantifying their financial impact, citing insufficient specificity. Bond investors are thus left reading climate risk language without any basis for judging how much of that risk belongs in the spread. That information gap is distorting capital allocation, and it is the central problem this report sets out to address.

- The dominant risk facing Samcheok Blue Power is transition risk. Detailed legislation and a binding implementation roadmap have yet to materialize, but South Korea's intent to phase out coal by 2040 is not in doubt. The government has signaled its commitment on the international stage through membership in the Powering Past Coal Alliance, and the 11th Basic Plan for Electricity charts a steady decline in coal's share of the generation mix. For a plant that only came online in 2025, a 2040 coal exit would force closure well short of its designed economic life, a severe blow to the project's economics.

- Physical climate risks present a more mixed picture. Samcheok Blue Power's use of seawater cooling and its elevated site elevation structurally limit its exposure to water-stress and flood risks. That said, the absence of thermal discharge regulations in South Korea is a material factor keeping current water-temperature risk artificially low, a vulnerability that could crystallize if regulations tighten. Wildfire poses a more immediate concern, not through direct damage to the plant but through potential disruption to the transmission lines that connect it to the grid. Current data limitations prevent precise quantification, but the weight of research suggests that refined estimates will likely show higher risk, not lower.

- PLANiT Institute has built a Climate Risk Premium (CRP) model to quantify these risks and map their impact on Samcheok Blue Power's credit rating and cost of capital. Even under the base-case scenario, which excludes incremental climate stress, transmission

constraints alone are projected to keep the company's financial ratios in BBB territory from 2026 through 2033, with a recovery to A-level metrics not expected until 2034. Under scenarios that incorporate climate risk, including Combined Moderate, Combined Aggressive, and Enhanced Combined, ratings deteriorate to the BBB-to-BB range. The most severe scenario, which fully reflects coal's shrinking share under the 11th Basic Plan, projects the company sliding into D-rated, stranded-asset territory by 2039.

- Rating deterioration compounds itself. As the credit profile weakens, refinancing costs rise, and with a leverage ratio already above 500%, Samcheok Blue Power has limited capacity to absorb higher interest burdens. A further concern is the company's growing dependence on retail investors for bond placement; any rating downgrade would likely trigger a sharper liquidity shock than a more institutionally held credit would face. The model captures this dynamic through a Credit Rating Death Spiral mechanism, in which rising funding costs feed back into further deterioration of financial ratios and ratings.

- The implications for each stakeholder group are clear. Investors and lenders should stop treating an A+ rating as a clean bill of health and instead reprice the asset to reflect its true climate-adjusted cost of capital. Policymakers should recognize that ambiguity in the coal phase-out timeline itself generates a risk premium, and that publishing a concrete schedule covering plant-level utilization forecasts, forced closures, and compensation would actually reduce market uncertainty. And power generators need to confront a straightforward reality: the sooner they acknowledge the deterioration in climate-exposed asset values and begin redirecting capital, the smaller their eventual losses will be.

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1. Background and Research Purpose

1.1 Climate Risk and Investment Decision-Making

Why It Matters Now

Climate change is no longer a distant threat. It is a present financial reality. As decarbonization policies, carbon regulations, and physical hazards accelerate, investment decisions that fail to reflect these forces rest on structurally mispriced risk. In long-duration infrastructure and energy investments, ignoring climate risk creates a significant gap between an asset's actual cash-generating capacity and its assessed creditworthiness. That gap is where hidden losses originate. This report uses Samcheok Blue Power as a case study to trace, quantitatively, the specific channels through which climate risk transmits into credit ratings and the cost of capital.

1.2 Why Samcheok Blue Power

A Bond That Sold Out While Climate Risk Went Unpriced

In February 2026, Samcheok Blue Power completed the sale of its 14th unsecured bond issue, initially sized at ₩100 billion. Oversubscription during bookbuilding pushed the final amount to ₩150 billion, priced 41 basis points inside the issuer's individual fair-value yield. By conventional measures, it was a successful placement.

The picture, however, was more complicated. The bond prospectus disclosed coal phase-out policy as a key investment risk, but stopped short of quantifying the size of that risk, citing uncertainty. Credit rating reports published around the same time noted that an unfavorable shift in national energy policy could negatively affect the company's performance and business stability amid a persistently difficult operating environment for coal power, but listed this only as a factor to monitor for a potential rating change, without assigning a financial magnitude to it.

