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ASSESSMENT OF GREENHOUSE GAS (GHG) EMISSION LEVELS IN THE COAL MINING SERVICES SECTOR AT PT ANTAREJA MAHADA MAKMUR

Deni Rahman Saputra*, Anton Triwibowo, Haris Fadhillah Batubara
PT. AMM Site Mifa Bersaudara, Indonesia
e-mail: denirahman@amm.id anton@amm.id haris.batubara@ppa.co.id

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ABSTRACT

The mining industry has a major influence on the increase in greenhouse gas (GHG) emissions in Indonesia, especially deforestation activities and the use of fossil energy. This makes it important to study the level of greenhouse gas emissions of a mining company so that it can determine the mitigation of reducing GHG emissions released. The research aims to assess the greenhouse gas emission levels in the coal mining services sector at PT Antareja Mahada Makmur. The study provides valuable insights into the environmental impact of coal mining activities, which is crucial for informing sustainable practices and regulatory compliance. The results of this analysis show a significant increase in total A2B and stationary sources (generators) from October 2023 to September 2024 as a source of immobile emissions. The analysis shows that carbon dioxide (CO2) gas is the most dominant component in total emissions from mobile sources (A2B). The findings of this study highlight the importance of mitigation efforts, such as improving energy efficiency and the integration of renewable energy sources, in reducing emissions in the mining sector. This research could help identify gaps and propose improvements to support companies in their mitigation efforts.

INTRODUCTION

PT Antareja Mahada Makmur is one of the mining service contractors operating in coal mining. In general, mining activities are activities that have a high level of risk and are capital-intensive. Open pit mining activities, especially coal, are currently a support in fulfilling national energy sources (Baskoro et al., 2021; Lechner et al., 2016; Mujiyanto & Tiess, 2013). Data from the Ministry of Energy and Mineral Resources noted that 54.58% of the electrical energy supply in Indonesia still depends on coal-fired power plants until 2023 (Kementerian Energi dan Sumber Daya Alam, 2024). On the other hand, in the energy sector, which includes coal mining activities, it also contributes to greenhouse gas emissions of 17,197.77 Gg Ton CO2 nationally based on data from the Ministry of Environment and Forestry in 2023. Environmental problems such as air, water, and soil pollution as well as social conflicts are common in mining activities. Nationally, the highest greenhouse gas emissions in the energy sector were achieved in 2014 with total GHG emissions reaching 614,215.45 tons CO2e.

The mining industry has a major influence on the increase in greenhouse gas (GHG) emissions in Indonesia, especially deforestation activities and the use of fossil energy. Mining companies need to inventory GHG to find out the source and amount of emissions produced, so as to develop more effective strategies to reduce the amount of GHG emissions (Aulay et al., 2024; Azadi et al., 2020; Cox et al., 2022; Ulrich et al., 2020; Valderrama et al., 2020). Coal mining activities are one of the capital-intensive, high-tech, and high-risk activities, so it is necessary to plan activities to achieve optimal productivity

(Koroteev & Tekic, 2021; Li, 2024; Syaputra et al., 2024; Toledano et al., 2022; Xu et al., 2020; Zhao et al., 2023).

In the extraction industry in general, it consumes a very large amount of energy and is a contributor to greenhouse gas emissions (Lamb et al., 2021; Talaei et al., 2020; Wang & Azam, 2024; Zheng et al., 2023). Since the pre-industrial era, the types of greenhouse gas emissions from human activities that have experienced an increase in concentration include CO2, CH4, and N2O (Sonwani & Saxena, 2022). Greenhouse gases are collections of gases that have active radiation properties and can absorb long-wave radiation released from the earth's surface (Bilgili et al., 2024; Maji et al., 2022; Smirnov, 2020). This makes it important to study the level of greenhouse gas emissions of a mining company so that it can determine the mitigation of reducing greenhouse gas emissions released.

The research aims to assess the greenhouse gas (GHG) emission levels in the coal mining services sector at PT Antareja Mahada Makmur. The research contributes to the understanding of greenhouse gas (GHG) emissions within the coal mining services sector, specifically at PT Antareja Mahada Makmur. By assessing emission levels, the study provides valuable insights into the environmental impact of coal mining activities, which is crucial for informing sustainable practices and regulatory compliance. This assessment can help identify key emission sources, enabling the company to develop targeted strategies for reducing GHG emissions and improving overall environmental performance. Additionally, the findings may serve as a benchmark for other companies in the sector, fostering a broader awareness of the need for emissions monitoring and mitigation in coal mining operations. Ultimately, this research supports the transition towards more sustainable energy practices and contributes to the global effort to combat climate change.

