

**THE INFLUENCE OF GREEN TECHNOLOGY INNOVATION,
RENEWABLE ENERGY CONSUMPTION AND MACROECONOMIC
VARIABLES ON ENVIRONMENTAL QUALITY IN INDONESIA**



THESIS

**SUBMITTED TO THE FACULTY OF ECONOMICS AND ISLAMIC
BUSINESS, UNIVERSITAS ISLAM NEGERI SUNAN KALIJAGA
YOGYAKARTA AS ONE OF THE REQUIREMENTS TO OBTAIN A
BACHELOR'S DEGREE IN ISLAMIC ECONOMICS**

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2025**

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Dear Dean of the faculty of Islamic Economics and Business
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Assalamualaikum Wr.Wb.

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It can be submitted to the Faculty of Islamic Economics and Business. Department/Sharia Economics Study Program, UIN Sunan Kalijaga Yogyakarta as one of the requirements to obtain a Bachelor of Science degree in the field of Islamic economics

With this, I hope that the thesis mentioned above can be submitted soon. I thank you for your attention

Yogyakarta, 14 December 2024

Acknowledge

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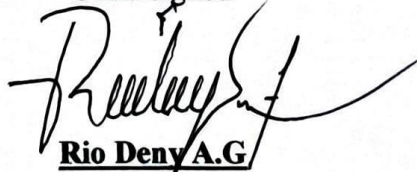
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MOTTO

“Live is not about who wins, but who dares to try”
Work Hard, Dream Big, Pray Hard, And Never Give Up



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ACKNOWLEDGMENT SHEET

With all gratitude, this thesis is dedicated to:

My beloved parents, Bapak and Ibuk

Who have been the light in my every step. Thank you for your never-ending prayers, sincere support, and irreplaceable love. All these achievements are the prove of the sacrifice and boundless love that you always give. May this work be my pride, be a small form of respect and gratitude for everything you have struggled for me.



PREFACE

Praise for the presence of Allah SWT who has given His grace and grace, so that the author is able to complete the final project entitled **“The Influence Of Green Technology Innovation, Renewable Energy Consumption And Macroeconomic Variables On Indonesia's Environmental Quality”**

May abundant blessings and peace be upon our Lord, Prophet Muhammad SAW. This thesis is written as part of the requirements to complete the Bachelor's degree in the Sharia Economics Study Program at the Faculty of Economics and Islamic Business, UIN Sunan Kalijaga Yogyakarta. The preparation of this thesis would not have been possible without the support of many individuals. Therefore, the author wishes to express heartfelt gratitude to all those who have contributed.:

1. Prof. Noorhaidi Hasan, S.Ag., M.A., M.Phil., Ph.D. as the Rector of Sunan Kalijaga Yogyakarta State Islamic University
2. Prof. Dr. Misnen Ardiansyah, S.E., M.Si., Ak., CA., ACPA. as the Dean of Faculty of Islamic Economics and Business Sunan Kalijaga Yogyakarta State Islamic University
3. Dr. Miftakhul Choiri, S.Sos.I., M.S.I. as Head of the Sharia Economics Study Program, Faculty of Islamic Economic and Business, Sunan Kalijaga Yogyakarta State Islamic University
4. Drs. Slamet Khilmi, M.SI. as Thesis Supervisor who is always patient and sincere in every directing and guiding the author from the really first word to the last dot of writing this thesis
5. All Lectures of the Faculty of Islamic Economics and Business, Sunan Kalijaga Yogyakarta State Islamic University who always provide knowledge and experience to the author during the lecturer process
6. All staff and administrative personnel at the Faculty of Islamic Economics and Business, UIN Sunan Kalijaga Yogyakarta..
7. Se-Frikuensi, to myfriends, thank you for always being on the same wavelength with me. Our discussions, laughs, and silly moments have made this journey so much more enjoyable. You guys have always provided color, humor, and

enthusiasm in this long journey. You are a source of joy in the midst of pressure.