It was against this backdrop that civic groups, including Korea's Climate Solutions, filed a complaint with the Financial Supervisory Service in January 2026, questioning whether the bond's credit rating was appropriate. Samcheok Blue Power has become the most prominent Korean example of bonds issued while material climate risks remain unpriced. That is why this report selected it as its central case study.

1.3 Company Profile and Financing History

Samcheok Blue Power is a 2,100MW coal-fired power plant (two units of 1,050MW each) located in Jeokno-dong, Samcheok, Gangwon Province, and is for all practical purposes the last coal plant to be built and operated in South Korea. Development planning began in 2013 and construction started in 2018, at a time when coal phase-out had not yet emerged as a serious policy consideration. By the time the units came online sequentially in 2024 and 2025, the policy landscape had shifted entirely, and a 2040 coal exit had become the established direction of government energy policy.

The company's financial structure amplifies its exposure. Of the roughly ₩4.9 trillion in total investment, 80% was debt-financed, resulting in a debt-to-equity ratio of approximately 518%. Shareholders include POSCO International (34%), Doosan Enerbility (9%), and financial investors (57%). From 2021 onward, institutional investors began tightening ESG guidelines and withdrawing from new coal commitments, tightening the company's access to capital. As a result, its credit rating was downgraded from AA- to A+ in 2022, and bond offerings began failing to attract sufficient institutional demand. To bridge the funding gap, the company even issued 150 billion won in commercial paper. Beginning in 2023, Samcheok Blue Power shifted to retail investors as its primary source of bond financing, and borrowing costs gradually declined as a result.

Financial Summary

Financial Item	FY2025, Bn KRW
Revenue	638.6
Operating Income	224.8
Net Income	23.1
Total Assets	5,209.2
Total Liabilities	4,366.6
Total Equity	842.6
Annual Generation	3,638,267 MWh (utilization 19.8%)
Credit Rating	A+ (downgraded from AA- in 2022)

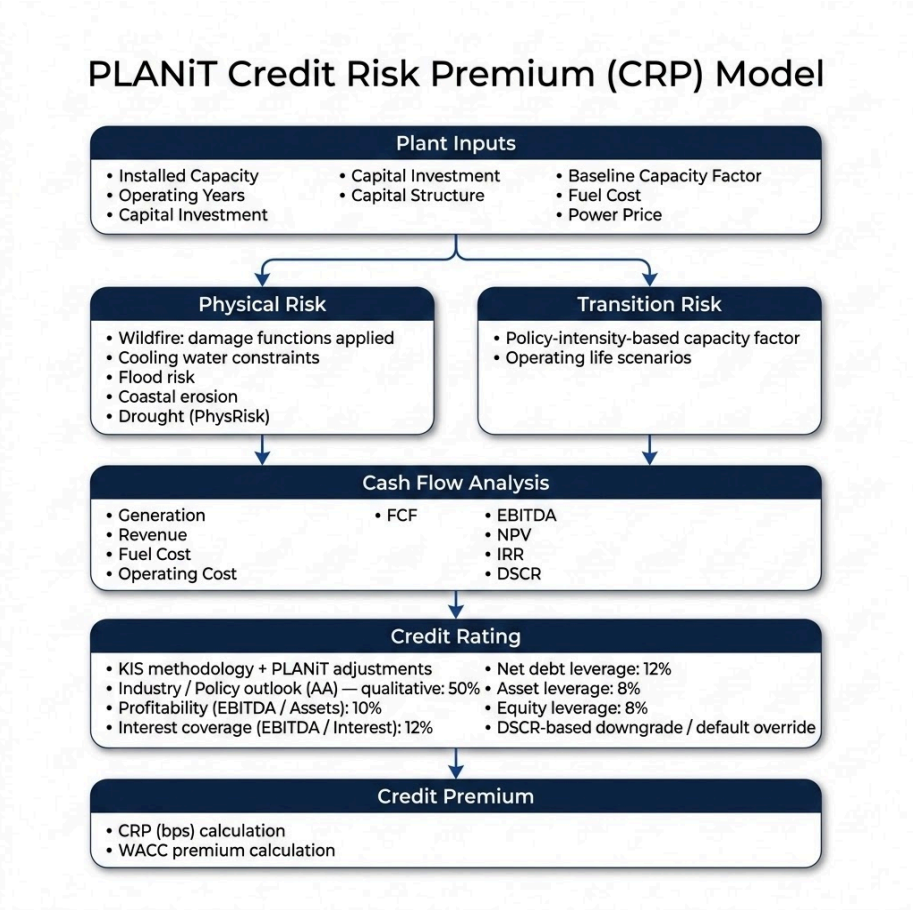
Source: Samcheok Blue Power Annual Report (FY2025), Korea Power Exchange Monthly Statistics (No. 555–567)

