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Developing Resilient Power Supply. Case Study: CVM Corp's Eastern Block

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Abstract: This research aims to develop a strategic plan for power infrastructure to support the expansion of production capacity at CVM CORP, with a particular focus on the Eastern Block. The implementation of Eco Mechanized Mining has encountered several key obstacles, including insufficient power supply capacity, high operational electricity costs, slow response to power outages, and significant delays in the development of a new Switching Station (SS), which has been under planning since 2018. Through Current Reality Tree (CRT) analysis, the main root cause was identified as the overreliance on SS TEU as the sole power source for the entire operational zone. To address these issues, the proposed strategy includes the development of a new Switching Station near the company's PLTU (steam power plant), determination of the optimal site using the Analytic Hierarchy Process (AHP), project scheduling via the Critical Path Method (CPM), cost-efficiency evaluation using full costing and the Levelized Cost of Electricity (LCOE), and investment feasibility analysis utilizing IRR, NPV, and Payback Period metrics. Additionally, the load distribution between SS TEU and the proposed new SS has been redesigned to enhance power efficiency and lower electricity expenses. The results show that a hybrid electricity supply model (PLN–PLTU) substantially reduces electricity costs and helps achieve production targets. The investment also demonstrates strong financial viability, with an IRR of 1398%, a Net Present Value (NPV) exceeding IDR 4.47 trillion, and a payback period of just one year. Project implementation is targeted to start by July 19, 2025, and be completed before October 21, 2026, with continuous risk mitigation throughout the execution phase. This comprehensive strategy ensures greater reliability of the power system and strengthens long-term operational resilience for CVM CORP.

Keyword: Power infrastructure, Switching Station, Levelized Cost of Electricity (LCOE), Analytic Hierarchy Process (AHP), Critical Path Method (CPM), Investment Feasibility, Risk Management

INTRODUCTION

According to the *Energy Institute Statistical Review of World Energy 2024*, global energy consumption reached a new peak in 2023, continuing its upward trend following the COVID-19 pandemic. Primary energy use increased by 2% compared to 2022, exceeding pre-pandemic levels, primarily driven by rising demand in non-OECD nations, especially in Asia. Although

renewable energy experienced rapid growth expanding six times faster than overall energy consumption—fossil fuels remained dominant, making up more than 81% of global primary energy use. This underscores the ongoing slow and uneven energy transition, where efforts to decarbonize are frequently offset by the growing energy demands of developing economies.

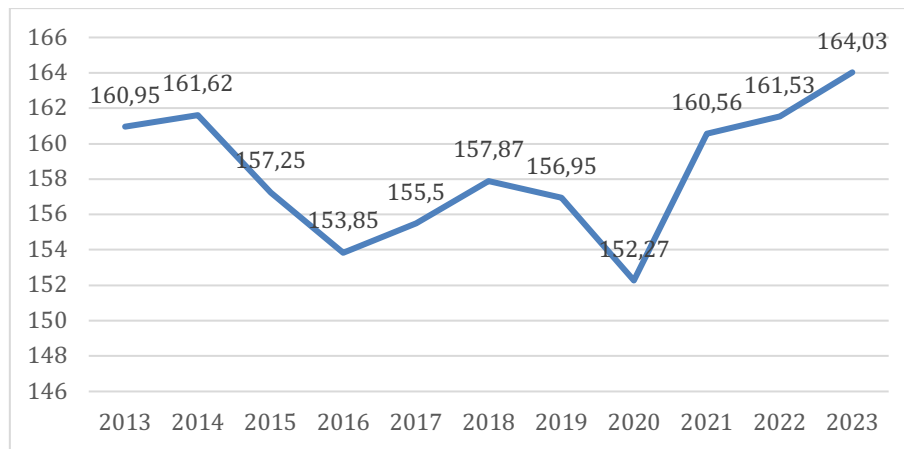


Figure 1. 1 Annual Global Coal Consumption Trend (Exajoules). Source: Energy Institute Statistical Review 2024, [Home](#) | [Statistical Review of World Energy](#)

Figure 1.1 shows global coal consumption trends from 2013 to 2023, highlighting a strong rebound post-2020, reaching a record 164.03 exajoules in 2023 driven largely by demand in Asia. Despite global decarbonization efforts, coal remains a key energy source, especially for countries like China and India, with major exporters such as Indonesia benefiting from rising demand. Indonesia, while maintaining high coal production, has committed to achieving Net Zero Emissions by 2060. Under the Low Carbon Compatible with the Paris Agreement (LCCP) scenario, the country plans to reduce emissions to 572 MtCO₂e by 2050, primarily through electrification and the transition to low-carbon energy. Compared to the Current Policy Scenario (CPOS), which keeps emissions high, the LCCP path emphasizes renewable energy, energy efficiency, and carbon capture technologies.

Coalventra Mining (CVM CORP), one of Indonesia’s largest coal producers, is working to balance business growth with the national goal of achieving net zero emissions by 2060. To support this, the company has adopted Eco Mechanized Mining, which has significantly increased its electricity needs. Currently, power is supplied by CVM CORP’s own coal-fired plant and backup from PLN. This study explores how CVM CORP can meet rising energy demands while staying aligned with government policies.