METHODS

The method used in calculating GHG emissions in this journal follows the Intergovernmental Panel on Climate Change (IPCC) in 2006 Chapter 3 Mobile Combustion & Chapter 2 Stationary Combustion because it is in accordance with the availability of data owned by the company. The type of fuel used is B35 with a composition of 35% FAME and 65% Solar. In general, the calculation of GHG emissions for mobile and immobile source emissions uses the following basic formula approach:

$$\text{Greenhouse gas emission (Tonne)} = \text{DA (TJ)} \times \text{FE (Kg/TJ)}$$

Information:

GHG emissions: Emissions from the type of energy used

Activity Data (DA): Total energy consumption

Emission Factor (FE): A specific type of GHG emission factor according to the energy used

From this calculation, GHG emissions will be equalized to tons of CO2e by multiplying each type of gas by the value of the Global Warming Potential (GWP) factor. In this journal, GHG emissions are aggregated into tons of CO2 equivalent through the multiplication between the emissions of each greenhouse gas produced by the value of the Global Warming Potential (GWP) factor. The value of the GWP factor used to equalize each GHG to CO2e refers to the IPCC Six Assessment Report (AR6) over a period of 100 years.

Table 1. Factors used in the calculation

No	Description	Value	Reference
		Solar	
1	Density	910 Kg/m3	Journal of Lemigas, 2011
2	Net Calorific Value (NCV)	42.12 Tj/Gg	Energy and Mineral Resources R&D Results 2017
3	CO2 emission factors	73,900 kg/tj	Energy and Mineral Resources R&D Results 2017
4	CH4 emission factors	3.90 Kg/TJ	IPCC, 2006 Table 3.2.2
5	N2O emission factors	3.90 Kg/TJ	IPCC, 2006 Table 3.2.2
		FAME	
1	Density	875 Kg/m3	Lemigas Journal, 2021
2	Net Calorific Value (NCV)	27 Tj/Gg	IPCC 2006 Table 1.2

3	CO2 emission factors	70,800 kg/tj	IPCC, 2006 Table 3.2.1
4	CH4 emission factors	3.00 Kg/TJ	IPCC, 2006 Table 2.2
5	N2O emission factors	0.60 kg/tj	IPCC, 2006 Table 2.2

RESULTS

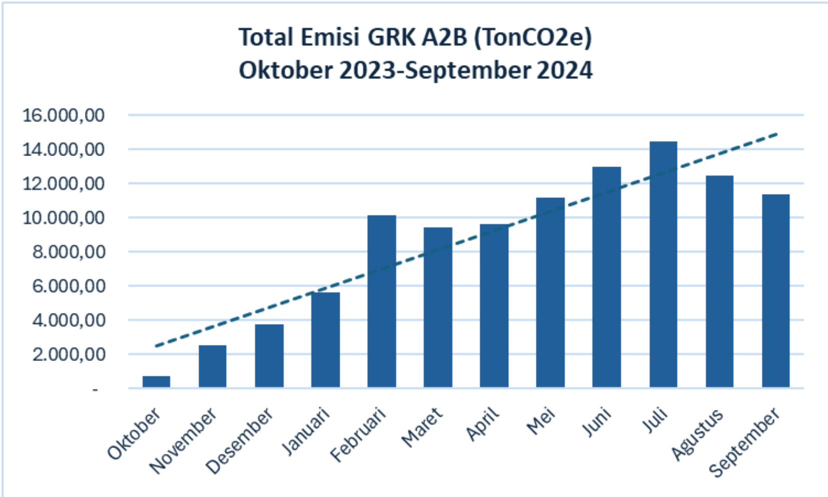

Figure 1. Total A2B Greenhouse Gas Emissions Every Month October 2023 – September 2024

The fuel used in operational activities is in the form of B35 type fuel oil. Figure 1. The above shows a significant upward trend in total A2B greenhouse gas (GHG) emissions from October 2023 to September 2024 from mobile emission sources. Mobile emission sources from A2B operational activities are included in Scope-1 (Scope-1). There has been a fairly sharp month-on-month increase, with the highest peak in July, followed by slight declines in August and September, but the overall uptrend is still dominant. This increase in emissions indicates an increase in the use of A2B for production operations.