1.4 Analytical Framework

The Climate Risk Premium (CRP) Model

PLANiT developed the Climate Risk Premium (CRP) model to quantify the financial impact of climate risk on Samcheok Blue Power's credit profile. The model treats transition risk and physical risk as distinct inputs, each translated into cash flow impacts through its own mechanism. On the transition risk side, the model estimates how policy-driven changes affect the plant's capacity utilization over time. On the physical risk side, climate hazards including rising air temperatures, increasing water temperatures, and wildfire are assessed in terms of their probability of causing operational disruption, which is then converted into expected generation losses.

These two inputs feed into a common cash flow framework, which in turn drives the credit rating assessment. The final output is the CRP itself: the additional cost of capital relative to a counterfactual asset of equivalent profile carrying no climate risk, benchmarked at an A rating. The analysis that follows applies this framework to assess the climate risks facing Samcheok Blue Power.



2. Transition Risk

2.1 Policy Pathways

The Coal Phase-Out Agenda and Early Closure Risk

South Korea has made its intentions on coal clear at the international level. At COP26 in 2021, it joined the commitment to phase out coal power by 2040, and in 2025 it became a member of the Powering Past Coal Alliance (PPCA). Its nationally determined contribution (NDC) is also premised on a steady reduction in coal's share of the generation mix.

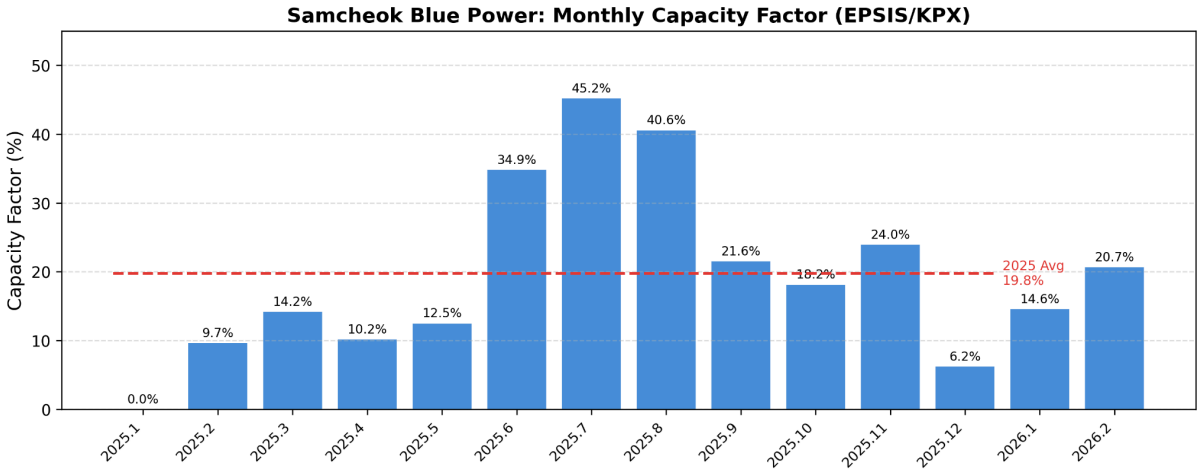
Domestically, the picture is less defined. Binding legislation and a concrete implementation roadmap have yet to materialize. That said, the 11th Basic Plan for Electricity projects coal's share of installed capacity declining from 32.7% in 2023 to 17.2% in 2030 and 10.1% by 2038, and the government has indicated that work is underway on a coal phase-out transition roadmap, including feasibility reviews for retiring and repurposing aging coal assets. Against this backdrop, the 12th Basic Plan, currently in preparation, will be closely watched for whether it sets a more specific trajectory and timeline for coal capacity reduction.

Samcheok Blue Power sits in a structurally disadvantaged position within this context of what might be called "certain uncertainty." Coal-fired plants are typically designed for a 30-year operating life. Samcheok Blue Power began commercial operations in 2025 and has a planned operating period running through 2053, three years beyond South Korea's 2050 carbon neutrality target. If a 2040 coal exit is enforced, the plant would be forced to shut down halfway through its designed economic life, making full recovery of project economics impossible. The situation is made more precarious by the fact that transmission constraints are already preventing the plant from generating the revenues it was underwritten to produce. A shorter cash flow runway on top of an already underperforming asset is a compounding problem.