Background

Coalventra Mining (CVM CORP) is a pseudonym for a major Indonesian coal mining company, aims to become an energy-based company by 2030, targeting 30% of its revenue from the energy sector, including ventures in New Renewable Energy (e.g., solar and wind). The company is pursuing cost efficiency, strategic partnerships, and sustainable practices such as electric-powered equipment and digital reporting systems to support decarbonization and competitiveness. In 2023, CVM CORP produced 41.9 million tons of coal, exceeding its target and reflecting 13% growth. With increasing production targets up to 60 million tons by 2060 the company is building two Train Loading Stations, featuring long conveyor systems and a combined capacity of 20 million tons per year to support logistics and growth.

Literature review

The Critical Path Method (CPM) is effective for identifying critical activities and optimizing project timelines in high-risk installations, as shown in the shipbuilding project of

PT PAL Indonesia and U.S. substation EPC scheduling (Tresnadi et al., 2020; Jamir, 2006). When time estimates are uncertain, the Program Evaluation and Review Technique (PERT) provides a probabilistic approach using optimistic, most likely, and pessimistic durations to improve schedule accuracy (Swanson & Woolsey, 1974). For strategic planning and multi-criteria decision-making, the Analytic Hierarchy Process (AHP) helps decompose complex problems into structured hierarchies, translating expert judgment into priorities (Saaty, 2008; Rahman, 1987). Meanwhile, applying ISO 31000:2018 in risk analysis, as demonstrated in the Gunungsari GIS project, enables proactive identification, evaluation, and treatment of risks, thus improving project resilience and delivery effectiveness (Al Aslamiyah et al., 2024).

A case study at the Barru coal-fired power plant (PLTU Barru) demonstrated that applying full costing revealed higher and more accurate electricity generation costs compared to the company’s internal method, which excluded some fixed costs (Rafika, Sujatmiko, & Samad, 2023). The observed discrepancy over IDR 27 billion—emphasizes how full costing provides a clearer financial picture and supports better pricing and efficiency decisions. While Hermanto and Ardianto (2020) used a Lagrangian approach rather than explicitly applying full costing, their model still incorporated total fuel and operational costs, aligning with comprehensive cost modeling. Similarly, full costing has been shown to prevent underpricing and margin erosion in the manufacturing sector (Adristi, Hendrarini, & Setiawan, 2023). In terms of regulation, the Ministry of Energy and Mineral Resources classifies industrial electricity users based on subscribed capacity and voltage levels, where high-voltage users above 30 MVA fall into the I-4/TT category and benefit from economies of scale while bearing significant infrastructure responsibilities (Kementerian ESDM, 2016).

Business Issue

Currently, the sole electricity supply for the entire Enom mining area is provided by the Tambang Enom Utama Switching Station (SS TEU). This station receives power from two main sources: a Mine Mouth Steam Power Plant (PLTU) with a capacity of 3x10 MW, and an electricity supply from PLN under a 21,250 KVA contract (approximately 17 MW, assuming a power factor of 0.8). The captive PLTU is situated in the eastern block and is managed by PT GST under a fixed-rate operation and maintenance agreement for a 25-year term. As shown in Figure 1.2, the power from SS TEU is distributed throughout the UPE operational area. Designed with a maximum capacity of 30 MW, SS TEU has been in continuous operation since 1982, reliably meeting the energy needs of the entire site.

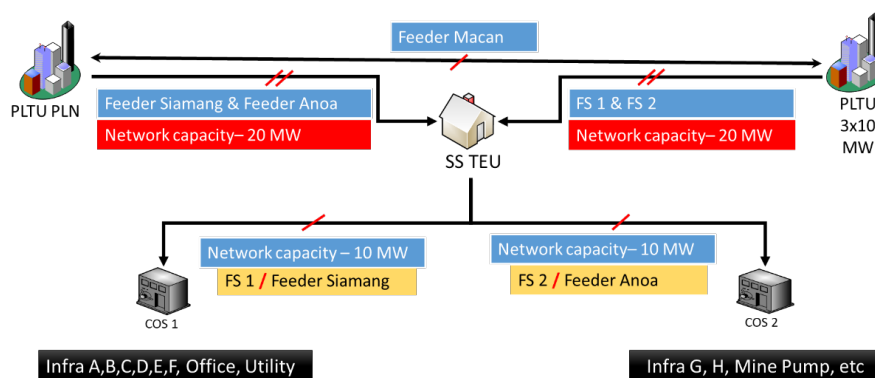


Figure 1. 2 Simple diagram of the UPE electricity distribution network.
(Source: internal company data)

Under normal conditions, the PLTU supplies electricity to SS TEU, which then distributes it across the UPE area. The eastern block is powered by two medium-voltage feeders on a shared pole, located over 5 km from the West Enom substation and about 34 km from Infra G. Each feeder has a 10 MW capacity, allowing a total of 20 MW to be delivered to the eastern block.

Feeder A20 serves INFRA C, D, and E, while the electrification feeder supplies power to electric shovels, mining pumps, and INFRA G.

Table 1.1: Infrastructure Development Plan (Source: internal company data)

Year	New Infrastructure	Electrical Power Capacity (MW)	Electrical Power Capacity (MVA)
2026	Infrastructure H	4.73	4.83
	Infrastructure I	4.41	4.50
2027	Infrastructure X	2.79	2.85
2028	Infrastructure J	3.62	3.69
	Infrastructure Y	2.21	2.26

To meet the target, the company intends to develop new infrastructure, as outlined in Table 1.1. It is essential to consider the power demands for future infrastructure expansion, as shown in the table. Several infrastructure projects are underway and are anticipated to be completed in the near future. Ensuring adequate power capacity and infrastructure to support these developments is critical.