The source of the increased GHG emissions is categorized as Scope-1 emissions, which come directly from the company's operational activities. This shows that production activities that use A2B as the main source contribute the most to the increase in GHG emissions. The sharp month-on-month increase in emissions, especially in July, indicates a significant peak period of production activity for the environment.

The overall emissions trend is still up, despite monthly variations, with slight declines in August and September after peaking in July. Factors such as seasonal changes, unstable production levels, or energy efficiency efforts undertaken over a period of time can affect these fluctuations. However, the continued upward trend shows that mitigation efforts have not been enough to stop the increase in emissions.

The use of B35 fuel causes an increase in greenhouse gas (GHG) emissions. Excessive emissions cause climate change, global warming, and other adverse effects, such as sea level rise, extreme weather, and ecosystem damage. As a result, to switch to greener and more sustainable energy sources and reduce reliance on fossil fuels, more serious action is needed.

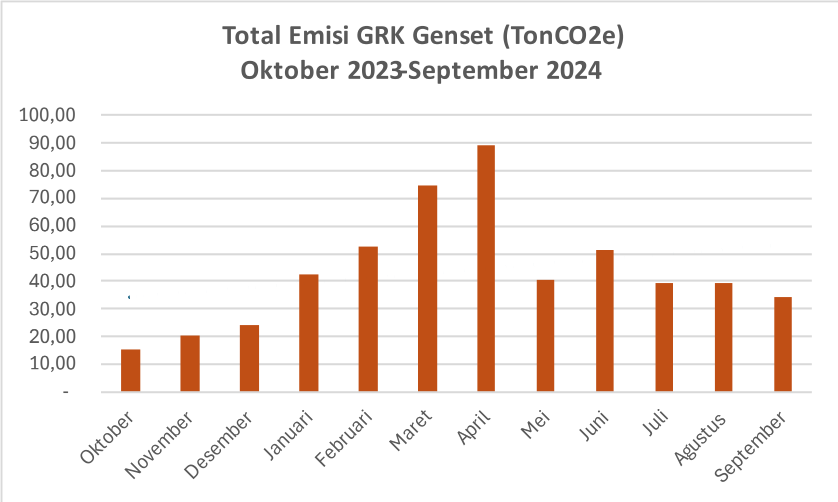

Figure 2. Total Generator Greenhouse Gas Emissions Every Month October 2023 – September 2024

Graph in Figure 2. Indicates an increasing trend in total Greenhouse Gas (GHG) emissions from generators from October 2023 to September 2024 as a source of immobile emissions. There are significant fluctuations from month to month, with the highest emissions peaking in April. Overall, there was a tendency to increase GHG emissions from generators throughout the observation period, although the rate of increase was inconsistent. This increase in emissions indicates an increase in the use of generators that have the potential to contribute to climate change.

The highest peak in emissions was recorded in April, indicating an increased level of activity that requires generators to generate energy. Changes in energy demand during the summer, disruptions to the main power grid, or increased production activity are some of the sources of these fluctuations. Despite the fluctuations, the overall trend of increasing GHG emissions from generators remained evident throughout the observation period.

The increase in greenhouse gas (GHG) emissions from these generators has a significant impact on the environment. Generator sets use fossil fuels, such as gasoline or diesel, which release many greenhouse gases into the atmosphere when burned. The increase in greenhouse gas emissions of generator sets is causing the greenhouse effect and climate change to become more severe.

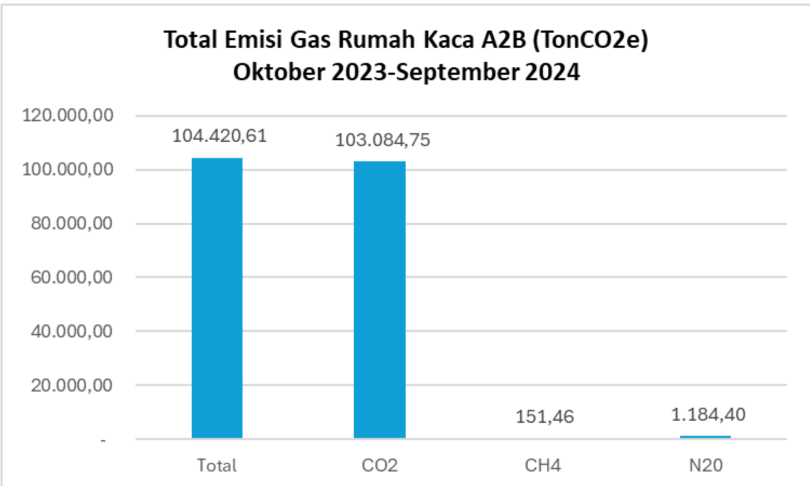

Figure 3. Total A2B Greenhouse Gas Emissions by Type October 2023 – September 2024