2.2 Grid Constraints

Capacity Pressure Already in Motion

Even before the coal phase-out policy takes hold, Samcheok Blue Power's earnings capacity is structurally constrained. The east coast corridor between Gangneung and Uljin hosts eight nuclear units (8.7GW), eight coal-fired units (7.4GW), and pumped hydro and renewables (1.8GW), bringing total installed generation capacity in the region to approximately 17.9GW. Transmission capacity to the greater Seoul area stands at only 11.6GW, leaving a significant and chronic shortfall. With grid priority allocated to nuclear and renewable sources, capacity utilization at the east coast thermal plants, including Samcheok Blue Power, GS Donghae Power, Gangneung Eco Power, and Samcheok Green Power, has fallen across the board. Samcheok Blue Power's utilization rate in 2025 came in at just 19.8% on an annual basis.



A central cause of the bottleneck is the delayed construction of the Donghae-Singapyang high-voltage direct current (HVDC) transmission line. Originally scheduled for completion in 2019, the project was pushed back repeatedly due to opposition from local residents over routing and sitting decisions. Completion is now targeted in two stages: Phase 1 (4GW) by October 2026 and Phase 2 (4GW) by 2027. Once fully operational, the line is expected to substantially ease the transmission bottleneck along the east coast. For Samcheok Blue Power, the extent to which utilization recovers following completion will have a material bearing on whether the project can approach anything close to its original economic assumptions.

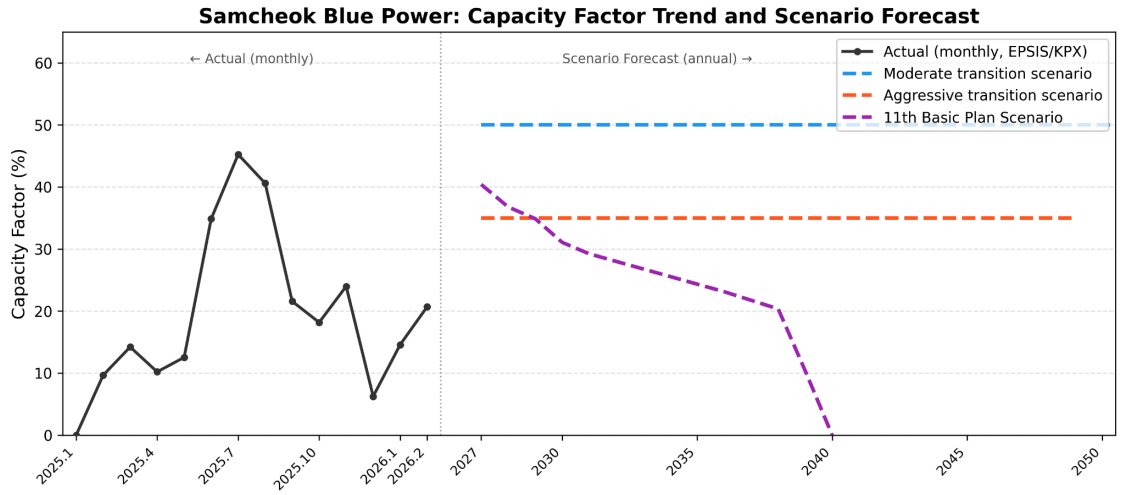
Coal-fired generation sits near the bottom of the merit order, below everything except LNG. Estimating how much utilization might recover following HVDC completion therefore requires a view on several moving parts: the pace of renewable energy development in the region, projected output from those sources, and the government's coal transition plans. If offshore wind and other renewable projects along the east coast proceed as currently envisaged, sustained low utilization at coal plants becomes increasingly difficult to avoid. The CRP model assumes a utilization rate of 50% in the absence of active coal phase-out policy pressure. According to media reports, a confidential study commissioned by the Korea Power Exchange and prepared by an accounting firm projected that, assuming transmission line construction is completed in the second half of 2026, the three private coal power generators in the region would achieve a combined utilization rate of around 40% in 2027.