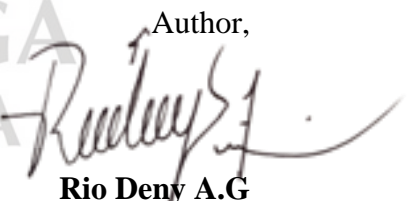
8. Real Member, to my friends, thank you for always being on the same wavelength with me. Our discussions, laughs, and silly moments have made this journey so much more enjoyable. You guys have always provided color, humor, and enthusiasm in this long journey. You are a source of joy in the midst of pressure.
9. The entire extended family of PMII Rayon Ekuilibrium Faculty of Economics and Islamic Business UIN Sunan Kalijaga Yogyakarta, especially the Emerald Corps, which has become my home when growing and developing in the land of Yogyakarta.
10. DEMA FEBI Cabinet Progresif 2023, I would also like to thank DEMA FEBI Cabinet Progressive 2023 for the cooperation, enthusiasm, and commitment that always inspire. Your contribution in supporting FEBI students is so meaningful.

Hopefully, all the kindness and usefulness that has been given will become a gooddeeds and facilitated all affairs by Allah SWT and hopefully this thesis can also provide benefits for readers, Aamiin.

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Yogyakarta, 14 December 2024

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ABSTRACT

Environmental degradation is currently the most talked about issue around the world. Climate change and global warming are indicators of this damage. Carbon emissions are one of the main causes of global warming. In 2001, Indonesia ranked 21st as the country with the largest CO₂ gas emissions. In 1990, the total emissions resulting from fossil fuel combustion reached about 83.8 million tons, and are expected to increase to 368.3 million tons by the end of 2020. By 2022 Indonesia ranks 7th in the world. In 2024, Jakarta ranked 4th as the capital city with the worst air quality in the world. This study aims to analyze the effect of Green Technology Innovation, Renewable Energy Consumption, GDP, and FDI on Carbon Emissions in Indonesia using the Autoregressive Distributed Lag (ARDL) method. The results showed that the Green Technology Innovation variable had a significant negative effect, the Renewable Energy Consumption variable had a significant negative effect, the GDP variable had a significant positive effect while FDI had a no effect.

Keywords: Carbon Emissions, Green Technology Innovation, Renewable Energy Consumption, GDP, FDI



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ABSTRACT

Kerusakan lingkungan saat ini menjadi isu yang paling banyak dibicarakan di seluruh dunia. Perubahan iklim dan pemanasan global adalah indikator dari kerusakan ini. Emisi karbon adalah salah satu penyebab utama pemanasan global. Pada tahun 2001, Indonesia menduduki peringkat ke-21 sebagai negara dengan emisi gas CO₂ terbesar. Pada tahun 1990, total emisi yang dihasilkan dari pembakaran bahan bakar fosil mencapai sekitar 83,8 juta ton, dan diperkirakan akan meningkat menjadi 368,3 juta ton pada akhir tahun 2020. Pada tahun 2022, Indonesia berada di peringkat ke-7 di dunia. Pada tahun 2024, Jakarta menduduki peringkat ke-4 sebagai ibu kota dengan kualitas udara terburuk di dunia. Penelitian ini bertujuan untuk menganalisis pengaruh Inovasi Teknologi Hijau, Konsumsi Energi Terbarukan, PDB, dan FDI terhadap Emisi Karbon di Indonesia dengan menggunakan metode Autoregressive Distributed Lag (ARDL). Hasil penelitian menunjukkan bahwa variabel Inovasi Teknologi Hijau berpengaruh negatif signifikan, variabel Konsumsi Energi Terbarukan berpengaruh negatif signifikan, variabel PDB berpengaruh positif signifikan sedangkan FDI tidak memiliki pengaruh.

Kata kunci: Emisi Karbon, Inovasi Teknologi Hijau, Konsumsi Energi Terbarukan, PDB, FDI

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CHAPTER I

INTRODUCTION

A. Background

Environmental degradation is currently the most talked about issue around the world. Climate change and global warming are indicators of this damage. Global warming refers to an increase in the average temperature of the Earth's atmosphere, oceans and land. The consequences of global warming include the loss of glaciers, extinction of various animal species, and negative impacts on agricultural yields (Buleleng, 2019). Currently, several countries are experiencing significant impacts from global warming and environmental damage, such as the extreme heatwave in India, where temperatures reached 45-50°C (Prihatini, 2022). In Kuwait, temperatures were even more extreme, reaching 63°C. In Mosquera, Colombia, there was severe environmental pollution, where the Balsillas River was filled with foul-smelling foam due to the disposal of detergent waste (Putri, 2022). These two examples show the magnitude of the impacts resulting from environmental degradation (Malihah, 2022).