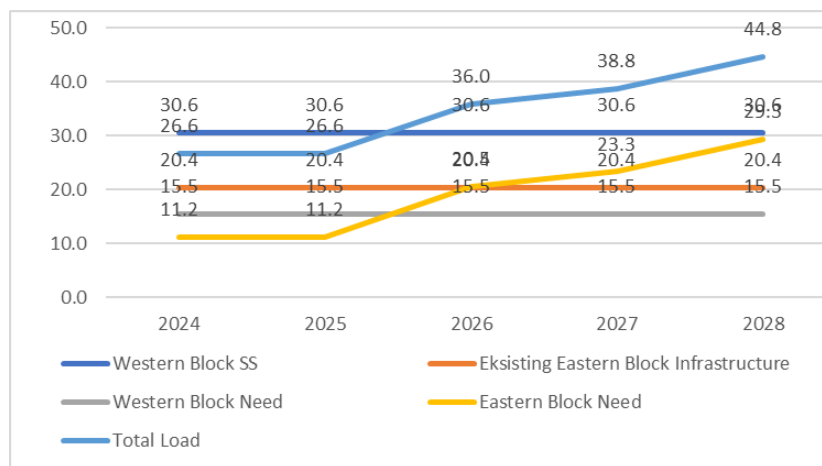


Figure 1. 3 Existing load capacity VS Plan (MVA) (Source: internal company data)

By 2026, the electricity load in the eastern block area is expected to exceed the current infrastructure capacity, and the total load in the UPE area will surpass the SS TEU design capacity. In addition to power capacity challenges, personnel placement for maintenance and managing power disturbances must be considered, as all staff are currently based at SS TEU, which affects response times for issues in the eastern block.

The electricity consumption for 2023, indicates that electricity use is primarily sourced from PLN, with only a small contribution from the PLTU on a monthly basis. As a coal-fired power plant, the PLTU struggles to respond quickly to the highly fluctuating operational electricity demands. To address this issue, the company launched a long-term strategy several years ago to build an independent load bank (ILB). The main goal of this initiative is to reduce the impact of load fluctuations on PLTU's operational stability. The ILB construction project is currently in progress and is expected to be completed by the first quarter of 2025. This study aims to address several critical issues related to the electricity infrastructure in the eastern block of CVM CORP. The key research questions focus on determining the optimal location for a new Switching Station (SS), optimizing project scheduling to align with the commissioning of the new Coal Handling Facility (CHF), and developing an efficient operational strategy for the new SS that ensures cost-effectiveness and long-term sustainability.

The research objectives are to identify the best location for the new SS to improve electricity distribution, establish an optimal timeline for the SS project to align with CHF commissioning, and conduct an investment feasibility analysis to ensure efficient operational costs. The scope of the study includes evaluating the existing infrastructure, selecting the optimal SS location, assessing project timelines, and analyzing electricity cost efficiency. However, it does not address workforce planning, macroeconomic forecasting, advanced risk modeling, or investigate delays in the SS project implementation, which was first proposed in 2018. The research relies on available internal data and regulatory documents, focusing on improving power supply reliability and supporting the commissioning of the CHF.

METHOD

This chapter presents the research methodology employed to explore and develop strategic solutions for the electricity infrastructure challenges in the Eastern Block. Due to the multifaceted nature of the issue, which encompasses technical, operational, financial, and risk factors, a multi-method approach was adopted for a thorough analysis. The methodology combines both qualitative and quantitative methods, customized to align with CVM Corp’s internal data, project limitations, and decision-making requirements. Each step of the process is designed to address the key research questions, from identifying root causes to assessing investment feasibility, ultimately leading to the formulation of a comprehensive business solution and implementation plan.

This research uses a mixed-method approach, combining quantitative and qualitative methods to address electricity demand and supply challenges in CVM CORP’s eastern block. The goal is to align the construction of the new Switching Station (New SS) with current and future electricity needs to meet operational and production targets. The methodology follows a multi-stage process, starting with identifying the root causes of limited electricity supply capacity and delayed outage response times using the Current Reality Tree (CRT) to map cause-effect relationships within the power distribution system.

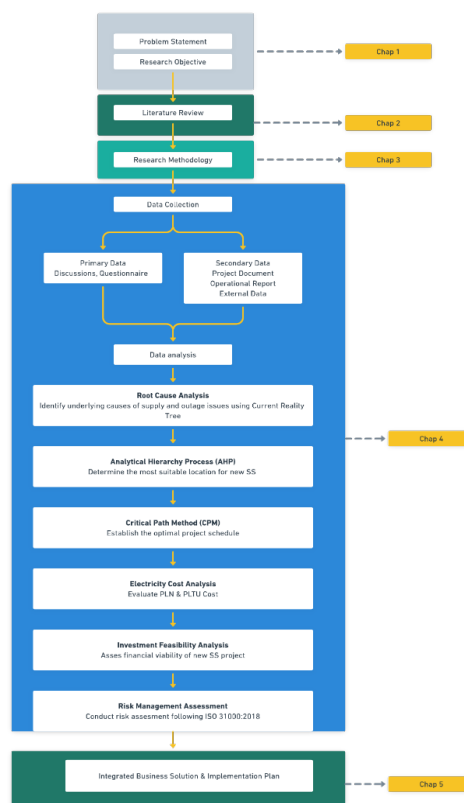


Figure 3. 1 Research Design

The research identifies core problems and uses the Analytical Hierarchy Process (AHP) to select the optimal location for the new substation (New SS), considering factors like proximity to demand centers and integration with infrastructure. The Critical Path Method (CPM) is then used to develop a construction schedule, ensuring synchronization with the commissioning target. A three-part cost analysis evaluates electricity supply options, and an Investment Feasibility Analysis confirms the financial viability of the project. A Risk Management Assessment, based on ISO 31000:2018, identifies project risks and mitigation strategies. The results are used to develop an Integrated Business Solution and Implementation Plan to ensure electricity reliability in the Eastern Block.