At utilization rates this low, the total cost recovery mechanism that underpins Samcheok Blue Power's earnings structure begins to break down. That mechanism, under which generators recover their full costs through a settlement adjustment coefficient applied to actual power sales, is the single most important reason credit rating agencies have maintained a constructive view on the sector. The problem is that cost recovery only occurs when power is actually generated and sold. Transmission constraints prevent full recovery, leaving unpaid balances that accumulate until the bottleneck is resolved. The resulting liquidity exposure is real, and the bond prospectus itself flags it as a risk factor.

2.3 Transition scenario analysis

Financial Outcomes Under the CRP Model

The PLANiT CRP model constructs three scenarios based on different combinations of policy trajectory and grid conditions. Figure 2 presents actual utilization data alongside the projected path under each scenario. The Moderate scenario assumes that HVDC completion eases transmission constraints and that coal phase-out policy is delayed or softened. Even under this relatively favorable set of assumptions, utilization is projected to plateau at around 50% after 2027. The Aggressive scenario incorporates simultaneous pressure on utilization and early closure risk under an active coal transition policy, with utilization settling at approximately 35% from 2027 onward. The 11th Basic Plan scenario directly maps the coal capacity reduction path set out in the current basic plan, with utilization declining in stages and converging to zero at the 2040 phase-out date.



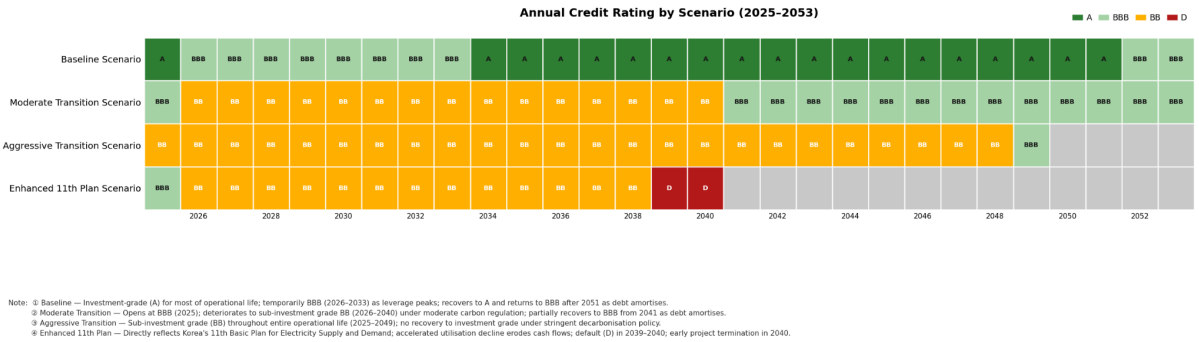
This utilization gap translates directly into financial deterioration. Lower generation output means lower revenue, which flows through to operating income. As operating margins compress, financial ratios weaken, credit ratings decline, and credit spreads widen.

Credit Rating Outcomes Under Transition Scenarios

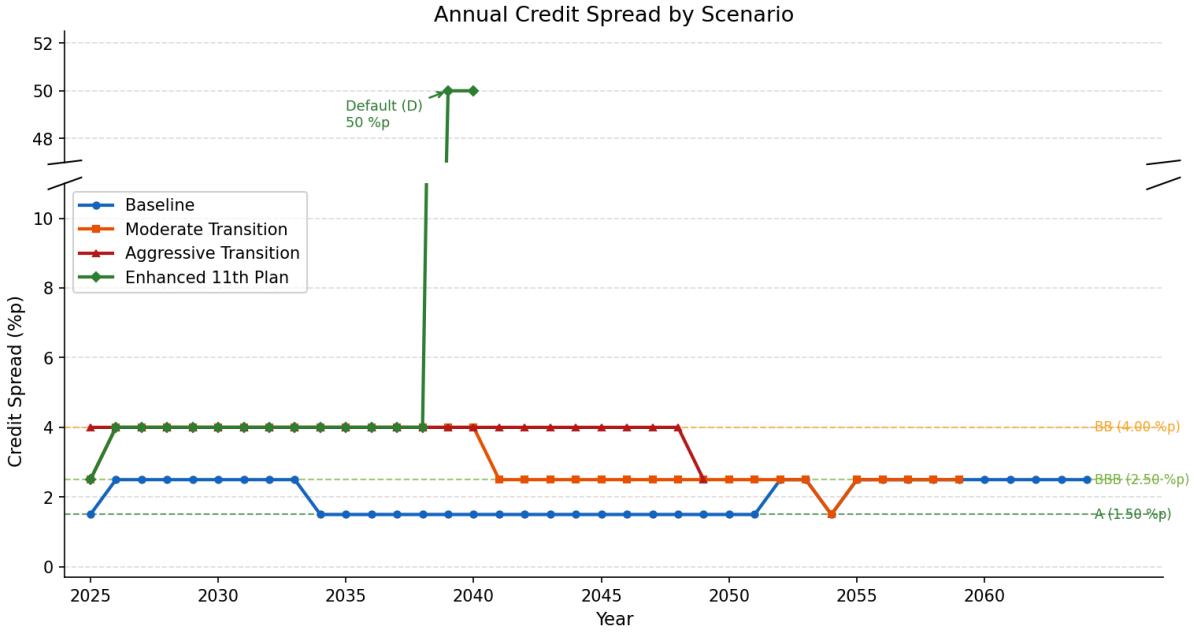
Across all transition scenarios modeled, the credit rating declines to the BBB–BB range — a meaningful downgrade from the current AA rating. This deterioration reflects the compounding effects of capacity factor depression, carbon cost exposure, and structural revenue shortfalls as coal phase-out policy pressures intensify.

