Ecoment Global Journal

Volume 9 Nomor 1 Edisi April 2024 ISSN. 2540 – 816X

Implementation of Greenhouse Gas (GHG) Emission Reduction Policy

***Azmi, U[1], Sasongko, A.U,[2], Murtiana, S[3], Saputro, G E[4]**

Department of Energy Security, Indonesia Defense University, IPSC Area, Sentul 16810, Indonesia

Correspondence*:
Jl. Salemba Raya No. 14 Kenari Kec. Senen Jakarta Pusat 10440| e-mail guntur.saputro@idu.ac.id

Abstract

Introduction. Greenhouse Gas (GHG) emissions are gases released into the atmosphere from various human activities on earth which cause a greenhouse effect in the atmosphere. These greenhouse gases are carbon dioxide (CO2), sulfur dioxide (SO2), nitrogen monoxide (NO), nitrogen dioxide (NO2), methane gas (CH4), and chlorofluorocarbons (CFC).
The problem is that carbon gas as the main pollutant is produced from burning oil, coal and other organic fuels. To reduce this negative impact, each country then ratified the Paris Agreement and committed to keeping the temperature increase to less than 2 degrees Celsius. In this regard, each country targets reducing GHG emissions, especially carbon, within a certain period of time.
Theory. This research explains the implementation of policies to reduce Green House Gas (GHG) emissions using the Edwards III approach. The indicators are Communication, Disposition, Resources and Bureaucratic Structure.
Research methods. The method used is a qualitative type of descriptive analysis. Data collection through literature study. Data was obtained from e-books, journals and articles.
The results achieved. The Indonesian government has set a target to reduce carbon emissions from all sectors by 2030 by 29 percent with its own efforts or up to 41 percent with funding assistance from abroad. In the 41% reduction target, the government hopes to collaborate with developed countries that have high levels of carbon emissions, through a "carbon trading" mechanism.
Keywords: Greenhouse Gas (GHG) Emissions, Policy Implementation, Energy Users

Keywords: Greenhouse Gas (GHG) Emissions, Policy Implementation, Energy Users

JEL Classification: M42, M48 [author should add 1-3 JEL classification number, information guide for the Journal of Economics Literature (JEL) can be found at https://www.aeaweb.org/jel/guide/jel.php]

Received, April 18, 2024.; Received in revised form: May, 18, 2024.Accepted: June, 13, 2024

Volume 9 Nomor 1 Edisi April 2024 ISSN. 2540 – 816X

Introduction

With its large population and status as a developing country, Indonesia tends to need more energy. From IDR 1,964 trillion in 2007 to IDR 2,463 trillion in 2011, Indonesia's GDP grew by 5.82 percent per year (Utaminingsih & Hidayah, 2019). With an average annual population growth rate of 1.45 percent between 2007 and 2011, Indonesia has a population of 241.1 million people. In contrast, from 2007 to 2011, crude oil prices rose by an average of 11.45% per year, from 72.31 US dollars per barrel to 111.55 US dollars per barrel. However, from 2006 to 2014, subsidized premium prices rose evenly. -an average of 4.7 percent per year, from IDR 4,500 per liter to IDR 6,500 per liter (Tomo & Brunner, 2022).

Indonesia is expected to experience rapid economic growth, with an average annual growth rate of around 6% between 2006 and 2030. It is estimated that energy consumption will increase approximately fourfold, from 815 million BOE (barrels of oil equivalent) in 2005 to 3629 million SBM in 2030, in order to maintain the rate of economic expansion. The energy intensity - GDP ratio has not increased significantly, and overall(Ministry of Energy and Information Technology, 2020), Indonesia's energy intensity - GDP ratio is much higher compared to industrial countries. This is caused by the low efficiency of energy consumption in Indonesia as a developing country.

In 2005, transportation became the third largest energy user with a growth rate of 9% per year, and in 2030 it will become the largest energy user. In 2006, the industry that uses the most fossil energy will be second with a growth rate of 6% per year(Anggraeni, 2015a).

Due to limited supply, petroleum will remain the main national energy source until 2030, with a biomass contribution of around 55%, an increase from the 2005 contribution of 37%(Chaerul et al., 2020). However, without biomass, the contribution of petroleum in 2030 will be almost the same as in 2005, and the use of biomass as fuel will be replaced by more efficient and practical energy sources (Prasetyo & Windarta, 2022).