Data Collection Method

In this study, data collection was designed to support each stage of the research framework, ensuring that all analyses are based on valid and relevant information specific to the project. Both primary and secondary data sources were utilized, tailored to the analytical techniques applied at each step. For primary data collection, structured questionnaires were distributed to internal experts from departments such as engineering, maintenance, project management, operations, and planning. These experts, holding leadership positions within the company, provided insights through the Analytical Hierarchy Process (AHP) for selecting the optimal site for the New Substation (New SS). Additionally, internal project records, including timelines, planning schedules, and procurement logs, were used to support the Critical Path Method (CPM) scheduling analysis. For the risk management assessment, internal stakeholders rated the likelihood and impact of identified risks using CVM Corp's customized risk parameter matrix.

Secondary data collection involved reviewing operational and technical reports, including historical data on outages, response times, and energy consumption, which were used for the Current Reality Tree (CRT) analysis. Regulatory and cost data, including electricity tariff and connection fees, were obtained from official documents from PLN and the Ministry of Energy and Mineral Resources. Financial data for investment planning, including variables used to calculate NPV, IRR, and PBP, were also referenced internally.

Data Analysis Method

This research utilizes both qualitative and quantitative data analysis methods to address various dimensions of the study, in accordance with the multi-method design framework.

Qualitative Data Analysis

- **Current Reality Tree (CRT)**
The Current Reality Tree (CRT) method is applied to qualitatively map and analyze the systemic issues contributing to electricity supply shortages and slow disturbance response times in the Eastern Block. By examining cause and effect relationships using internal operational data and expert inputs, this method helps identify the root causes of the problems.
- **Analytical Hierarchy Process (AHP)**
While the AHP method generates numeric weights, it initially relies on qualitative judgment from internal experts. These experts complete questionnaires that provide subjective insights, which are then structured into pairwise comparison matrices.

Quantitative Data Analysis

- **Critical Path Method (CPM)**
The Critical Path Method (CPM) is used for project scheduling, focusing on internal project plans and activity durations. This quantitative analysis calculates the total

duration of the project and determines the latest possible start date to ensure the commissioning target is met on time.



Figure 3. 2 Steps to Apply CPM

The stages of CPM analysis to be applied in this study are illustrated in Figure 3.3 above.

RESULTS AND DISCUSSION

To support increased production in the East Block, CVM CORP faces significant challenges in meeting the rising electricity demand due to infrastructure constraints and slow response times to power disturbances. These issues will be examined using the Current Reality Tree (CRT) to uncover their root causes. To determine the best location for the new Main Switching Substation (New SS), the Analytic Hierarchy Process (AHP) will be employed, evaluating site options based on technical, operational, and economic factors. The Critical Path Method (CPM) will then be utilized to establish the optimal project timeline and the latest start date to ensure the New SS is ready before the new Coal Handling Facility (CHF) commissioning. Furthermore, inefficiencies in electricity usage from the captive coal-fired power plant (PLTU) will be tackled by applying a full costing method to calculate the Levelized Cost of Electricity (LCOE) and establish a more precise internal tariff. By integrating these analytical approaches, this study aims to provide strategic recommendations to enhance infrastructure reliability, operational performance, and investment feasibility in the eastern block.

Analysis

Root Cause Analysis

The electrical load required for the region's operations can be analyzed through continuous monitoring of load data from the incoming SS TEU, which receives power from both PLN and PLTU. Between November and December 2024, the highest recorded load was 20.24 MVA, while the lowest was 2.49 MVA.

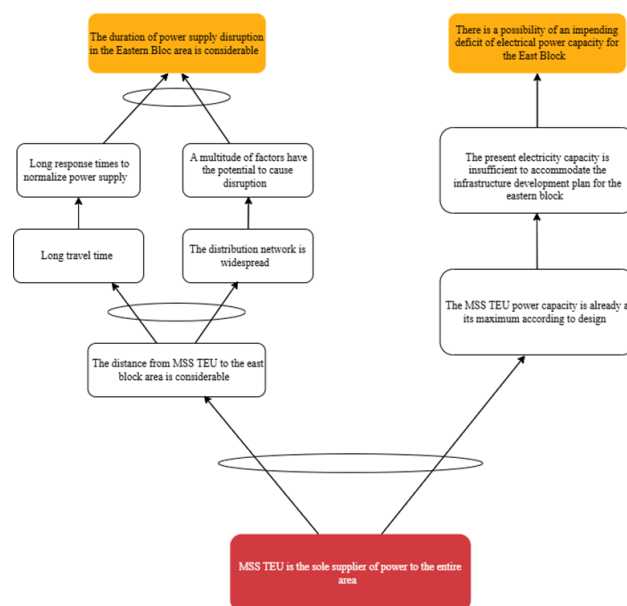


Figure 4. 3 Current reality tree

The SS TEU is approximately 7.35 km away from the nearest load in the eastern block area. This distance is covered using both the mine’s operational road and the highway. With an average speed of 25 km/h, the travel time is estimated to be around 20 minutes. However, this estimate does not consider possible delays caused by traffic congestion or difficult conditions on the mine road.

