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STRATEGIC FEASIBILITY OF FGD GYPSUM COMMERCIALIZATION IN A COAL-FIRED POWER PLANT: A CASE STUDY OF PT SUMATERA PEMBANGKIT

KELAYAKAN STRATEGIS KOMERSIALISASI GYPSUM FGD DI PLTU BEBERAPA: STUDI KASUS PT SUMATERA PEMBANGKIT

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ABSTRACT

PT Sumatera Pembangkit, operator of a 1,320 MW mine-mouth coal-fired power plant (CFPP) in South Sumatra, is currently facing increasing challenges in managing its Flue Gas Desulfurization (FGD) gypsum waste, which remains classified as hazardous (B3) material. This by-product remains unused despite its chemical purity and applicability in the cement and construction industries. This study evaluates the strategic and financial feasibility of commercializing flue gas desulfurization (FGD) gypsum as an unrelated diversification strategy that supports waste reduction, compliance improvement, and alternative revenue generation. The research employs a mixed-method approach combining external analysis, internal analysis, financial viability, and B2B marketing strategy. Findings reveal that the gypsum produced by PT Sumatera Pembangkit meets the technical specifications required by cement producers. The commercialization strategy shows a positive Net Present Value (NPV) and internal rate of return, although it is constrained by regulatory limitations, lack of SNI certification, and infrastructure readiness. The study proposes a phased business model incorporating regulatory enablement, market development, and infrastructure enhancement. The study offers a practical framework for waste utilization in the energy sector and contributes to Indonesia's circular economy goals by transforming industrial waste into business value.

Keywords: *Gypsum Commercialization, Waste Utilization, Coal-Fired Power Plan, Circular Economy, B2b Marketing, Cost-Benefit Analysis.*

ABSTRAK

PT Sumatera Pembangkit, operator pembangkit listrik tenaga batu bara (PLTB) berkapasitas 1.320 MW di Sumatra Selatan, saat ini menghadapi tantangan yang semakin besar dalam mengelola limbah gypsum dari sistem penghilangan belerang gas buang (FGD), yang masih diklasifikasikan sebagai bahan berbahaya (B3). Limbah ini tetap tidak terpakai meskipun memiliki kemurnian kimia yang tinggi dan dapat diterapkan dalam industri semen dan konstruksi. Studi ini mengevaluasi kelayakan strategis dan finansial komersialisasi gypsum FGD sebagai strategi diversifikasi yang tidak terkait, yang mendukung pengurangan limbah, peningkatan kepatuhan, dan pembangkitan pendapatan alternatif. Penelitian ini menggunakan pendekatan campuran yang menggabungkan analisis eksternal, analisis internal, kelayakan finansial, dan strategi pemasaran B2B. Temuan menunjukkan bahwa gypsum yang diproduksi oleh PT Sumatera Pembangkit memenuhi spesifikasi teknis yang dibutuhkan oleh produsen semen. Strategi komersialisasi menunjukkan Nilai Sekarang Bersih (NPV) dan tingkat pengembalian internal yang positif, meskipun dibatasi oleh batasan regulasi, ketidakhadiran sertifikasi SNI, dan kesiapan infrastruktur. Studi ini mengusulkan model bisnis bertahap yang menggabungkan pemberdayaan regulasi, pengembangan pasar, dan peningkatan infrastruktur. Studi ini menawarkan kerangka kerja praktis untuk pemanfaatan limbah di sektor energi dan berkontribusi pada tujuan ekonomi sirkular Indonesia dengan mengubah limbah industri menjadi nilai bisnis.

Kata Kunci: Komersialisasi Gipsum, Pemanfaatan Limbah, Pembangkit Listrik Tenaga Batubara; Ekonomi Sirkular, Pemasaran B2B, Analisis Biaya-Manfaat.