From a supply perspective, Indonesia has a lot of energy resources, both non-renewable and renewable resources. However, research on these resources focuses more on non-renewable fossil resources, while renewable resources are still underutilized. This condition causes the availability of fossil energy, especially crude oil, to become increasingly scarce(Anggraeni, 2015b). According to the Ministry of Energy and Mineral Resources, Indonesia is now a net importer of crude oil and its derivative products. Indonesia's energy resources can only be produced or will run out in 22 years, gas in 53 years and coal in 83 years(Ministry of Energy and Mineral Resources, 2020).On the other hand, renewable energy has enormous potential, but is still not utilized optimally. The new installed capacity is 6,057 MW, with a usable water energy capacity reaching 75,000 MW(Ministry of Energy and Mineral Resources, 2016).

In general, it is thought that rising oil prices will encourage diversification with cheaper fuels such as coal and natural gas. Apart from that, this will also open up opportunities to utilize environmentally friendly renewable energy resources, which will reduce environmental pollution, including greenhouse gas emissions. The use of such resources will result in a sharp increase in CO2 emissions from 117 million tons in 2006 to around 582 million tons in 2030(KLHK, 2020).

Indonesia does not have an obligation to reduce greenhouse gas emissions because it is not included in the "Annex I" or "Annex II" group of countries. However, as a country that ratified the Kyoto Protocol, Indonesia must report the amount of its emissions and help developed countries reduce emissions through the green development mechanism (CDM).(Swastika, 2014). This program can encourage the use of environmentally friendly renewable energy3). In this regard, energy programs that have the potential to be applied through the CDM mechanism need to be prepared, developed and socialized (Kurnia W. et al., 2022).

Literature Review and Hypotheses Development

Greenhouse gases are gases in the atmosphere that can absorb and re-emit infrared radiation from the sun. GHGs exist naturally in the Earth's atmosphere and are very important for the survival of life on Earth (Dhillon & von Wuehlisch, 2013). Greenhouse gases are a number of gases that can cause a greenhouse effect, namely the trapping of heat in agricultural systems that use greenhouses. The types of gases that are classified as greenhouse gases are carbon dioxide (CO2), nitrous oxide (N2O), methane (CH4), sulfur hexafluoride (SF6), perfluorocarbons (PFC), and hydrofluorocarbons (HFC). Some of the

Volume 9 Nomor 1 Edisi April 2024 ISSN. 2540 – 816X

short-wave solar radiation received by the earth's surface is emitted back into the atmosphere in the form of long-wave radiation (infrared radiation). The long wave radiation emitted by greenhouse gases in the lower atmospheric layers, close to the earth's surface, will be absorbed and cause a heat effect known as the greenhouse effect (Ministry of the Environment, 2012).

Without GHGs, the earth's surface temperature would drop to -18 °C, but with the presence of GHGs, the temperature would drop to 15 °C. Gases that are included in the GHG group are CO2, CH4, N2O and fluorinated gases (F-gas) which include the perfluorocarbon group (PFCs), hydrofluorocarbon group (HFCs) and sulfur hexafluoride (SF6) and compounds that destroy the ozone layer (IPCC, 2007b). Each GHG has a different Global Warming Potential (GWP) value, the greater the GWP value, the more it will cause global warming. Global Warming Potential is the potential for a gas to cause global warming which is measured relatively based on CO2 emissions with a value of 1 (one). For example, CH4 has a GWP value of 21, meaning that each unit of CH4 is 21 times more effective than CO2 in preventing the release of infrared radiation from the earth's atmosphere. Even though the GWP CO2 value is not large, CO2 is the type of GHG with the largest concentration in the atmosphere. IPCC data (2007) shows that in 2004 CO2 emissions contributed 76.7% of total GHG emissions caused by human activities, followed by CH4 emissions of 14.3%, N2O emissions of 7.9% and other gases only contributed 1.1%.

Method

The success of implementing greenhouse gas (GHG) emissions policies will be determined by many variables or factors, and each of these variables is interconnected with one another. However, in this study the author assumes that each of these variables, without being related to each other, directly influences the implementation of greenhouse gas (GHG) emission reduction policies (Ampri, 2013). To enrich understanding of the various variables involved in implementing policies to reduce greenhouse gas (GHG) emissions, therefore in this research the author chose the approach proposed by Edwards III, namely communication, resources, disposition and bureaucratic structure. The research method used is qualitative, descriptive analysis type. The data used is secondary data obtained from literature study techniques in the form of books*(e-books)*, papers and *journal online*.

Result and Discussion

Sources of greenhouse gas emissions fall into two categories: sources produced by humans (man-made sources) and natural sources (natural sources). These sources are divided into countable and non-countable categories, known as fugitive sources. To meet human needs in various economic sectors, burning carbon from fossil energy (natural gas, oil and coal) is the main cause of emissions caused by human activities (Dewa & Sejati, 2019). Because there is no clear evidence, forest fires are usually difficult to prove. This paper provides calculations for carbon dioxide emissions resulting from the use of fossil energy sources 2 in various parts of the business. This calculation is also adjusted to the type of energy used (Danar & Wahyu, 2019).