Under the Enhanced 11th Plan scenario, which incorporates an explicit coal phase-out timeline and non-zero carbon costs, the plant enters default (D) from 2039 onward — a finding that underscores the severity of transition risk when policy commitments are treated as binding.

Under the Moderate Transition scenario, the trajectory diverges modestly in the later period: debt reduction progresses sufficiently by 2040 to support a partial recovery to BB. This improvement, however, reflects deleveraging mechanics rather than any fundamental improvement in operating conditions, and should not be read as a signal of restored financial health.

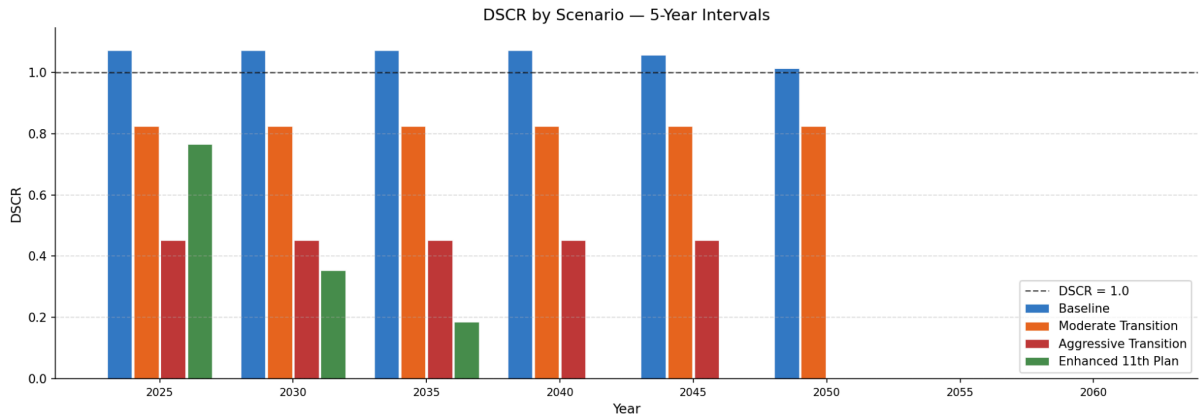


Note: ① Baseline — Investment-grade (A) for most of operational life; temporarily BBB (2026–2033) as leverage peaks; recovers to A and returns to BBB after 2051 as debt amortises.
② Moderate Transition — Opens at BBB (2025); deteriorates to sub-investment grade BB (2026–2040) under moderate carbon regulation; partially recovers to BBB from 2041 as debt amortises.
③ Aggressive Transition — Sub-investment grade (BB) throughout entire operational life (2025–2049); no recovery to investment grade under stringent decarbonisation policy.
④ Enhanced 11th Plan — Directly reflects Korea's 11th Basic Plan for Electricity Supply and Demand; accelerated utilisation decline erodes cash flows; default (D) in 2039–2040; early project termination in 2040.



DSCR Outcomes Under Transition Scenarios

The Debt Service Coverage Ratio (DSCR), the standard measure of debt serviceability in project finance and the threshold used in the CRP model to trigger accelerated credit deterioration, tells a stark story. Under every transition scenario except the Baseline, which assumes a capacity factor of 60%, the DSCR falls below 1.0. A DSCR below 1.0 means the project is generating insufficient cash flow to cover its debt obligations, a condition that in project finance typically signals financial distress and triggers covenant breaches or lender intervention.



