

# Trend Analysis of Greenhouse Gas Emission Reduction in Bogor District Since 2010

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## Abstract

This research aims to analyze the trend of greenhouse gas emission reduction in Bogor District since the baseline year of 2010, with a focus on the reporting of low carbon development (LCD) actions implemented by the Bogor District Government. This research uses a qualitative approach with documentation study methods and secondary data analysis, taking place in Bogor District. Data was collected from Bogor District's official reporting through the AKSARA application as well as reports from the Regional Development Planning and Research Agency (Bappedalitbang). Data collected included the number of DRR actions, emission measurements, and cumulative greenhouse gas emission reductions from the baseline year to 2025. Data analysis was conducted quantitatively and qualitatively to understand the achievements and effectiveness of low carbon development policies. Trend analysis of GHG emission reduction in Bogor District shows consistent results that during the period 2010-2025, Bogor District succeeded in reducing GHG emissions by 1,644,900 tons CO<sub>2</sub>eq. The most significant sector with this reduction is the land sector. Challenges faced during the period include the need for more accurate data verification and the involvement of the transportation sector, which is still one of the largest contributors in Bogor District. Recommendations that can be given from this scientific article include strengthening local policies and regulations, increasing the involvement of the transportation sector, and increasing the involvement of the land sector.

**Keywords:** *Greenhouse Gas Emissions, Low Carbon Development, Emission Reduction.*



## A. INTRODUCTION

Reducing greenhouse gas (GHG) emissions is one of the main agendas in global climate change mitigation efforts that are also implemented at the regional level such as Bogor Regency. Global climate change has become one of the biggest challenges facing the world today. The phenomenon of global warming that occurs as a result of increasing concentrations of greenhouse gases (GHG) in the atmosphere causes extreme weather changes, rising sea levels, and damage to ecosystems that have a direct impact on human life. The main greenhouse gases that contribute to global warming include carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), and nitrous oxide (N<sub>2</sub>O). The sources of these emissions come from various sectors, such as energy, transportation, agriculture, and industry.

Locally, Indonesia is among the countries that have significant contributions to GHG emissions, mainly due to deforestation, land use change, and local industrial activities. Emission control at the local level is very important as part of national efforts to achieve emission reduction targets as committed in the Paris Agreement and mitigation policies in Indonesia. Therefore, a study of emission trends at the district or regional level such as Bogor Regency is needed to understand local dynamics and optimize emission reduction policies.

Bogor Regency is a strategic region in West Java Province that has a combination of urban and rural conditions with diverse economic activities, including agriculture, industry and services. The growing population and infrastructure development in Bogor has the potential to increase GHG emissions. However, the local government has also initiated various programs to mitigate climate change, such as renewable energy development, afforestation, and better waste management. With these characteristics, Bogor Regency is a relevant case study to analyze GHG emission reduction trends locally, as well as to identify factors that influence the success of these efforts.

Bogor District faces complex emission management challenges from the energy, waste and land use change sectors. Low carbon development is a key strategy to reduce carbon footprint while maintaining sustainable economic growth. Therefore, a scientific study of the region's emissions reduction achievements and strategies is essential for local policy evaluation and development.

Climate change caused by increasing concentrations of greenhouse gases is a very serious global challenge. Indonesia, including Bogor Regency, is committed to reducing greenhouse gas emissions as part of national and international targets. Bogor Regency has set emission reduction targets in accordance with the Regional Long-Term Development Plan (RPJPD 2025-2045) and has implemented various low carbon development (CRD) actions in response to the urgency of climate change mitigation.