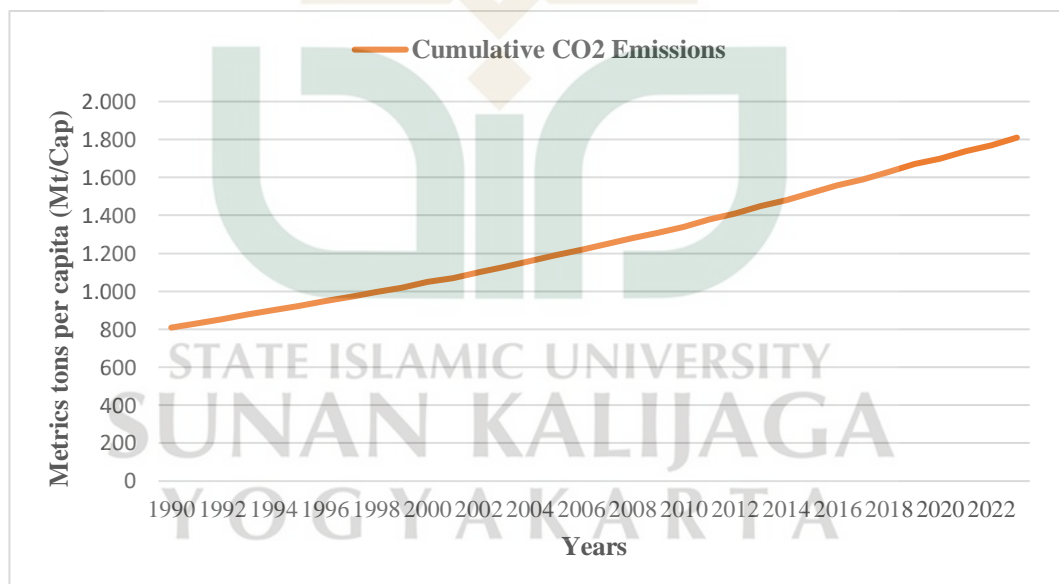
Climate change and environmental degradation are increasingly pressing global challenges, and these issues are not unique to the rest of the world. Every country is experiencing the impact of climate change, which affects the lives of people in various parts of the world. According to the 2018 Intergovernmental Panel on Climate Change (IPCC) report, temperature increases due to global warming, estimated at 1.5 to 2.0 degrees Celsius, could have serious impacts on health, livelihoods, food security, water availability, human security, and economic growth (Rahmandani & Dewi, 2023).

Rising temperatures and extreme weather lead to the emergence of new diseases and increase the risk of dehydration and heatstroke, which adversely affect health. Deteriorating air quality also leads to respiratory and cardiovascular problems, and increases the risk of cancer. The transmission of diseases through water, food and rodents becomes more rapid. On the economic side, the agriculture, forestry and tourism sectors are affected by erratic weather patterns, adding to the

social and economic burden. Extreme weather damages infrastructure, while permafrost thaw and sea level rise threaten local populations and resource development (Selvi et al., 2020)

According to WHO data in 2018, more than 90% of the world's population is exposed to air with dangerous levels of pollution. In fact, around 3 billion people, mostly women and children, still breathe harmful fumes. This situation is caused by poor air quality, mainly due to residual combustion of carbon compounds, such as from the use of stoves and fuels (Suwandi et al., 2022).

Greenhouse gas emissions, especially carbon dioxide, are the main cause of global warming. This is due to two main factors: first, emissions of this gas directly cause the Earth's temperature to rise; second, carbon dioxide has a longer residence time in the atmosphere compared to other types of greenhouse gases. As a result, these emissions pose a greater risk to climate change (Cahyani & Aminata, 2020).



Graphics 1. 1 Global Cumulative CO2 Emissions Graph

Source : World Bank (<https://data.worldbank.org>)