These technical observations underscore the fundamental challenges faced by the Eastern Block, particularly in terms of capacity limitations and the geographical difficulties in power distribution. As discussed in Section 1.3 Business Issues, the Eastern Block is facing two main problems. First, power outages tend to last longer due to the significant distance between SS TEU and the Eastern Block. Second, there is a potential shortfall in electrical capacity to meet the growing demand in the area. The rapid development of operational infrastructure in the Eastern Block has not been matched by sufficient power supply network expansion, raising concerns that the existing system may be inadequate for future needs. To identify the root causes of these issues, the author uses the Current Reality Tree (CRT) depicted in Figure 4.3.

Location for a New Switching Station (SS)

From Figure 4.3, it can be concluded that the root cause of the issue lies in the fact that the entire region's power supply is exclusively distributed from SS TEU. Addressing this core issue is expected to resolve both previously identified concerns: prolonged outage durations and the risk of inadequate power capacity in the Eastern Block. After consultations with relevant stakeholders within the company, two alternative locations have been proposed to tackle this challenge:

1. Establishing a new SS near the PLTU in the Eastern Block.
2. Establishing a new SS at a central location within the load distribution area of the Eastern Block.

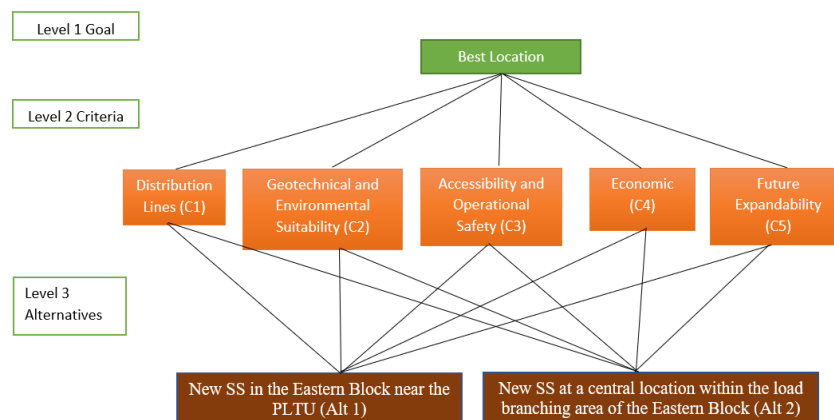


Figure 4. 4 AHP framework for best location

Figure 4.4 shows the AHP framework, which consists of three levels: the top level represents the goal of identifying the best location for the SS, the second level includes five evaluation criteria (Distribution Lines, Geotechnical and Environmental Suitability, Accessibility and Operational Safety, Economic, and Future Expandability), and the third level presents two location alternatives: (1) New SS near the PLTU, and (2) New SS at a central location in the Eastern Block. Through structured pairwise comparisons, the criteria and alternatives are evaluated to determine the optimal SS location, converting qualitative expert judgments into quantitative scores.

Questionnaire Design

To ensure a credible and thorough evaluation in the Analytic Hierarchy Process (AHP), a structured survey was conducted with selected respondents who are experts and active practitioners in project management and medium-voltage infrastructure. The participants are

members of management (BOD-2 and BOD-3) with expertise as both strategic decision-makers and hands-on professionals, making them highly qualified to assess complex infrastructure planning scenarios. These individuals hold leadership roles and have significant practical experience in managing and executing power infrastructure projects. Their combined expertise provides valuable insights that are both technically sound and relevant to real world challenges. The table below outlines the profiles of the survey respondents:

Table 4.1 List of Respondents for AHP Questionnaire

No.	Name	Position	Work Experience	Alias
1	Mrs L	Assistant Manager - Transport Performance Evaluation	>10 Years	R1
2	Mrs V	Junior Business Analyst	>10 Years	R2
3	Mr F	Assistant Vice President - Maintenance Strategy & Planning	>15 Years	R3
4	Mr T	Chief of Engineering	>15 Years	R4
5	Mr E	Assistant Vice President - HSE Compliance and Control	>25 Years	R5
6	Mr I	Project Engineer	>15 Years	R6
7	Mr K	Assistant Manager - Electrical Supply and Distribution Maintenance	>32 Years	R7

Weighting the Alternatives

The AHP process began with individual pairwise comparison matrices, followed by aggregation using the geometric mean, normalization, eigenvector calculation, and a consistency check resulting in the priority weights of each criterion.

After confirming the priority weights and consistency of expert judgments, each alternative location is evaluated by combining its local weights (from matrix normalization) with the global criterion weights. This yields a composite score for each option, as shown in Table 4.5, identifying the most suitable site for the Switching Station.

Table 4.5: Weighting the Alternatives

Criteria	Local Weight Alt 1	Local Weight Alt 2	Criterion Weight
C1	0.99	0.01	0.10
C2	0.98	0.02	0.13
C3	0.99	0.01	0.42
C4	0.64	0.36	0.10
C5	0.96	0.04	0.25

As indicated in Table 4.5, Alternative 1 consistently outperforms Alternative 2 across all five criteria, particularly in the key areas of Accessibility and Operational Safety (C3) and Future Expandability (C5), where it scores 0.99 and 0.96, respectively. When these local scores are factored in with the corresponding criterion weights, Alternative 1 achieves a global score of 0.95, while Alternative 2 scores just 0.05. This substantial difference highlights a strong preference for Alternative 1 as the most suitable location for the new Switching Station. The significant gap underscores the alignment between the site characteristics of Alternative 1 and the evaluation priorities set by the expert respondents, confirming its technical and strategic advantages.

