ASSESSMENT OF EXHAUST GAS EMISSION IMPACTS ON AIR QUALITY SURROUNDING PT PLN NUSANTARA POWER, NAGAN RAYA

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Abstract
Air pollution is an environmental issue that has a broad impact on human health and ecosystem balance. PT PLN Nusantara Power UP Nagan Raya as a coal-fired steam power plant (PLTU) has the potential to produce exhaust emissions that can reduce air quality in the surrounding area. This study aims to assess the impact of exhaust emissions on ambient air quality in organizations around the PLTU. The study uses a quantitative descriptive approach by measuring several air pollutant parameters, namely SO_2, NO_2, CO, O_3, NMHC, PM_{10}, $PM_{2.5}$, and Pb at the UA-1 observation point located east of the PLN Nusantara Power, then compared with ambient air quality standards based on PP No. 22 of 2021. The measurement results show that all pollutant parameters are still below the national air quality standard threshold, including SO_2 <33.438 µg/m³, NO_2 <6.143 µg/m³, CO 2298.91 µg/m³, PM_{10} 22.80 µg/m³, and $PM_{2.5}$ 16.11 µg/m³. This indicates that at the time of the measurement, coal burning activities at the PLN Nusantara Power had not had a significant impact on air quality in surrounding organizations. However, continuous monitoring is still needed to ensure air quality remains safe and prevent potential long-term health risks.
Keywords: Assessment, exhaust emissions, air quality, PLN Nusantara Power.

INTRODUCTION

Air pollution is an environmental issue that remains a global concern. Its impact is the release of greenhouse gases, which can increase the Earth's surface temperature. Furthermore, air pollution can impact productivity, harm the health of humans and other living things, and can be detrimental if it accumulates in the air at high concentrations (Shafwah, 2022). Gas emissions are the release of gases or certain substances into the atmosphere due to natural processes and human activities, such as the combustion of fossil fuels, industry, and transportation. These gases can include carbon dioxide (CO_2), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), and other particulates that have the potential to pollute the air and affect health and the environment (Lutfi et al., 2025).

PT. PLN Nusantara Power UP (Generation Unit) Nagan Raya is a company engaged in the field of Steam Power Plant (PLTU), the company began operating since 2013, and is located in Suak Puntong Village, Kuala Pesisir District, Nagan Raya Regency. This uses coal as fuel to produce steam, where this steam will be used to rotate a steam turbine that has been coupled with an electric generator to produce electricity. The electricity produced is then distributed to various points of the body spread throughout Aceh and North Sumatra through high-voltage air lines. PT. PLN Nusantara Power UP strives to protect the environment by controlling air pollution from exhaust emissions. Air quality monitoring is conducted routinely to ensure regulatory compliance and assess the impact of emissions. This process is mandatory for companies that produce air pollutants. To achieve this, a Continuous Emission Monitoring System (CEMS) is used. This tool continuously measures emission levels and flow rates (Damanik, 2025).

However, coal combustion in power plants still remains one of the largest contributors to atmospheric pollutants, especially SO_2, NO_2 and particulate matter, which can trigger respiratory disorders, acid rain, and decrease visibility (Huda, 2024).

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Therefore, monitoring ambient air quality around power plants is essential to ensure that pollutant emissions do not exceed established environmental thresholds and to protect surrounding communities from potential health risks.

Based on the Regulation of the Minister of Environment and Forestry of the Republic of Indonesia Number 13 of 2021, every business and/or activity that is required to monitor emissions using the Continuous Emission Monitoring System (CEMS) is required to integrate its emission monitoring into the Continuous Industrial Emission Monitoring Information System (SISPEK). The Ministry of Environment and Forestry (KLHK) targets that power generation companies must integrate their CEMS into the Continuous Industrial Emission Monitoring Information System (SISPEK) by June 2022 at the latest, while to carry out this integration the company needs to provide a larger cost. Currently, PT. Indonesia Power Grati POMU has only integrated 1 (one) of its 8 (eight) HRSGs into the KLHK in the Continuous Industrial Emission Monitoring Information System (SISPEK), namely HRSG 2.3 which is in block 2 (two).

Previous research conducted by (Rizki, 2023) found that PT PLN Nusantara Power UP Nagan Raya is a major contributor to greenhouse gas emissions that cause climate change. Emissions resulting from coal combustion at PT PLN Nusantara Power UP Nagan Raya, such as carbon dioxide, contribute significantly to global warming and impact human health and the environment. The next previous study is (Wakhid, 2018) The results of the study show that the air quality at UIN Raden Intan Lampung is still good with stored carbon reserves of 3805,760 (Ton/year) so that exhaust emissions from motor vehicles at UIN Raden Intan Lampung can be absorbed completely.