INTRODUCTION

Indonesia's energy and environmental policy is significantly transforming towards a more sustainable and low-carbon trajectory. In response, the government has introduced stricter environmental regulations requiring power producers to reduce emissions and responsibly manage industrial waste. Coal-fired power plants (CFPP),

traditionally considered major contributors to environmental degradation, are now being challenged to explore cleaner and more circular operational strategies. PT Sumatera Pembangkit, operator of a 1,320 MW mine-mouth CFPP in South Sumatra, is under increasing pressure to comply with these environmental standards while maintaining operational and economic efficiency.

A major challenge encountered by CFPP is the accumulation of industrial by-products such as Fly Ash, Bottom Ash, and Flue Gas Desulfurization (FGD) gypsum. Although Fly Ash has found widespread acceptance in cement production, FGD gypsum, generated through the desulfurization of flue gas using limestone, remains underutilized, particularly in Indonesia. Despite its high chemical purity, FGD gypsum is still classified as hazardous waste (limbah B3) and is typically stockpiled, incurring storage costs and long-term environmental risks. Meanwhile, the national demand for gypsum, especially in the cement and construction sectors, continues to increase and is predominantly met by imports from countries such as Thailand and Oman. This paradox highlights an untapped opportunity for domestic utilization of industrial waste.

The concept of a circular economy offers a compelling rationale for rethinking industrial waste. It emphasizes resource efficiency through reuse, recycling, and industrial symbiosis (Ghisellini, Cialani, & Ulgiati, 2016). In mature industrial economies, FGD gypsum has already been utilized as a raw material for cement, gypsum board, and soil conditioners (Chatterjee, 2019). However, in Indonesia, market awareness remains low and regulatory hurdles persist. Recent studies underline the potential of FGD gypsum as a substitute for natural gypsum, aligning with national goals for reduced import dependency and hazardous waste accumulation (Zhang, Li, & Chen, 2021).

Beyond environmental considerations, the commercialization of FGD gypsum also aligns with corporate strategy frameworks, particularly through unrelated diversification. Diversification enables companies to leverage underutilized assets and reduce revenue dependency. In capital-intensive industries like power generation, diversification decisions are often shaped by regulatory exposure and the need for operational resilience (Grant, 2019). However, effective diversification requires the alignment of internal capabilities with external opportunities.

Feasibility evaluation tools such as Cost-Benefit Analysis (CBA), Net Present Value (NPV), and Internal Rate of Return (IRR) are essential in determining the financial and strategic viability of new ventures (Boardman et al., 2018). These tools also account for indirect benefits, including cost savings from waste reduction, improved regulatory compliance, and enhanced corporate reputation in environmental, social, and governance (ESG) contexts.

In line with the commercialization goal, a Business-to-Business (B2B) marketing approach is also critical. The target customers—cement and construction manufacturers—evaluate procurement decisions based on rational criteria such as cost efficiency, regulatory compliance, and technical reliability (Robinson et al., 1967). The STP (Segmentation, Targeting, Positioning) framework and marketing mix (Product, Price, Place, Promotion) provide structured guidance for supplier differentiation and market entry (Kotler & Keller, 2022).

Despite the compelling rationale, no existing study has comprehensively analyzed the strategic feasibility of FGD gypsum commercialization within the context of Indonesia's regulatory, technical, and market constraints. This study fills that gap by focusing on PT Sumatera Pembangkit, whose commercial operations began in 2023 and is expected to generate substantial volumes of FGD gypsum annually. The absence of a utilization strategy not only limits economic potential but also creates long-term environmental and regulatory liabilities.

This research aims to evaluate the strategic feasibility of FGD gypsum commercialization by assessing market readiness, internal capability, financial viability, and regulatory alignment. The study also applies a structured B2B marketing strategy to formulate a go-to-market plan. It is hypothesized that FGD gypsum can be transformed from a hazardous waste liability into a commercially viable, ESG-aligned industrial input, thereby contributing to Indonesia's circular economy agenda. The findings are expected to support decision-making at PT Sumatera Pembangkit and serve as a model for other power plants exploring sustainable diversification.