Critical Path Method (CPM) Analysis

To ensure the new Switching Station (SS) supports the CHF commissioning by October 2026, a project schedule and risk analysis were developed using CPM and PERT. This approach, based on three-point duration estimates, identifies the critical path and informs

strategic planning. Assumptions rely on internal plans, public data, and prior preparations since 2018, with updated timelines reflecting current conditions.

Identifying activities and their dependencies is a key first step in project scheduling. It breaks the project into manageable tasks and defines the logical sequence for execution. This forms the foundation for creating a network diagram and ensures efficient planning and monitoring.

Table 4.7 PERT-Based Activity Duration Estimates

Activity Code	Predecessor(s)	Optimistic (O)	Most Likely (M)	Pessimistic (P)	PERT Estimate (days)
A	-	60	90	120	90
B	A	300	360	390	355
C	B	5	7	7	7
D	-	5	7	10	7
E	D	20	30	40	30
F	C, E	5	7	10	7
G	F	-	-	-	-

Table 4.7 presents PERT-based duration estimates for each activity in the SS project, using three time scenarios (O, M, P) to calculate weighted averages. Activities A and B show wide duration ranges, indicating higher uncertainty and risk, especially in procurement and construction. In contrast, administrative tasks like D and E have shorter, more predictable durations. Activity F has a stable estimate, while Activity G, as a milestone, has no duration. These estimates form the basis for scheduling, buffer planning, and identifying potential delays along the critical path.

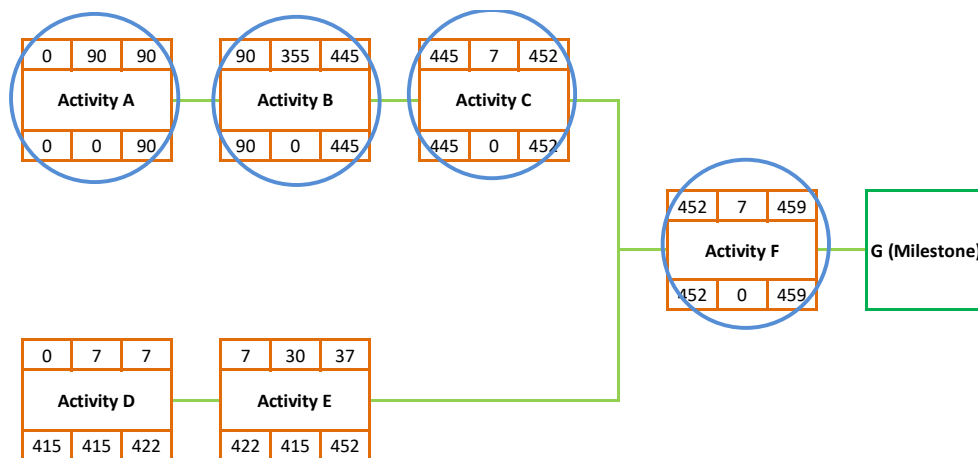


Figure 4. 1 Total Float Calculation and Critical Path Identification for the Switching Station Project

The forward and backward pass calculations show that the Switching Station project can be completed in exactly 459 calendar days, with Activity A starting at Day 0 and the final milestone, Activity G, finishing at Day 459. Critical path analysis, based on zero total float, identifies Activities A, B, C, F, and G as critical, as shown in Figure 4.10 (highlighted in blue), while D and E are non-critical. This critical path follows the technical stream from procurement to CHF commissioning. To meet the commissioning target of 21 October 2026, the project must begin by Friday, 18 July 2025 the last feasible working day before the deadline.

Electricity Cost

This study evaluates the economic viability of electricity supply options for the eastern bloc by analyzing three key components: the cost of PLN subscription and grid connection, the optimal Levelized Cost of Electricity (LCOE) from the company's captive coal-fired power plant (PLTU), and the total electricity cost under various supply configurations. The analysis of PLN subscription and connection fees reveals the fixed costs of accessing grid electricity, while the LCOE calculation provides insight into the full cost structure of internal generation over the PLTU's operational life. By comparing these two sources in terms of unit cost and operational flexibility, the study identifies the most efficient electricity cost structure to support production goals and ensure financial sustainability.

PLN Subscription and Grid Connection Fee

The planned increase in electricity demand from PLN refers to the projected load growth outlined in this study. The total demand considers the potential interconnection between the existing SS UPE and the new Switching Station, which is technically feasible and expected to improve power supply reliability through mutual backup between the two blocks. However, detailed technical design of the interconnection is not included in this study.

Table 4. 1 Planned Subscribed Capacity

Year	Available Subscribed Capacity (MVA)	Planned Subscribed Capacity (MVA)	Subscription and Grid Connection Fee	Minimum Billing (Monthly)
(1)	(2)	(3)	(4)	(5)
2026	8.66	8.66	Rp 7,510,960,000.00	Rp 369,558,017.76
2027	10.00	1.34	Rp 1,245,040,000.00	Rp 426,741,360.00
2028	15.00	5.00	Rp 4,378,000,000.00	Rp 640,112,040.00

Table 4.9 presents the estimated PLN Subscription and Grid Connection Fee, which includes cost components related to new power subscriptions and connections to the medium-voltage network. These are calculated based on the Planned Subscribed Capacity from Table 4.5 and follow the provisions of Permen ESDM No. 27 of 2017. The capacity for 2027 and 2028 is determined as the incremental difference from the previous year, reflecting PLN's progressive expansion policy. In 2026, CVM CORP subscribed to 8.66 MVA with a cost of Rp 7,510,960,000.00, followed by 1.34 MVA in 2027 (Rp 1,245,040,000.00), and 5.00 MVA in 2028 (Rp 4,378,000,000.00). The Minimum Billing (Monthly), governed by Annex IV of Permen ESDM No. 28 of 2016, rose with capacity: Rp 369,558,017.76 in 2026, Rp 426,741,360.00 in 2027, and Rp 640,112,040.00 in 2028. Meanwhile, planned capacity expansion from the PLTU side is not discussed in this study. The use of PLTU-generated power is intended to maximize the existing 30 MW capacity, while any shortfall is currently under internal review for Solar Power Plant (PLTS) development, also outside the scope of this document.