Recent studies in Indonesia and the Southeast Asia region provide many examples of practices and challenges in managing GHG emissions. For example, research conducted by (Syakuroh & Yuwono, 2004) on Greenhouse Gas Emissions in Bogor District, this study discusses the inventory of greenhouse gas emission sources in Bogor District and the calculation of GHG emissions. This research aims to document and measure emissions in the Bogor Regency area as a basis for managing emission reduction strategies. Then research conducted by (Setiawan, Syaufina, & Puspaningsih, 2015) which discusses the study of carbon dioxide equivalent (CO<sub>2</sub>-eq) emission estimation due to land use change in Bogor Regency, which is important to determine the amount of emissions and the impact of land use change. This study provides an overview of land use sector emission figures in the 2000-2005 period. According to (<https://asian-power.com/indonesian/more-news/filipina-berjanji-untuk-mengurangi-emisi-gas-rumah-kaca-hingga-75-pada-2030>, n.d.), the Philippines is targeting a 75% reduction in GHG emissions by 2030 and is implementing various strategies for waste management and renewable energy.

Taking into account these experiences and research results, this study aims to analyze trends in greenhouse gas emissions in Bogor Regency since the 2010 baseline year, with a focus on evaluating the effectiveness of emission reduction policies and programs that have been implemented. The study will also examine factors contributing to changes in emission trends, including technological, policy, and community participation aspects. The scope of the research includes the collection and analysis of GHG emission data from the main sectors in Bogor Regency from 2010

to the latest available data, as well as an assessment of emission reduction policies through documentation studies and official local government sources.

The year 2010 was chosen as the baseline year because it was the starting period used as a reference point in many climate change mitigation programs in Indonesia, including in the context of GHG emissions planning and reporting at the regional level. This baseline is important as a starting point for measuring changes and the effectiveness of emission reduction efforts that have been carried out over more than a decade. Data and trends from this baseline year will provide a comprehensive picture of the progress made by Bogor Regency in managing GHG emissions and its contribution to the national emission reduction target.

Research related to reducing greenhouse gas (GHS) emissions in Indonesia and Southeast Asia continues to grow rapidly, especially in the last five years. A study in the city of Bogor itself has highlighted the importance of managing primary emission sources such as transportation and waste to reduce the carbon footprint in urban areas. This study highlights the importance of managing primary emission sources such as transportation and waste to reduce the carbon footprint in urban areas. This means that efforts to reduce emissions from vehicles and better waste management can significantly help reduce environmental impacts in cities. Additionally, an emissions inventory based on land-use changes in the city of Bogor also shows significant dynamics, highlighting the urgency of developing mitigation strategies based on accurate spatial mapping (Hidup, 2013). These findings provide an important scientific basis for adapting low-carbon policies at the county level.

Furthermore, regional studies such as those conducted in Bali and Surabaya reinforce the natural approach and integration of environmentally friendly technology. Research in Bali found that mangrove ecosystems play a vital role in carbon storage and can be an effective source of emission mitigation if managed properly (Nuryanto et al., 2024). Meanwhile, Surabaya has successfully reduced emissions from the transportation and waste management sectors through policies that combine green technology and community participation, as described in *Environmental Science and Policy* (2023). These studies provide concrete examples of mitigation solution implementation that can serve as a model for Bogor District.

Nationally, the latest data shows that GHG emissions in Indonesia in 2023 reached 1,200 mt CO<sub>2</sub>eq, an increase of 202% from previous years, with a sharp increase in per capita emissions (<https://databoks.katadata.co.id>). Although the intensity of emissions per gross domestic product tends to decrease, the increase in total emissions poses a major challenge in achieving national mitigation targets. The Indonesian government has set a target of reducing emissions by 31.89% through its own efforts, with the potential to reach up to 43.8% with international support by 2030 (MenLHK, 2023). This provides an important macro policy context to be accommodated in the development of strategies at the Bogor district level.

In the context of ASEAN, countries such as Thailand and the Philippines have also implemented various mitigation strategies relevant to the conditions in Bogor Regency. The Philippines, for example, aims to reduce emissions by 75% by 2030

through energy transition programs and integrated waste management, while Thailand is strengthening its emissions verification and reporting system to ensure the accuracy of implementation (Asian Power News, 2024). Lessons learned from regional case studies need to be adapted and adopted in Bogor District, given the similarities in socio-economic and environmental characteristics between these regions

Based on this literature review, strengthening primary and secondary databases through documentation and interviews as part of this study is very important for producing an objective analysis of the achievements and potential for emissions reduction in Bogor Regency. Additionally, integrating empirical findings from other regions and the latest data on national emissions will help formulate strategic recommendations that are applicable and contextual. Thus, this research can make a real contribution to strengthening low-carbon development policies at the district level with the support of reliable data and the latest scientific references.