METHOD

This study adopts a mixed-methods research design, which combines qualitative and quantitative approaches to provide a comprehensive assessment of the strategic feasibility of FGD gypsum commercialization. According to Creswell (2014), the mixed-methods approach is suitable for studies that aim to integrate numerical analysis with contextual understanding, particularly in complex, multi-dimensional decision-making scenarios such as environmental resource utilization.

The object of this research is the Flue Gas Desulfurization (FGD) gypsum generated at PT Sumatera Pembangkit, a 1,320 MW mine-mouth coal-fired power plant located in South Sumatra, Indonesia. The subjects of the research include internal stakeholders at PT Sumatera Pembangkit and potential industrial buyers from the cement and construction sectors.

Data collection techniques included internal company document reviews, interviews with key decision-makers at PT Sumatera Pembangkit, and a survey distributed to companies operating in the cement and construction sectors. Secondary data sources included academic journals, market reports, and government regulations.

Data analysis was carried out using several tools. External and internal factors were analyzed using PESTEL analysis, Porter's Five Forces, and SWOT/TOWS frameworks. Financial viability was assessed through Cost-Benefit Analysis (CBA), using indicators such as Net Present Value (NPV) and Internal Rate of Return (IRR) as outlined in Boardman et al. (2018). Market feasibility was developed using a B2B marketing framework involving Segmentation, Targeting, Positioning (STP) and the 4Ps of the marketing mix (Kotler & Keller, 2022). The research was conducted at PT Sumatera Pembangkit in Muara Enim, South Sumatra.

RESULT AND DISCUSSION

This study found that Flue Gas Desulfurization (FGD) gypsum generated by PT Sumatera Pembangkit has strong potential for commercial use, both from a technical and economic standpoint. This research evaluates the strategic feasibility of Flue Gas

Desulfurization (FGD) gypsum commercialization at PT Sumatera Pembangkit by analyzing four critical dimensions: technical feasibility, financial viability, external market readiness, and internal organizational capability. Each dimension contributes insights into the opportunities and challenges regarding transforming FGD gypsum from an environmental burden into a viable industrial product.

Laboratory test results show that the FGD gypsum produced by PT Sumatera Pembangkit contains high levels of purity, particularly $CaSO_4 \cdot 2H_2O$ and SO_3, making it suitable for industrial applications such as cement manufacturing and gypsum board production. However, despite its technical viability, the product is currently classified as hazardous waste (limbah B3) due to its origin from a coal-fired process. This classification has become a major legal and perception barrier, as it limits the ability of the company to transport and sell the gypsum without special permits. The absence of Indonesian National Standard (SNI) certification makes FGD Gypsum unable to be commercialized.

Table 1. Laboratory Analysis Results for Gypsum FGD

Parameter	Unit	Result	Method
Phosphorus Pentaoxide (P_2O_5)	%	0.02	ASTM
Combine Water	%	20.19	ASTM
$CASO4._2H_2O$	%	96.45	ASTM
Sulfur Trioxide (SO_3)	%	44.92	ASTM
$CASO4._2H_2O$ based on SO_3	%	96.58	ASTM
Free Moisture 45^0	%, AR	3.99	ASTM

This disconnect between technical capability and legal-commercial acceptability represents a critical bottleneck. While the material itself is industrially viable, its regulatory status as a B3 waste and the absence of formal standardization (SNI) currently prevent market entry. As such, regulatory advocacy, technical validation, and standardization efforts are essential first steps in operationalizing the technical feasibility into a commercial pathway.

Cost-Benefit Analysis (CBA) reveals that the FGD Gypsum commercialization has significantly more favorable financial outcomes. In the current condition, the plant incurs ongoing costs for gypsum handling, storage, and regulatory compliance. These costs are expected to rise over time due to limited ash yard space and increasing enforcement of environmental regulations.

In the commercialization of FGD Gypsum, the company could generate direct revenue by selling gypsum to the cement and construction sectors. Based on projected market prices and conservative sales estimates, the commercialization model produces a positive Net Present Value (NPV) and Internal Rate of Return (IRR). These results indicate that gypsum commercialization is not only financially viable but also superior to the current disposal-based approach.