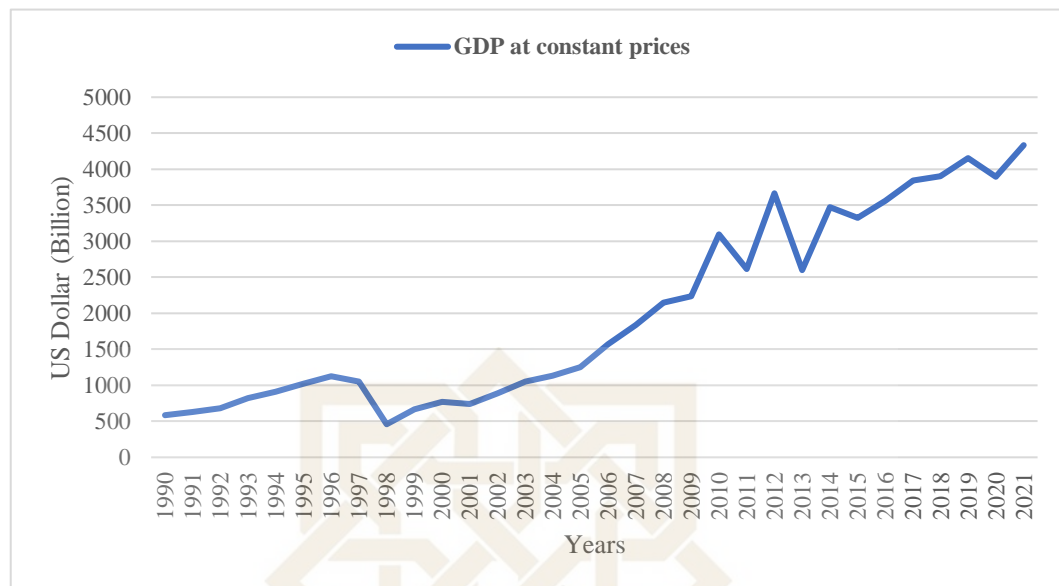
From the available data, it can be seen that global carbon emissions show a very significant upward trend between 1990 and 2022. This increase indicates that the problem of global warming is not just speculation or unfounded assumptions,

but a real challenge that requires serious attention and collective action from various parties, including government, industry and society.

A strong commitment is needed to address the world's high carbon emissions. Some of the efforts that have been made by developed countries include the implementation of policies to reduce the use of fuel oil, especially those of fossil origin, as fuel for engines and vehicles. In addition, the addition of green open spaces is also one of the strategies to reduce carbon emissions in big cities. However, these plans require careful preparation to project the extent of implementation and address carbon emissions, so as to reduce production costs and reduce the risk of failure in implementation. One method that can be used is forecasting carbon emissions for future periods (Suwandi et al., 2022).

Countries have implemented policies to reduce the impact of global warming, in line with the Sustainable Development Goals (SDGs). The SDGs, which follow on from the Millennium Development Goals (MDGs), consist of 17 goals with 169 targets to be achieved by 2030. These goals include the elimination of poverty, hunger, improved health, education, gender equality, access to clean water, affordable energy, decent work, and environmental protection (Malihah, 2022).

Over the past 15 years, Indonesia's economic growth has been recorded at 6%. This figure reflects an increase in a country's output, which has an impact on meeting people's needs for goods and services. It is expected that Indonesia's economy will continue to improve along with the increase in economic growth. This economic growth is inseparable from the important role of the industrial sector, which is one of the main contributors to the development of the Indonesian economy (Malihah, 2022).