Graph data Figure 3. shows the total emissions of A2B type Greenhouse Gases (GHGs) in tons of CO2e (carbon dioxide equivalent) for the period October 2023 to September 2024. There are three types of emissions presented, namely total emissions, CO2 emissions, CH4, and N2O. Total emissions were dominated by CO2 in almost the same amount for both periods shown. CH4 and N2O emissions are much smaller compared to CO2 and total emissions. This data indicates that most of the A2B GHG emissions come from carbon dioxide gas.

The results of data analysis show that carbon dioxide (CO2) gas is the main contributor to total A2B greenhouse gas emissions. The very high proportion of CO2 emissions compared to other greenhouse gases such as methane (CH4) and nitrous oxide (N2O) suggests that most of the emissions come from processes that produce CO2. Factors such as the burning of fossil fuels, the decomposition of organic matter, or by-products of burning fossil fuels.

All A2B GHG emissions were relatively stable throughout the observation period, as shown in the graph. The overall trend shows the same trend, although there are some monthly fluctuations. Overall, this stability of emissions suggests that mitigation efforts may have been successful in preventing emissions levels from increasing significantly. Nonetheless, further analysis is needed to find components that affect the stability of these emissions.

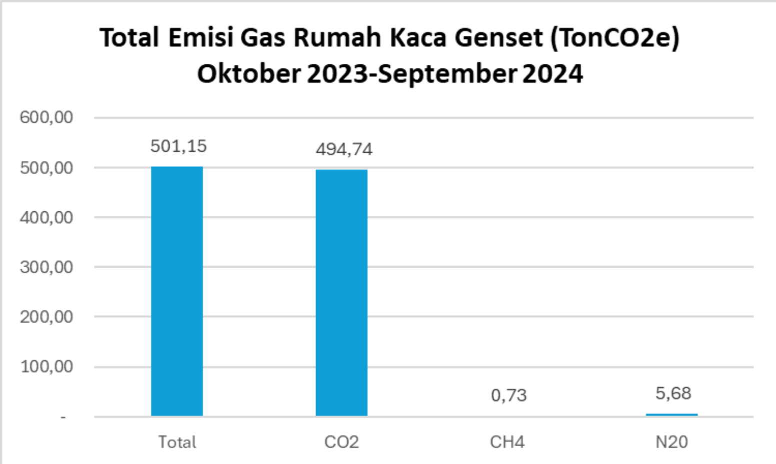

Figure 4. Total Greenhouse Gas Emissions of Generator Sets by Type October 2023 – September 2024

Meanwhile, the composition of GHG gas types from generator sets shows that the largest contribution to total GHG emissions comes from CO2 emissions, followed by CH4 and N2O in much smaller amounts. The dominance of CO2 emissions indicates that the process of burning fossil fuels in generator sets is the main source of GHG emissions. Relatively small fluctuations in total emissions and their components over the observation period indicate relatively stable emission levels.

The results of the analysis of the composition of greenhouse gases (GHGs) produced by generators show that carbon dioxide (CO2) is the most dominant component. This is in line with the common understanding that the burning of fossil fuels, which is commonly used in generator sets, produces CO2 as a major by-product. Thus, the dominance of CO2 in GHG emissions from generators suggests that most of the generators' contribution to climate change comes from these greenhouse gas emissions.

According to data collected from generators during the observation period, there was a relatively small variation in the total amount of emissions and their components; This shows that the level of GHG emissions of generator sets tends to be stable during that period. Various factors, such as the type of fuel used, combustion efficiency, and generator set workload, can affect the stability of these emissions.

Mitigating greenhouse gas emissions in the mining sector is an important step in addressing climate change as the process of burning fossil fuels, blasting, and processing minerals is the main source of greenhouse gas emissions. Some mitigation methods that can be used are as follows:

1) First, energy efficiency. In the production process, it can reduce energy consumption by optimizing energy use. This can be achieved through the use of more efficient equipment, the implementation of better control systems, and the use of renewable energy such as wind or solar instead of fossil energy sources.
2) Second, effective waste management. If mining waste is not managed properly, and contains harmful chemicals so that it can release greenhouse gases. By using appropriate waste management techniques, such as liquid and solid waste treatment, as well as reclamation of land that has been used as mines, greenhouse gas emissions can be reduced. Third, the adoption of low-carbon technology. Technologies such as carbon capture and storage (CCS) can help capture and store carbon dioxide before it is released into the atmosphere.