Table 2. Financial Projection Summary of FGD Gypsum Commercialization (2025–2030)

		2025	2026	2027	2028	2029	2030	Total
Capital Expenditure								
Storage Infrastructure		1,589,928,393	-	-	-	-	-	1,589,928,393
Handling Equipment: Wheel Loader		666,000,000	-	-	-	-	-	666,000,000
Regulatory Compliance (environmental permit revision)		440,000,000	-	-	-	-	-	440,000,000
Certification (SNI)		150,000,000	-	-	-	-	-	150,000,000
Total		**2,845,928,393**	-	-	-	-	-	**2,845,928,393**
Operational Expenditure								
Labor Cost		314,178,652	326,746,006	339,815,846	353,408,480	367,544,819	382,246,612	**2,083,940,616**
Fuel		536,797,800	558,269,712	580,600,500	603,824,520	627,977,501	653,096,601	**3,560,566,636**
Maintenance		406,175,420	422,422,436	439,319,334	456,892,107	475,167,792	494,174,503	**2,694,151,592**
Third Party Tranportation		3,012,262,841	3,012,262,841	3,765,446,989	3,765,446,989	4,297,705,114	3,765,446,989	**21,618,571,761**
SNI Resertification		-	-	-	-	40,000,000	-	**40,000,000**
Total		**4,269,414,913**	**4,319,700,995**	**5,125,182,669**	**5,179,572,097**	**5,768,395,226**	**5,294,964,705**	**29,997,230,605**
Revenue								
Revenue from FGD Gypsum Sales		3,744,250,000	3,744,250,000	4,680,375,000	4,680,375,000	4,961,250,000	4,680,375,000	**26,490,875,000**
Cost Saving from B3 Waste Disposal Avoidance		1,594,527,849	1,594,527,849	1,993,186,427	1,993,186,427	2,112,799,970	1,993,186,427	**11,281,414,948**
Total		**5,338,777,849**	**5,338,777,849**	**6,673,561,427**	**6,673,561,427**	**7,074,049,970**	**6,673,561,427**	**37,772,289,948**
Net Income	-	1,776,565,457	1,019,076,853	1,548,378,758	1,493,989,330	1,305,654,744	1,378,596,722	**4,969,130,950**
Discount Rate	10%							
PV		- 1,776,565,457.31	926,433,502.82	1,279,651,865.79	1,122,456,296.30	891,779,758.45	856,000,100.32	**3,299,756,066.34**
NPV	3,299,756,066.34							
IRR	66.30%							

In addition to direct revenue, there are indirect financial benefits that enhance overall viability. These include reduced risk of regulatory sanctions, decreased long-term environmental liabilities, and potential reputational gains from sustainability and ESG (Environmental, Social, and Governance) alignment. Such qualitative factors, though not always captured in standard financial metrics, contribute meaningfully to risk mitigation and strategic positioning.

However, it is important to note that the realization of these benefits is contingent upon the successful execution of several enabling conditions. Delays in regulatory approvals or cost overruns in logistics and certification processes could erode margins, underscoring the importance of phased investment and tight cost control during the early implementation phase.

Survey results collected from cement and construction companies in Sumatra, Jakarta, and West Java suggest a growing interest in locally sourced gypsum. Many industrial buyers have begun to show interest in alternative gypsum sources, especially those that are domestically produced and aligned with environmental sustainability goals. This interest has grown stronger in response to increasing challenges associated with imported gypsum, including price volatility, logistical disruptions, and foreign exchange exposure. Respondents indicate that their purchasing decisions are primarily influenced by quality consistency, regulatory compliance, and delivery reliability. Several respondents expressed willingness to switch to local FGD gypsum if technical standards and cost parity with imports are maintained.

However, skepticism remains due to the product's B3 classification, unfamiliarity with power plant-derived gypsum, and perceived risk in switching suppliers. This indicates that targeted customer education, product testing, and partnership-based trials are essential before large-scale adoption can be achieved.