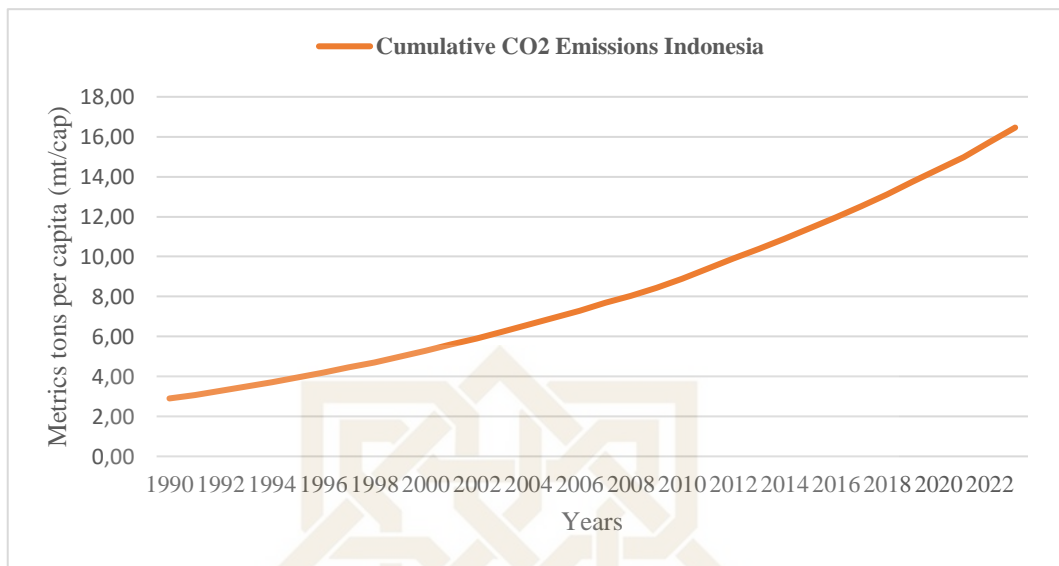


Graphics 1. 2 GDP at Constant Prices

Source : World Bank (<https://data.worldbank.org>)

However, behind the country's increasing achievements in economic growth, there are significant negative externalities. One of the main impacts is the destruction of Indonesia's natural environment. Intensive exploitation of natural resources, such as logging and mining, has resulted in extensive deforestation. This not only threatens biodiversity, but also contributes to climate change. In addition, water and air pollution from industrial waste adds to public health problems (Malihah, 2022).

A key challenge in economic development is balancing the need to address development goals with the efforts to protect the environment (Fauzi.A, 2004). Development that depends on natural resources without considering sustainability will eventually harm the environment. This is because natural resources and the environment have finite capacities. In other words, economic growth that disregards the limitations of natural resources and the environment can lead to future problems (Rahadian, 2016).



Graphics 1. 3 Cumulative CO₂ emissions in Indonesia

Source : World Bank (<https://data.worldbank.org>)

The data collected shows that carbon emissions in Indonesia have seen a significant increase from 1990 to 2022. This trend is in line with analysis showing that the average temperature in the country has also increased consistently over the same period.

This phenomenon of increasing carbon emissions and average temperatures demonstrates the close relationship between economic activity and environmental impacts. This underscores the importance of considering sustainability in the planning and implementation of economic activities. Indonesia also wants to ensure the country is prepared for any changes caused by climate change in critical areas such as food, water, energy, etc. and the environment. This will help the country's economy remain strong and reduce the country's potential GDP loss of 3.45% due to climate change by 2050 (Dwi, D., & Yanto, 2022).

In 2001, Indonesia ranked 21st as the country with the largest CO₂ gas emissions. In 1990, the total emissions resulting from fossil fuel combustion reached about 83.8 million tons, and are expected to increase to 368.3 million tons by the end of 2020. By 2022 Indonesia ranks 7th in the world. In 2024, Jakarta was

ranked as the 4th capital city with the worst air quality in the world (Selvi et al., 2020).

Indonesia is committed to improving air quality through emission reduction, as stated in its NCD (Nationally Determined Contribution) proposal. The country has ratified the Paris Agreement through Law No. 16/2016. In the NCD, Indonesia aims to reduce emissions by 29% by 2030 without external assistance, and up to 41% with foreign support, based on 2010. This target states that Indonesia is committed to a 29% reduction in greenhouse gas emissions compared to a business-as-usual (BAU) scenario projected to reach around 2,869 GtCO₂e by 2030, reflecting current energy policy developments, particularly regarding coal-fired power plants (Selvi et al., 2020).

Environmentally friendly technology, known as green technology, plays a role in reducing negative impacts on the environment through prevention, recycling, and utilization of waste into valuable products. More environmentally friendly materials and products have their own advantages and are increasingly in demand by consumers. In Indonesia, the development of environmentally friendly materials, products and technologies has started with the emergence of various green certifications, such as organic, eco-friendly and green labels. These green products are designed to meet consumer demand for products that are healthier and have a lower environmental impact over their entire life cycle (UNDIP, 2022).

Renewable energy sources are also one of the economical solutions to increase access to electricity, reduce air pollution, and lower carbon dioxide emissions globally. The use of renewable energy, such as solar panels, is a very accessible and available option, especially considering the geographical conditions of most of Indonesia, which receives sunlight almost all year round (Rahmandani & Dewi, 2023).

Environmental sustainability is now the main focus of development. The negative impacts of development that does not pay attention to environmental

aspects are increasingly evident, raising awareness of the importance of sustainability in recent years (Ferdiansyah et al., 2023).