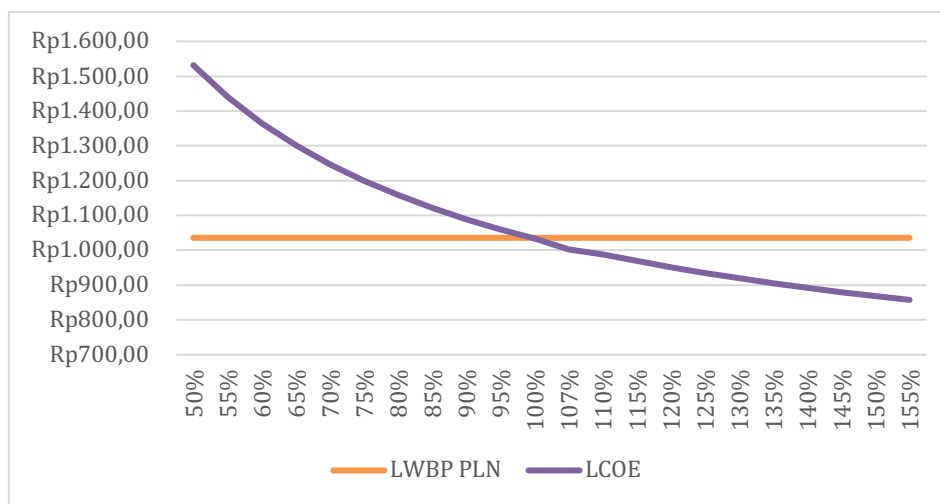


Figure 4. 11 LCOE Sensitivity to Electricity Distribution Rate vs Annual Target and PLN Off-Peak (LWBP) Tariff

Figure 4.11 illustrates how the Levelized Cost of Electricity (LCOE) decreases as PLTU production increases, compared to PLN's LWBP tariff of IDR 1,035.78/kWh. At low production (e.g., 50%), LCOE exceeds IDR 1,600/kWh due to high fixed costs. As output rises, LCOE drops sharply, reaching breakeven at 106.91% of the target (128.3 million kWh), where it equals the PLN tariff. Beyond this point, self-generation becomes more economical at 150% utilization, LCOE falls to around IDR 900/kWh. This underscores the cost advantage of maximizing PLTU capacity.

Table 4. 12 Electricity Cost Comparison: Full PLN vs Hybrid PLN–PLTU Scenario (2024–2028)
(Source: Internal Company Data)

Year	Growth	Total electricity consumption (KWH)	Source (KWH)		LCOE PLTU	% ToTarif PLN	Electricity Cost		
			PLN	PLTU			Only PLN	With PLTU	Gap
2024		112,000,000	23,520,000.00	88,480,000	Rp 1,260.5	110%	Rp 128,091,460,000.0	Rp 138,429,082,589.93	-Rp 10,337,622,589.93
2025	0%	112,000,000	23,520,000.00	88,480,000	Rp 1,260.5	110%	Rp 128,091,460,000.0	Rp 138,429,082,589.93	-Rp 10,337,622,589.93
2026	135%	151,200,000	13,002,384.91	138,197,615	Rp 1,000.0	87%	Rp 172,923,471,000.0	Rp 153,514,667,176.8	Rp 19,408,803,823.16
2027	146%	163,520,000	13,584,905.66	149,935,094.34	Rp 963.7	84%	Rp 187,013,531,600.0	Rp 160,496,771,250.3	Rp 26,516,760,349.67
2028	168%	188,160,000	15,758,490.57	172,401,509.43	Rp 908.0	79%	Rp 215,193,652,800.0	Rp 175,108,051,531.3	Rp 40,085,601,268.73

Table 4.12 compares electricity costs between full PLN reliance and a hybrid setup with the company's PLTU. In 2024–2025, full PLN use is cheaper by about Rp 10.3 billion annually due to the PLTU's higher LCOE (Rp 1,260.5/kWh). From 2026 onward, rising demand and declining PLTU LCOE make the hybrid model more cost-effective, saving up to Rp 40 billion in 2028 highlighting the growing benefit of internal power generation as demand increases.

Investment Feasibility Analysis

This study evaluates the financial feasibility of the new Switching Station (SS) project using NPV, IRR, and Payback Period to assess potential returns, investment recovery, and associated risks. The analysis is based on realistic financial assumptions, including initial costs, projected cash flows, and a discount rate derived from the company's WACC. Revenue projections reflect avoided opportunity losses if the SS is built, while operational expenses are expected to grow moderately over time. Overall, this approach provides a practical and data-driven assessment of the project's viability.