To achieve effective emission mitigation, not only technical efforts are needed, but also a broader approach. Governments, mining companies, and communities must work together to create policies and regulations that support efforts to reduce emissions. Investments also need to be made in research and development of new technologies to continue to find innovative solutions to address climate change issues. By implementing various mitigation strategies in an integrated manner, the mining sector can achieve sustainable development goals and reduce the impact of climate change. Mitigating greenhouse gas emissions in the mining sector can generate economic benefits for companies in addition to benefiting the environment. Mining companies can reduce operational costs and increase competitiveness by improving energy efficiency and implementing new technologies. Companies can also gain a good reputation as a socially and environmentally responsible business, which attracts investors and customers alike.

Mitigation of greenhouse gas emissions is an environmental obligation but also an opportunity for mining companies to generate large economic benefits. Reduced operational costs are one of the most obvious advantages. Companies can significantly reduce fossil fuel and electricity consumption by optimizing energy use at every stage of the production process, from mining to processing. This goal can be achieved significantly by using energy-efficient technologies, such as more efficient control systems, appliances that have lower energy consumption, and LED lights.

Reduced energy consumption can improve operational reliability and reduce fuel and electricity bills. Companies can reduce the risk of production disruptions caused by unstable energy supplies by reducing their reliance on variable external energy sources. High energy efficiency can also lower the maintenance frequency and life of the equipment, thereby reducing maintenance costs.

In the long run, investments in energy efficiency can provide very attractive returns. While it requires a sizable initial investment, the operational cost savings resulting from improved energy efficiency can quickly offset the cost of that investment. In addition, companies can also obtain indirect benefits such as improving the company's reputation in the eyes of investors, customers, and the public. Thus, mitigating greenhouse gas emissions is not only an environmental obligation, but also a smart investment that can increase a company's profitability in the long run.

CONCLUSION

Data analysis indicates a significant rise in greenhouse gas (GHG) emissions from both mobile and stationary sources, predominantly due to CO2 emissions from fossil fuel combustion. Monthly fluctuations in emissions suggest various influencing factors, underscoring the necessity for mitigation efforts, such as enhancing energy efficiency and adopting renewable energy. For mining companies, implementing these strategies is essential not only for contributing to global climate change initiatives but also for achieving long-term benefits like reduced operational costs and improved reputations. Future research should focus on longitudinal studies to track emission trends, evaluate the effectiveness of mitigation strategies, conduct comparative analyses across sectors, explore technological innovations like carbon capture, assess economic and social impacts, analyze policy frameworks, and study organizational culture to promote sustainable practices.

REFERENCES

Aulay, P., Suwardi, H. W., Dyah, T. S., Putri, O., & Octaviana R. (2024). Perhitungan Emisi Gas Rumah Kaca dalam Kawasan Pertambangan. *Jurnal Pengelolaan Lingkungan Pertambangan*, *1*(1).

Azadi, M., Northey, S. A., Ali, S. H., & Edraki, M. (2020). Transparency on greenhouse gas emissions from mining to enable climate change mitigation. *Nature Geoscience*, *13*(2). https://doi.org/10.1038/s41561-020-0531-3

Baskoro, F. R., Takahashi, K., Morikawa, K., & Nagasawa, K. (2021). System dynamics approach in determining coal utilization scenario in Indonesia. *Resources Policy*, *73*. https://doi.org/10.1016/j.resourpol.2021.102209

Bilgili, M., Tumse, S., & Nar, S. (2024). Comprehensive Overview on the Present State and Evolution of Global Warming, Climate Change, Greenhouse Gasses and Renewable Energy. *Arabian Journal for Science and Engineering*, *49*(11), 14503–14531. https://doi.org/10.1007/s13369-024-09390-y

Cox, B., Innis, S., Kunz, N. C., & Steen, J. (2022). The mining industry as a net beneficiary of a global tax on carbon emissions. *Communications Earth and Environment*, *3*(1). https://doi.org/10.1038/s43247-022-00346-4

Kementerian Energi dan Sumber Daya Alam. (2024). *Statistik Ketenagalistrikan 2023*.