The Environmental Kuznets Curve Theory says that as a country's income level increases, environmental quality will also improve. This hypothesis argues that in the early phases of economic development, countries tend to neglect environmental quality in favor of economic growth. However, when income reaches a certain level, the economy starts focusing on improving environmental conditions by promoting more sustainable growth. This theory is usually depicted in the form of an inverted U curve (Rahmandani & Dewi, 2023).

To support economic growth, a country uses investment, either in the form of Foreign Direct Investment (FDI) which includes technology and production companies, or portfolio investment in financial assets (Winda & Falianty, 2023). FDI can increase productivity with efficient technology transfer, improve product quality, and reduce production costs, which in turn drives economic growth. However, investment often has a negative impact on the environment, such as CO₂ emissions that exacerbate global warming. The Pollution Haven Hypothesis, proposed by Copeland and Taylor (1994), links environmental degradation to international trade patterns, as seen in trade between the US and Mexico in the NAFTA agreement (Lesmana et al., 2024).

Often, economic activities aimed at the development of a country ignore environmental impacts, which may result in environmental degradation in the future. Therefore, it is important to maintain a balance between economic activity and environmental sustainability. Both need to be considered together so that the economy can continue to grow without compromising the environment.

The novelty of this study lies in the simultaneous analysis of the influence of green technology innovation, renewable energy consumption, as well as macroeconomic variables (GDP and FDI) on carbon emissions in Indonesia, which is still limited in the existing literature. This research focuses on the interaction between technological and economic factors to measure their impact on

environmental quality, particularly in the context of Indonesia which faces a major challenge in reducing carbon emissions while maintaining economic growth. Research gaps identified are the lack of studies integrating green technology and renewable energy aspects in macroeconomic models to explain the variability of carbon emissions in developing countries such as Indonesia, as well as the absence of a deep understanding of how FDI plays a role in environmental quality in a country with a rapidly growing industrial level.

With this background, the author chose the thesis title **“ANALYSIS OF THE INFLUENCE OF GREEN TECHNOLOGY INNOVATION, RENEWABLE ENERGY CONSUMPTION, FDI, AND MACROECONOMIC VARIABLES ON CARBON EMISSIONS IN INDONESIA”**. This thesis aims to analyze more deeply the relationship between green technology innovation, renewable energy consumption, GDP and foreign direct investment in influencing the level of carbon emissions in Indonesia. This research is expected to provide useful insights for the development of more sustainable and environmentally friendly policies.

B. Research Question

Based on the above background, several problems can be formulated as follows:

1. How does green technology innovation affect carbon emissions in Indonesia?
2. How does renewable energy consumption affect carbon emissions in Indonesia?
3. How does gross domestic product affect carbon emissions in Indonesia?
4. How does foreign direct investment affect carbon emissions in Indonesia?

C. Research Objectives

From some of the problem formulations above, we can get the following research objectives :

1. To analyze the effect of green technology innovation on carbon emissions in Indonesia.

2. To analyze the effect of renewable energy consumption on carbon emissions in Indonesia.
3. To analyze the effect of gross domestic bruto on carbon emissions in Indonesia.
4. To analyze the effect of foreign direct invesment on carbon emissions in Indonesia.

With these objectives in mind, it is hoped that this research can provide greater insight into the factors that influence carbon emissions and assist in the development of more effective environmental policies.

D. Significance of Study

1. For the Author
 - a. This research provides an opportunity to develop analytical and methodological skills, and deepen understanding of the relationship between technology, energy and the environment.
 - b. The research results can be used as a reference for further academic works, both in the form of article publications and theses/final assignments.
2. For Academics
 - a. This research can enrich the academic literature on carbon emissions, green technology innovation, and renewable energy consumption in the Indonesian context.
 - b. The research findings can be used as a basis for further research, classroom discussions, and curriculum development in environmental economics and sustainability.
3. For the Government
 - a. The research results can assist the government in formulating more effective policies to address climate change and improve environmental sustainability.
 - b. This research provides relevant data and analysis to support strategic decisions related to investment, innovation, and natural resource management.

- c. By understanding the influence of various factors on carbon emissions, the government can develop more targeted and evidence-based programs to mitigate climate change.