The external market for gypsum in Indonesia presents a promising but guarded opportunity. Industrial buyers are beginning to look inward for reliable, cost-efficient, and sustainable sources of raw material. However, this readiness is conditional and contingent upon supplier efforts to meet regulatory, technical, and reputational expectations. FGD gypsum from PT Sumatera Pembangkit can position itself as a viable domestic alternative, but only through careful

alignment with the operational and compliance needs of its target market.

Internally, PT Sumatera Pembangkit already possesses essential infrastructure for gypsum generation and temporary storage, but lacks dedicated facilities for long-term handling, quality control, and dispatch. The company also does not have an existing commercial unit responsible for marketing or external stakeholder engagement related to by-product sales.

Interviews with internal stakeholders reveal organizational interest in diversification but highlight capacity gaps in marketing, logistics, and regulatory licensing. These gaps suggest the need for phased implementation, potentially starting with outsourcing certain functions such as transportation, testing, and certification to third-party providers.

The findings collectively suggest that PT Sumatera Pembangkit is well-positioned to enter the industrial gypsum market, contingent upon resolving key regulatory and operational barriers. The product meets technical standards, the market exhibits a potential demand, and the financial case is compelling. However, strategic interventions in infrastructure, stakeholder engagement, and capability building are essential to ensure the transition from regulatory liability to revenue-generating industrial resource.

CONCLUSION

This research concludes that the strategic commercialization of Flue Gas Desulfurization (FGD) gypsum generated by PT Sumatera Pembangkit is not only technically viable but also financially advantageous. The product meets the industrial quality specifications required by downstream sectors such as cement and gypsum board manufacturing. These technical attributes provide a strong foundation for market entry and differentiation.

From a financial perspective, Cost-Benefit Analysis (CBA) indicates that commercialization of FGD gypsum results in a significantly higher economic return than continued stockpiling or disposal. Key metrics such as Net Present Value (NPV) and Internal Rate of Return (IRR) show that the initiative delivers positive value and a short payback period. These outcomes demonstrate that transforming FGD gypsum from a regulatory burden into a value-generating product aligns with both operational efficiency and long-term financial sustainability.

Nevertheless, the pathway toward commercialization is not without challenges. Internally, PT Sumatera Pembangkit faces gaps such as the absence of SNI (Indonesian National Standard) certification, limited infrastructure for handling and dispatch, and no existing commercial team or market-facing unit dedicated to by-product commercialization. Externally, the gypsum market in Indonesia is dominated by imported material, and industrial customers tend to be risk-averse, particularly when sourcing new input materials classified as hazardous waste (B3) under prevailing regulations.

To address these issues and move from opportunity to execution, a structured managerial roadmap is required.

Managerial Implications

The study proposes a strategic framework that can guide PT Sumatera Pembangkit in executing the commercialization initiative effectively. This framework is rooted in the company's current capabilities, stakeholder expectations, and regulatory context, while drawing from best

practices in industrial marketing and business transformation.

Regulatory and Operational Enablement

The priority is ensuring legal and technical operability. This includes initiating the environmental permit revision process by including the use of FGD gypsum in the permit through coordination with relevant ministries and environmental authorities. Parallel to that, the company should pursue SNI certification and establish basic but compliant infrastructure for gypsum handling, testing, storage, and transport. These foundational efforts are crucial for unlocking legal access to industrial markets and building trust with potential customers.

Market Development and Customer Engagement

The second pillar emphasizes early market validation and demand creation. Management is advised to initiate pilot partnerships with cement and construction firms to allow technical trials and product testing under controlled settings. In parallel, PT Sumatera Pembangkit should develop a targeted customer education strategy that emphasizes environmental, social, and governance (ESG) alignment, reduced carbon footprint from local sourcing, and cost competitiveness. Market development efforts must also address perceived risks by demonstrating consistent quality and compliance through data transparency and third-party endorsements.

Capability Enhancement

Internally, the organization needs to strengthen its capacity to support non-core business activities. This includes the formation of a dedicated commercialization within the business development function. While internal capacity is being built, key operational functions such as logistics, certification testing, and customer interface can be outsourced to specialized third parties to reduce upfront complexity. Over time, these capabilities can be absorbed in-house as volume scales and organizational experience deepens.