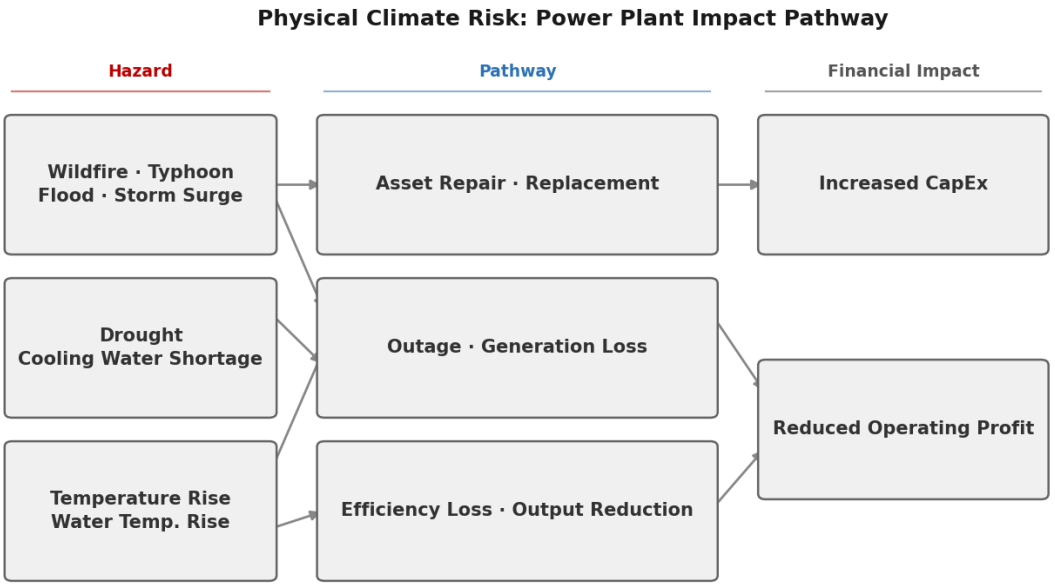
3. Physical Risk

Physical climate risk undermines power plant economics through multiple channels: extreme weather causes direct asset damage and raises capital expenditure; cooling water shortages or wildfire-related transmission failures reduce revenue through operational disruption; and rising air and water temperatures gradually erode generation efficiency. These effects do not operate in isolation. They accumulate, interact, and must be assessed across the full chain from the plant to the transmission infrastructure it depends on.

3.1 Methodological Challenges

Physical climate risk assessment traces its origins to the catastrophe models developed by the insurance industry, which estimate the probability and severity of extreme natural hazards such as hurricanes, floods, and earthquakes. In conventional financial analysis, physical risk has largely been treated as a capital expenditure problem — repair costs, replacement costs, reconstruction.

This framing has two significant gaps. First, a substantial portion of climate impact on power generation assets comes from chronic risk: gradual increases in temperature, declining water availability, and more frequent drought conditions reduce generation efficiency without destroying infrastructure. Luo et al. (2023), analyzing 80 power plants for the European Bank for Reconstruction and Development, found that rising water temperatures were among the largest drivers of generation losses, projected at 1.9 to 4.6 TWh by 2030 under RCP4.5, a category largely absent from mainstream climate risk disclosure guidelines. Second, even acute hazards impose costs well beyond asset repair. Revenue losses from operational outages can be as financially significant as the physical damage itself, yet are rarely quantified.



The PLANiT CRP model addresses both gaps. Following the methodology of Luo et al. (2023) and drawing on the OS-Climate PhysRisk framework, it incorporates both chronic efficiency losses and acute operational disruption into a revenue loss framework, translating expected reductions in generation output directly into cash flow impact.

3.2 Samcheok Blue Power Physical Risk Profile

Samcheok Blue Power's topography limits its exposure to the hazards most commonly emphasized in the Korean context. Its elevated site and seawater cooling system structurally reduce vulnerability to storm surge, flooding, and freshwater stress. However, two risk factors warrant closer attention. First, wildfire risk along the east coast has grown materially in recent years and poses a credible threat to transmission infrastructure rather than the plant itself. Second, while the absence of thermal discharge regulations in Korea keeps water temperature risk low relative to European peers, that gap could close if regulations are introduced, at which point the risk would enter the cost structure immediately.