E. Systematization of Writing

The study in this final project writing consists of 5 (five) discussion chapters. This systematic discussion is a description of the flow of the author's thoughts from beginning to end. The description is as follows :

CHAPTER I This chapter discusses the background of the research, which includes the phenomenon of the object of study, theoretical basis (essence), and supporting data. In addition, the first chapter includes the formulation of the problems raised by the author, as well as the objectives and benefits of this research. Then it ends with a thorough discussion to get an overview of the research objectives.

CHAPTER II The author develops a framework and develops current hypotheses to facilitate understanding of the research by outlining important definitions and ideas used in the theory used in the second chapter. This chapter also explains previous research related to the author's research.

CHAPTER III In this chapter, the research variables used are discussed, as well as data collection techniques and their operational definitions. In addition, there is an explanation of the analysis methods and analysis instruments used in the study.

CHAPTER IV This chapter explains the research results, including descriptive analysis and implementation of the processed data results. This explanation answers the problem formulation in the first chapter.

CHAPTER V The last chapter presents conclusions and recommendations for various parties. In addition, this chapter conveys its shortcomings as a basis for further research.

CHAPTER V

CLOSING

A. Conclusion

Based on the testing and analysis discussed in the previous section concerning the effects of green technology innovation, renewable energy consumption, gross domestic product, and foreign direct investment on carbon emissions in Indonesia using the Autoregressive Distributed Lag (ARDL) approach, the following conclusions are drawn by the author.

Green Technology Innovation, Renewable Energy Consumption, Gross Domestic Product, and Foreign Direct Investment all affect Carbon Emissions in Indonesia. Each of these factors has a significant influence on carbon emissions. The R-squared value of 0.947124 shows that 95% of the variation in the dependent variable (Carbon Emissions) can be accounted for by the independent variables, including Green Technology Innovation, Renewable Energy Consumption, Gross Domestic Product, and Foreign Direct Investment.

1. The ITH (Green Technology Innovation) variable has a notable negative effect on carbon emissions in the short term at lag 0, and this negative impact persists in the long term. According to the ARDL model, a 1% increase in ITH results in a significant reduction of 0.068532% in carbon emissions in the long run.
2. The KET (Renewable Energy Consumption) variable does not affect carbon emissions in the short term, but it significantly influences carbon emissions in the long term with a negative coefficient. The ARDL model suggests that a 1% rise in KET leads to a significant decrease in carbon emissions by 0.629911% over the long term.
3. The GDP (Gross Domestic Product) variable does not affect carbon emissions in the short term, but in the long term, it has a significant positive effect. The ARDL model indicates that a 1% increase in GDP leads to a slight, though statistically insignificant, increase of 0.215887% in carbon emissions in the long run.

4. The FDI (Foreign Direct Investment) variable has a significant negative effect on Carbon Emissions in the short term, FDI has no significant effect on carbon emissions, because the probability is greater than 0.05 ($p > 0.05$), which means there is not enough evidence to suggest that FDI affects the dependent variable.

B. Research Limitations

In this study, there are several limitations that can affect the results of the analysis obtained, including :

1. Data Limitations

This study uses time series data from 1990 to 2021, which may not fully illustrate the long-term dynamics or recent trends that have emerged after that period.

2. Unobserved External Variables

This study only considers some macroeconomic variables, such as Gross Domestic Product (GDP) and Foreign Direct Investment (FDI). However, there are many external factors that can affect environmental quality, such as government policies, international environmental regulations, or global climate change, which are not included in the analysis model.

3. Limitations of Research Scope

This research was only conducted in Indonesia, which has different social, economic, and political conditions from other countries. Therefore, the results of this study may not be fully applicable or generalizable to other countries with different characteristics.

C. Suggestions

For future research, some suggestions that can be considered to improve the quality and depth of analysis include :

1. Use of More Recent Data

Future research can use more recent data to analyze the impact of newly implemented policies or newer green technology trends. Using data up to 2023

or 2024 will provide a more accurate picture of the influence of these variables on environmental quality.

2. Addition of External Variables

To provide a more comprehensive picture, it is recommended to include external variables that can affect environmental quality, such as international environmental policies, new government regulations, and the impact of global climate change.

3. Improvement of Analysis Methodology

Future research could consider more sophisticated analytical methods or a combination of various analytical techniques to address potential problems in the model, such as using cointegration or VAR methods to examine the dynamic relationship between variables in the short term.

By implementing these suggestions, future research can provide a more holistic insight into the influence of green technology innovation, renewable energy consumption, and macroeconomic variables on environmental quality in Indonesia.