To support this strategy, the study recommends applying a Business-to-Business (B2B) marketing framework centered around the STP model (Segmentation, Targeting, and Positioning). The industrial segment, specifically large cement producers with steady gypsum demand, should be prioritized. The positioning message should highlight PT Sumatera Pembangkit's gypsum as a high-quality, locally sourced, and ESG-compliant substitute to imported material. The marketing mix (4Ps) was also defined. The Product offered is high-quality FGD gypsum that meets industrial specifications and is compliant with regulatory standards. The Price strategy leverages the material's low production cost to offer competitive rates that undercut imported gypsum. For Place, distribution is planned through direct channels with outsourced logistics to manage delivery and compliance. Lastly, Promotion will focus on B2B channels such as industrial forums, sustainability conferences, and targeted technical trials designed to build trust, validate product performance, and demonstrate long-term reliability.

This integrative strategy enables PT Sumatera Pembangkit to address both the supply-side and demand-side barriers while aligning its operations with national sustainability objectives. Furthermore, the commercialization of FGD gypsum offers a model for other coal-fired power plants facing similar waste management challenges, thus

contributing to Indonesia's broader circular economy agenda.

Research Limitations & Suggestions for Future Research

While this study offers practical insights into the strategic feasibility of FGD gypsum commercialization in coal-fired power plants, several limitations should be acknowledged. First, the analysis is based on a single case study of PT Sumatera Pembangkit, which may limit the generalizability of the findings to other power plants with different operational scales, regulatory environments, or waste compositions. Second, the financial analysis employs projected estimates and conservative assumptions based on limited historical data, which may be sensitive to market fluctuations in raw material prices, transportation costs, and regulatory changes. Third, while survey and interview responses provide directional insights into customer perception, the sample size remains limited and may not capture the full spectrum of views across all relevant stakeholders, particularly smaller manufacturers and regional distributors.

Additionally, the study does not account for potential future innovations in gypsum utilization technology, nor does it model broader systemic impacts such as lifecycle emissions reduction or regional economic development. These limitations highlight the need for more diverse and data-rich analyses to fully capture the implications of industrial by-product commercialization.

Future research can build on this study by expanding the empirical scope and methodological depth. A multi-case study approach involving several coal-fired power plants across different regions in Indonesia could offer comparative insights and improve generalizability. Additionally, future studies could incorporate lifecycle assessment (LCA) and environmental impact analysis to quantify the broader sustainability contributions of FGD gypsum commercialization, particularly in terms of carbon footprint reduction and resource conservation. On the market side, discrete choice modeling or conjoint analysis could help quantify industrial buyers' preferences and trade-offs when considering alternative gypsum sources.

Finally, future studies could explore downstream innovation by assessing how FGD gypsum can be integrated into new product development in construction or agriculture, opening new revenue pathways beyond traditional cement applications. Such research would further strengthen the economic and environmental case for industrial waste commercialization in Indonesia and other emerging economies

REFERENCES

Boardman, A. E., Greenberg, D. H., Vining, A. R., & Weimer, D. L. (2018). Cost-Benefit Analysis: Concepts and Practice (5th ed.). Cambridge University Press.

Chatterjee, A. K. (2019). Gypsum utilization in the cement industry. Cement and Concrete Research, 124, 105849.

Ghisellini, P., Cialani, C., & Ulgiati, S. (2016). A review on circular economy: The expected transition from a linear economy to a circular one. Journal of Cleaner Production, 114, 11–32.

Grant, R. M. (2019). Contemporary Strategy Analysis (10th ed.). Wiley.

Kotler, P., & Keller, K. L. (2022). Marketing Management (15th ed.). Pearson.

Robinson, P.J., Faris, C.W. & Wind, Y. (1967). Industrial Buying and

Creative Marketing. Boston: Allyn and Bacon.

Zhang, Y., Li, J., & Chen, M. (2021). Reutilization of FGD gypsum in construction materials: A review. Construction and Building Materials, 273, 121697.