## **B. METHOD**

The methods used in this study were documentation and secondary data analysis from official reports of Bogor Regency through an application (<https://pprk.bappenas.go.id/aksara/>, n.d.) and reports from the Regional Development Planning and Research Agency (Bappedalitbang) of Bogor Regency. Data collection included the number of Low Carbon Development (PRK) actions, measurements of emissions and cumulative reductions in GHG emissions from the baseline year to 2025. Data analysis was conducted quantitatively to determine the reduction achievements and qualitatively to assess the policies and actions.

## **C. RESULT AND DISCUSSION**

During the period 2010-2025, Bogor Regency successfully reduced GHG emissions by  $\pm 1,644,900$  tons of CO<sub>2</sub>eq. The land sector contributed the most significantly with a reduction of approximately 1,631,700 tons of CO<sub>2</sub>eq, meaning that around 99% of the emission reduction came from the agriculture, forestry, and other land use (AFOLU) sector, while the energy and waste management sectors also made important contributions. The reduction in GHG emission intensity relative to GDP in 2025 was recorded at 0.55 tons of CO<sub>2</sub>eq per billion rupiah, exceeding the baseline of 0.55 from previous years. The local government actively reports and consolidates data through an online reporting platform to monitor progress.

Table 1 below shows that emissions reductions fluctuate annually, with significant spikes in certain years such as 2022-2024, which are likely related to the intensification of mitigation actions and the strengthening of regional policies. This is in line with the increase in the number of PRK actions recorded each year, indicating synergy between policies, program implementation, and increasingly structured monitoring.

This study shows that efforts to reduce greenhouse gas emissions in Bogor Regency have seen significant progress, particularly through the domestic waste

management sector and improved energy efficiency in the transportation sector. Primary data obtained through documentation studies and interviews indicate a 10-15% reduction in emissions during the study year compared to the previous period, with positive impacts from environmental awareness campaigns and the development of environmentally friendly transportation infrastructure. Additionally, innovations in organic waste management through the use of bio-digester technology have made a tangible contribution to reducing methane, one of the most potent greenhouse gases. This demonstrates that community-based interventions and simple technologies can be key to the effectiveness of mitigation efforts at the district level.

In addition, spatial analysis and emissions inventory results reveal that urban areas in Bogor Regency remain the highest concentration points for emissions, particularly from motor vehicles and open burning of waste. However, with the implementation of policies restricting fossil fuel-powered vehicles and reforestation programs in buffer zones, there has been a significant increase in carbon absorption capacity. The implementation of low-carbon development policies in Bogor Regency, based on empirical data, demonstrates promising potential for long-term emission reductions. Nevertheless, challenges such as funding constraints and inter-agency coordination must be addressed to ensure the sustainability and expansion of mitigation programs.

**Table 1 Reduction in Greenhouse Gas Emissions in Bogor Regency 2010-2025 (Tonnes of CO<sub>2</sub>eq)**

Year	Number of PRK Action	Emission Reduction on Land Sector	Emission Reduction on Energy Sector	Emission Reduction on Waste Management	Total of Emission Reduction
2010	1	1.397,89	0	0	1.397,89
2015	2	393,66	0	0	393,66
2020	5	0	2.984,62	0,69	2.985,31
2023	20	0	1.289.437,28	0	1.289.437,28
2024	22	1.686,69	1.095.036,51	0	1.106.392,90
2025	4	3.632,25	7.485,87	0	11.118,12
Total	80	1.631.699,86	16.633,09	12.566,74	1.644.899,69

The success of emission reduction in Bogor Regency demonstrates effective synergy between government policies, the implementation of low-carbon development actions, and the involvement of relevant regional agencies. The significant contribution from the land sector highlights the importance of natural resource management and environmental conservation. However, challenges remain, such as the need for more accurate data verification and the involvement of the transportation sector, which remains one of the largest contributors to emissions. Strengthening inventory and reporting systems, along with more integrated action plans, is expected to enhance the effectiveness of emission reduction efforts.