Wildfire Risk and Transmission Vulnerability

The March 2022 Uljin-Samcheok wildfire, which burned approximately 25,000 hectares, knocked out six of eight transmission lines serving the Hanul nuclear plant, narrowly avoiding a wider blackout and resulting in approximately 19 billion won in compensation to private generators. In March 2025, fires in North Gyeongsang Province burned around 99,300 hectares. The pattern points to a structural trend rather than isolated events.

Recent attribution research supports this assessment. Barnes et al. (2025), analyzing the March 2025 fires, found that climate change has approximately doubled the likelihood of the fire weather conditions that drove the outbreak, with peak fire weather intensity around 25% more

intense in today's climate than in the pre-industrial baseline. Looking ahead, the study projects a further doubling in likelihood and an additional 5% increase in intensity under continued warming to 2.6°C above pre-industrial levels. The findings suggest that the frequency and severity of extreme wildfire conditions in South Korea will continue to increase, making transmission infrastructure exposure a growing financial risk for east coast power generators.

3.3 Risk Assessment Results

Flood, cooling water availability, and temperature-related hazards yielded no statistically significant results under current modeling frameworks.

For wildfire risk, applying the assumptions from Barnes et al. (2025) produces estimated annual revenue loss ratios of 0.0082% (2024), 0.0164% (2030), 0.0164% (2050), and 0.0329% (2100) — figures that appear modest relative to transition risk. This should not, however, be interpreted as an absence of physical risk. The muted results are more accurately attributed to the limitations of existing methodologies and the relatively thin body of empirical research on physical climate hazards in the Korean context. As assessment tools improve and empirical evidence accumulates, measured physical risk is likely to increase.

Taken together, physical risk factors do not produce a materially meaningful change in the credit rating outcome under current assumptions.

4. Conclusions and Implications

4.1 The Case for Quantification

Why Measurement Comes First

The Samcheok Blue Power case illustrates that climate risk can no longer be treated as a secondary consideration in asset valuation. Credit rating reports and bond prospectuses flag the coal phase-out policy and transmission constraints as risks worth monitoring, yet stop short of quantifying how severely these factors could affect cash flows and credit ratings. Uncertainty is offered as the justification, but uncertainty is not the same as absence of risk. Against the backdrop of rising global temperatures and South Korea's coal transition trajectory, these are not hypothetical threats. They are risks that are already in motion. When risks go unquantified and unpriced, the broader conversations that Korean society will need to have, including how to handle potentially stranded assets and how to allocate the associated costs, become harder to initiate. That is precisely why developing more rigorous, quantitative approaches to climate risk assessment matters. Measurement and recognition are where all of those conversations have to begin.

4.2 Implications for Stakeholders

Current credit assessments do not adequately reflect the climate risks facing Samcheok Blue Power. Rating agencies acknowledge policy risk and transmission constraints as downside monitoring factors, but stop short of translating them into quantitative impacts on cash flows or credit ratings. Treating the current A+ rating as a reliable signal of financial stability is therefore not warranted. The CRP framework presented in this report provides a financial basis for understanding how climate risk raises the true cost of capital for coal assets, with direct implications for the potential losses embedded in bond and loan agreements that have not adequately priced that risk.

For investors and lenders

- When evaluating bond investments, independently assess the substance and likelihood of the climate-related downside monitoring factors disclosed in rating reports, rather than relying on the headline rating alone.
- Model the long-term cash flow implications of the coal capacity reduction schedule set out in the 11th Basic Plan (22.9% by 2030, 13.8% by 2038) as part of scenario analysis.
- When assessing physical risk, account for the geographic and design characteristics of each specific asset. Exposure varies materially from one plant to another even within the same sector.

For policymakers

- Ambiguity in the coal phase-out implementation schedule is itself a driver of risk premiums in capital markets. The most effective way to reduce that premium is to reduce the uncertainty that generates it.
- Codify a concrete implementation schedule for coal capacity reduction, covering the timing of utilization restrictions, the criteria and compensation framework for forced closures, and the future operation of the settlement adjustment coefficient mechanism.

For civil society organizations

- The fact that rating agencies have formally incorporated climate risk as a factor in credit assessment represents a significant shift in the terms of the debate. The argument that climate risk has already placed this asset on a downside watch list, as stated in official rating documentation, is more effective in capital market and policy discussions than appeals based on environmental impact alone.
- This report and the PLANiT CRP open-source model are designed as empirical tools that civil society organizations can deploy credibly in public debates on energy policy and infrastructure planning.(github.com/PLANiT-Institute/climate_risk_premium

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