Koroteev, D., & Tekic, Z. (2021). Artificial intelligence in oil and gas upstream: Trends, challenges, and scenarios for the future. *Energy and AI*, *3*. https://doi.org/10.1016/j.egyai.2020.100041

Lamb, W. F., Wiedmann, T., Pongratz, J., Andrew, R., Crippa, M., Olivier, J. G. J., Wiedenhofer, D., Mattioli, G., Khourdajie, A. Al, House, J., Pachauri, S., Figueroa, M., Saheb, Y., Slade, R., Hubacek, K., Sun, L., Ribeiro, S. K., Khennas, S., De La Rue Du Can, S., … Minx, J. (2021). A review of trends and drivers of greenhouse gas emissions by sector from 1990 to 2018. *Environmental Research Letters*, *16*(7). https://doi.org/10.1088/1748-9326/abee4e

Lechner, A. M., Kassulke, O., & Unger, C. (2016). Spatial assessment of open cut coal mining progressive rehabilitation to support the monitoring of rehabilitation liabilities. *Resources Policy*, *50*. https://doi.org/10.1016/j.resourpol.2016.10.009

Li, A. (2024). An Analysis of Optimal Decision on Capital Structure. *Highlights in Business, Economics and Management*, *28*, 178–183. https://doi.org/10.54097/pmtbfg41

Maji, S., Ahmed, S., & Ghosh, S. (2022). Source Apportionment of Greenhouse Gases in the Atmosphere. In *Greenhouse Gases: Sources, Sinks and Mitigation*. https://doi.org/10.1007/978-981-16-4482-5_2

Mujiyanto, S., & Tiess, G. (2013). Secure energy supply in 2025: Indonesia's need for an energy policy strategy. *Energy Policy*, *61*. https://doi.org/10.1016/j.enpol.2013.05.119

Smirnov, B. M. (2020). Greenhouse Phenomenon in the Earth's Atmosphere. In *Global Atmospheric Phenomena Involving Water* (pp. 153–203). Springer. https://doi.org/10.1007/978-3-030-58039-1_6

Sonwani, S., & Saxena, P. (2022). Introduction to Greenhouse Gases: Sources, Sinks and Mitigation. In *Greenhouse Gases: Sources, Sinks and Mitigation*. https://doi.org/10.1007/978-981-16-4482-5_1

Syaputra, R., Alfianita, L., & Andriansyah, R. (2024). Coal Mining Activities: Case Study of Pit Elang, Muara Enim Regency, South Sumatra . *Jurnal Teknologi Pertambangan Dan Geosains*, *1*(1).

Talaei, A., Gemechu, E., & Kumar, A. (2020). Key factors affecting greenhouse gas emissions in the Canadian industrial sector: A decomposition analysis. *Journal of Cleaner Production*, *246*. https://doi.org/10.1016/j.jclepro.2019.119026

Toledano, P., Ramdoo, I., Cosbey, A., & Geipel, J. (2022). New Tech, New Deal: Mining Policy Options in the Face of New Technology. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.4045058

Ulrich, S., Trench, A., & Hagemann, S. (2020). Greenhouse gas emissions and production cost footprints in Australian gold mines. *Journal of Cleaner Production*, *267*. https://doi.org/10.1016/j.jclepro.2020.122118

Valderrama, C. V., Santibanez-González, E., Pimentel, B., Candia-Véjar, A., & Canales-Bustos, L. (2020). Designing an environmental supply chain network in the mining industry to reduce carbon emissions. *Journal of Cleaner Production*, *254*. https://doi.org/10.1016/j.jclepro.2019.119688

Wang, J., & Azam, W. (2024). Natural resource scarcity, fossil fuel energy consumption, and total greenhouse gas emissions in top emitting countries. *Geoscience Frontiers*, *15*(2). https://doi.org/10.1016/j.gsf.2023.101757

Xu, X. L., Shen, T., Zhang, X., & Chen, H. H. (2020). The role of innovation investment and executive incentive on financial sustainability in tech-capital-labor intensive energy company: Moderate effect. *Energy Reports*, *6*. https://doi.org/10.1016/j.egyr.2020.09.011

Zhao, F., Meng, T., Wang, W., Alam, F., & Zhang, B. (2023). Digital Transformation and Firm Performance: Benefit from Letting Users Participate. *Journal of Global Information Management*, *31*(1). https://doi.org/10.4018/JGIM.322104

Zheng, X., Lu, Y., Ma, C., Yuan, J., Stenseth, N. C., Hessen, D. O., Tian, H., Chen, D., Chen, Y., & Zhang, S. (2023). Greenhouse gas emissions from extractive industries in a globalized era. *Journal of Environmental Management*, *343*. https://doi.org/10.1016/j.jenvman.2023.118172