METHODS

This study uses a quantitative descriptive approach to assess and analyze the impact of exhaust emissions on air quality around PT PLN Nusantara Power, Nagan Raya. This method was carried out by measuring the concentrations of several air pollutant parameters generated from power generation activities and then comparing them to ambient air quality standards stipulated by Government Regulation of the Republic of Indonesia Number 22 of 2021 concerning the Implementation of Environmental Protection and Management. The research was conducted in the area surrounding PT PLN Nusantara Power, Nagan Raya Regency, Aceh. Data were collected at several observation points representing the dominant wind directions (upwind and downwind) from the emission source. The research period was July to September 2024. Pollutant parameters tested include:

Table 1. Pollutant parameters tested

No	Parameter Uji
1	Sulfur Dioksida (SO_2)
2	Karbon Monoksida (CO)
3	Nitrogen Dioksida (NO_2)
4	Oksidan Fotokimia (O_x) as Ozon (O_3)
5	Hidrogen Non Metana (NMHC)
6	Dust Particulates < 100µm (NMCH)
7	Dust Particulates <10µm (PM10)
8	Dust Particulates < 2,5 µ
9	Timbal (PB)

Measurement results were compared with the National Ambient Air Quality Standards (PP No. 22 of 2021). Interpretation of pollution levels was carried out using a descriptive approach.

RESULTS AND DISCUSSION

Several air pollutant parameters measured include major pollutant gases resulting from coal combustion such as sulfur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), photochemical oxidants (as O_3), non-methane hydrocarbons (NMHC), respirable particulates (PM_{10} and $PM_{2.5}$), and the heavy metal contaminant Lead (Pb) (Romansyah, 2019). All of these parameters are pollutants that have the potential to affect air quality and impact public health, especially the respiratory system. Measurements were conducted using instruments that comply with the Indonesian National Standard (SNI), and the results were then compared with the national ambient air quality standards based on Government Regulation Number 22 of 2021. This comparison was used to assess the level of air quality safety and to evaluate any indications of pollution due to PLTU exhaust emissions.

Table 2. Air Quality Measurement Results

No	Test Parameters	Results	Quality standards	Unit	Measurement Method
1	Sulfur Dioksida (SO_2)	<33,438	150	$\mu g/m^3$	SNI 19-7119.7-2-17
2	Karbon Monoksida (CO)	2298,91	10000	$\mu g/m^3$	22-044/IK/SMM-ASS (C0 meter)
3	Nitrogen Dioksida (NO_2)	<6,143	200	$\mu g/m^3$	SNI-7119-2:2017
4	Oksidan Fotokimia (O_x) Sebagai Ozon (O_3)	<21,403	150	$\mu g/m^3$	SNI 19-7119.8-2017
5	Hidrogen Non Metana (NMHC)	64,36	160	$\mu g/m^3$	SNI 7119.13:2009
6	Partilulat Debu < 100µm (NMCH)	23,98	230	$\mu g/m^3$	SNI 7119-3:2017
7	Partikulat Debu <10µm (PM10)	22,80	75	$\mu g/m^3$	SNI 7119-15:2016
8	Partikulat Debu < 2,5 µ	16,11	55	$\mu g/m^3$	SNI 7119-14:2016
9	Timbal (PB)	<0,0438	2	$\mu g/m^3$	SNI 7119-4:2017

Ambient air quality measurements around the Nagan Raya PLTU at point UA-1 indicate that all tested air pollutant parameters are below the quality standards stipulated in Government Regulation Number 22 of 2021 concerning the Implementation of Environmental Protection and Management. This indicates that coal combustion activities at the power plant have not had a significant negative impact on air quality in residential areas east of the PLTU. The measured concentrations of SO_2 (<33,438 µg/m³) and NO_2 (<6,143 µg/m³) are very low compared to the quality standards of 150 µg/m³ and 200 µg/m³, respectively. These two parameters are indicators of combustion quality and the efficiency of emission control equipment. The low levels of SO_2 and NO_2 indicate that the combustion process is relatively complete and that emission control technologies such as Flue Gas Desulfurization (FGD) and Low NOx Burners are functioning properly.

The respirable particulate matter parameters, namely PM_{10} (22.80 µg/m³) and $PM_{2.5}$ (16.11 µg/m³), also showed values significantly lower than the quality standards of 75 µg/m³ and 55 µg/m³, respectively. Particulate matter is a pollutant with a high potential to disrupt the human respiratory system. Because particulate matter is strongly influenced by wind direction and transportation activity, these low values indicate effective pollutant dispersion and minimal dust-generating activities around residential areas. Furthermore, the CO value (2298.91 µg/m³) was still well below the quality standard of 10,000 µg/m³, indicating no large-scale incomplete combustion phenomenon impacting the community. Other pollutant parameters such as O_3 (<21.403 µg/m³), NMHC (64.36 µg/m³), and Pb (<0.0438 µg/m³) are also at safe levels for health.

Furthermore, even though the measurement results show that the concentration of all pollutants is still below the quality standards, the potential for increased emissions can still occur if there is an increase in production capacity, meteorological conditions that are less conducive to the spread of pollutants, or a decrease in the performance of control equipment such as Electrostatic Precipitators (ESPs) and Flue Gas Desulfurization (FGD). Therefore, continuous air quality monitoring is still necessary as an early preventive measure to maintain environmental quality and public health around the PLTU area (Fahrizal & Subardono, 2017; Damanik, 2025). Consistent emission control efforts are also important to support the implementation of national regulations related to air pollution control and the commitment to reducing greenhouse gas emissions.

CONCLUSION

Test results showed that all air pollutant parameters measured around PT PLN Nusantara Power UP Nagan Raya were below government-set standards. This indicates that air quality at the location is still considered safe and does not pose a potential threat to public health, at least at the time the samples were taken.

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