Based on the study, revenue generation for the new Switching Station (SS) project begins in 2026, following an initial investment of IDR 65.31 billion in 2025. The projected revenue starts at approximately IDR 902 billion in 2026 and grows steadily to over IDR 1.4 trillion by 2029 and 2030, driven by anticipated improvements in network reliability and service efficiency. Operational Expenses (OPEX), including Insurance Costs, O&M Costs, PLN

Subscription Fees, Network Connection Fees, and Minimum Billing Fees, are expected to rise moderately over time due to inflation and expanding operational demands. From the first operational year, the project generates a positive EBITDA of IDR 902 billion, with consistent growth in subsequent years, indicating strong financial performance as the station integrates into the broader network.

Risk Management Assessment

The risk management approach for the new Switching Station (SS) project follows the ISO 31000:2018 framework, ensuring structured identification, assessment, and treatment of risks to enhance project resilience and outcomes. A critical risk identified is potential delays in the procurement of the SS contractor, which could significantly impact the overall project timeline.

Risk Identification

The initial step in the risk management process is identifying potential risks that could disrupt project execution. This was done through analysis of similar projects, document reviews, and consultations with internal experts to ensure all critical risks are captured.

Table 4.15 – Risk Identification

No	Identified Risk	Risk Code
1	Early procurement planning and establishment of material buffer stocks, ensuring that material procurement responsibilities are clearly stipulated in the EPC contractor's scope of work and monitored through strict progress reporting mechanisms.	R1
2	Construction delays due to extreme weather	R2
3	Delay in project commissioning	R3
4	Poor quality of cable installation and equipment	R4
5	Cost overrun due to scope changes	R5
6	Scheduling conflicts between civil and electrical contractors	R6
7	Operational disruption from the PLTU during integration	R7
8	Non-compliance of material specifications with contracts	R8
9	Occupational health and safety risks during equipment installation	R9
10	Fluctuation in material costs	R10
11	Delay in Procurement of EPC for new SS Project	R11

Table 4.15 outlines key risks in the substation project, including procurement delays, technical issues, scheduling conflicts, operational disruptions, safety hazards, and contractor selection setbacks. Given the project's complexity, early risk identification is vital to ensure effective control over timelines and budgets.

Risk Analysis

The project's risk analysis follows ISO 31000:2018 and incorporates company-specific parameters reflecting internal risk tolerance. It uses two key tools: the Risk Rating - Impact Matrix, which scores impact (1–5) across financial, safety, legal, environmental, and stakeholder aspects, and the Risk Rating - Likelihood Matrix, which rates frequency from Rare (1) to Almost Certain (5). Risk scores are calculated by multiplying impact and likelihood, then classified as Extreme (≥ 15), High (9–14), Medium (6–8), or Low (< 6) based on company-defined thresholds.

Risk Treatment Planning

Following the risk analysis, targeted treatment strategies are developed for critical and high-priority risks through avoidance, mitigation, transfer, or acceptance. Table 4.17 details these actions, with special focus on R11 (procurement delay), which requires fast-tracking and parallel tender processing to reduce its impact.

Table 4. 2 Risk Treatment Planning

<i>Risk</i>	<i>Treatment Strategy</i>
<i>R1</i>	Early procurement planning and establishment of material buffer stocks.
<i>R2</i>	Development of contingency work schedules for weather-related disruptions.
<i>R3</i>	Weekly milestone tracking and fast escalation for delays.
<i>R4</i>	Strict Quality Assurance Plan and frequent site inspections.
<i>R5</i>	Tight Change Management Control to prevent unauthorized scope changes.
<i>R6</i>	Daily coordination meetings and integrated scheduling between contractors.
<i>R7</i>	Synchronization of PLTU operations and substation integration planning.
<i>R8</i>	Mandatory pre-delivery inspections for all key materials.
<i>R9</i>	Implementation of comprehensive safety programs and audits.
<i>R10</i>	Fixed-price contracting and supplier diversification.
<i>R11</i>	Early procurement initiation, fast-track evaluations, parallel tender processes, and Owner Estimate-based negotiation frameworks.

Business Solution

To resolve the electricity supply challenges in the Eastern Block and support the company’s production growth, a set of integrated business strategies has been formulated. These solutions are grounded in root cause analysis, projected electricity demand, and cost effectiveness. The core strategy is the construction of a new Switching Station (SS) near the PLTU in the Eastern Block, which will eliminate the single-point dependency on SS TEU and improve power reliability. To meet the project timeline, the EPC procurement process must begin no later than July 18, 2025, as defined by the Critical Path Method analysis. Furthermore, the company plans a phased increase in PLN subscribed capacity from 8.66 MVA in 2026 to 15 MVA by 2028 to match demand growth. Electricity loads will be strategically distributed between the existing SS TEU and the new SS, and strategically allocated between PLN and the captive PLTU to optimize operational electricity costs, with PLTU production maintained above 128,296,951 kWh per year to enhance cost efficiency. Financially, the project shows exceptional viability, with an IRR of 1398%, an NPV above IDR 4.47 trillion, and a one-year payback period. Lastly, a proactive risk management approach will be applied to execute mitigation measures and ensure close monitoring of risks throughout the project lifecycle.

CONCLUSION

This research concludes that the main issue with the electricity supply in CVM CORP’s Eastern Block is its full dependence on the SS TEU switching station, which threatens operational reliability amid planned production increases. To resolve this, a strategic plan was developed involving optimal site selection (near PLTU) using AHP, precise project scheduling with CPM (completion by 21 October 2026), and a cost efficient hybrid supply model

leveraging the captive PLTU. Financial analysis confirms strong feasibility with an IRR of 1398%, NPV above IDR 4.47 trillion, and a one-year payback. A structured risk management plan is also in place. Overall, building a new switching station is a well-justified solution that enhances energy security and supports future growth.

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