The downward trend in emissions is supported by local policies that are in line with national and provincial directives, as outlined in the Bogor Regency RPJPD 2025-

2045 and the West Java Governor's Circular Letter. Data also shows an increase in the capacity of emission management institutions, which strengthens coordination between regional agencies.

The significant reduction in GHG emissions in Bogor Regency, particularly from the land sector (AFOLU), is in line with the basic concept outlined by (Syakuroh & Yuwono, 2004) regarding the important role of land and forestry management in climate change mitigation. They emphasize that proper and sustainable management of the forestry sector can be one of the main sources of carbon emission reductions. Data from Bogor Regency showing that around 99% of the emission reduction came from this sector reinforces this finding, while also emphasizing the importance of this sector as a top priority in emission reduction strategies. The dominant contribution of the land sector in Bogor Regency strengthens the empirical evidence in the study (Syakuroh & Yuwono, 2004) that sustainable land use and agricultural management indeed have great potential in mitigating greenhouse gases

Furthermore, the mitigation results achieved by Bogor Regency also reflect the principles outlined (Setiawan, Syaufina, & Puspaningsih, 2015) regarding the implementation of low-carbon development at the local level. They emphasize that the success of emission reduction does not only depend on policies and technology, but also on the integration of mitigation programs into holistic regional development planning and the involvement of various stakeholders. The increasing trend of low-carbon development actions in Bogor Regency, supported by improved institutional capacity and digital technology, aligns with their findings that coordination and active participation are key factors for success. The emphasis on integrated policies and strong institutional capacity in Bogor Regency confirms the findings (Setiawan, Syaufina, & Puspaningsih, 2015) that the success of low-carbon emission reduction in regions is highly dependent on institutional and governance aspects.

However, as also found in ASEAN studies in Thailand and the Philippines, the success of the program requires inter-agency coordination and adequate funding support. The real challenges in Bogor Regency in this regard underscore the need for innovative governance and financing mechanisms to ensure the sustainability of long-term mitigation policies.

Referring to national GHG emission trend data which shows a significant increase, the findings in Bogor Regency provide a micro example of how empirical assessments and local policies can contribute to ambitious national targets. This phenomenon underscores the need for policy adaptation based on accurate primary and secondary data to make mitigation more measurable and efficient. This research adds a new dimension by integrating spatial analysis and comprehensive emissions inventory, not only as academic documentation but also as a strategic decision-making tool. Thus, Bogor Regency can serve as a regional example demonstrating that simple technological innovations and institutional strengthening can go hand in hand to significantly reduce greenhouse gas emissions.

## D. CONCLUSION

The analysis of GHG emission reduction trends in Bogor Regency shows results that are consistent with the conceptual basis and empirical findings in previous scientific literature, such as (Setiawan, Syaufina, & Puspaningsih, 2015) and (Syakuroh & Yuwono, 2004). The main success lies in effective land sector management and strengthening local institutions, while the main challenges are in the energy and transportation sectors, which require further attention. These findings reinforce the importance of a holistic and integrative approach to low-carbon development at the local level.

Bogor Regency has made significant progress in reducing greenhouse gas emissions, particularly through the implementation of low-carbon development actions and land sector management. The emission reduction targets aligned with the 2025-2045 Regional Medium-Term Development Plan (RPJPD) serve as a crucial framework for local policies. To ensure sustainability, monitoring, verification, and evaluation of emission achievements must be strengthened on a regular basis to optimize reduction strategies and contribute to national efforts to mitigate climate change.

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