Greenhouse gases (GHG) are gases in the atmosphere that can cause a greenhouse effect which can cause an increase in the earth's temperature. The types of gas that are classified as GHG are: *carbon dioxide* (CO_2), *Nitrogen oxide*(N_2O),*Methane*(CH_4), *Sulfur heksaflorida* (SF_6) *perfluorocarbon*(PFCs) and *hydrofluorocarbon* (HFC_s) (Ayuvitari & Wijayanti, 2022). This gas actually naturally appears in the environment, but can also arise from human activities. If GHGs are not controlled, they can increase the earth's temperature or global warming. The global average temperature at the Earth's surface has increased by 0.74 ± 0.18 °C (1.33 ± 0.32 °F) over the last hundred years(Ramdhani et al., 2019). *Intergovernmental Panel on Climate Change* (IPCC) concluded that, "most of the increase in global average temperatures since the mid-20th century is likely due to increasing concentrations of greenhouse gases due to human activities" (Amheka & Higano, 2015). Industrial activities are human activities that contribute to GHG concentrations in the atmosphere. Indonesia is in 6th place with carbon dioxide emissions of 1.98 billion tons of CO2 emissions per year. GHG contribution consists of: 1. Forestry and peatlands 58%; 2. Energy 24%; 3. Waste 11%; 4. Industry 2%; 5. Agriculture 5%.

Volume 9 Nomor 1 Edisi April 2024 ISSN. 2540 – 816X

Communication

a. Communication Process Between Related Parties

Presidential Regulation of the Republic of Indonesia number 61 of 2011 concerning the National Action Plan for Reducing Greenhouse Gas Emissions was issued by the government as a policy and concrete action target in the field to support a reduction in emission levels of 26% or for the forestry sector 14% by 2020(Kramawijaya & Dewi, 2017). Presidential Decree 61 needs to be supported because quantitative targets for reducing emissions for each sector have been determined, where the forestry sector is grouped into the forestry and peatland sectors. Thus, RAN-GRK is a binding regulation and contains work plans for implementing various activities that directly and indirectly reduce greenhouse gas emissions in accordance with national development targets.(Chaerul et al., 2016). The contents of Presidential Decree 61 show general regulations regarding efforts to reduce emissions. RAN-GRK consists of core activities and supporting activities. RAN-GRK activities cover the following areas: a. Agriculture; b. Forestry and peatlands; c. Energy and transportation; d. Industry; e. Waste management; and f. Other supporting activities(Regulation of the President of the Republic of Indonesia No. 61 of 2012 on the National Action Plan for Reducing Greenhouse Gas Emissions, 2011).

RAN-GRK is a guideline for: a. Ministries/institutions to carry out planning, implementation, as well as monitoring and evaluation of GHG emission reduction action plans, b. Regional government in preparing RAD-GRK, and c. become a reference for the community and business actors in planning and implementing GHG emission reduction. To reduce GHG emissions in each provincial region, the Governor must prepare RAD-GRK(Wieddya et al., 2017). The preparation of RAD-GRK must therefore be guided by RAN-GRK and regional development priorities.

The attachment to the Presidential Decree shows that there are many supporting activities that cannot be directly quantified into emission reduction target figures. Several assumptions are needed so that supporting activities can be quantified in the form of emission reductions, namely:

a. Area or volume as activity data
b. Carbon stock or carbon potential from the area or volume of activities
c. The amount of emissions or absorption is compared with BAU (business as usual) if these activities are not carried out

For example, in the formation of a KPH, the quantification of emission reductions can only be calculated based on the assumed area of the KPH formed, the assumed carbon stock of the KPH and how much area or volume of wood (logging) will occur if the KPH is not formed. Quantifying supporting activities will require many assumptions which result in low accuracy of emission reduction calculations.

In implementing emission reduction activities, apart from supporting activities, activities are needed that can directly reduce emissions. Activities that can directly reduce emissions are planting activities (creating plants) as well as activities to prevent deforestation and degradation. Further information about direct emission reduction activities is needed so that the implementation of RAN GRK can achieve maximum results (ESDM, 2020).

b. Communication media

The Directorate General of EBTKE carries out two main activities: first, holding seminars, workshops, displaying advertisements about energy savings in newspapers and electronic media, brochures, bulletins; second, holding a national level Energy Saving Competition (Saharjo, 2022). The 2013 National Energy Efficiency Award has the following benefits: First, for the Government, it is an effective tool to promote energy efficiency and conservation in the industrial and building sectors (Wicaksono & Nugroho, 2023). Second, for competition participants, they will receive national recognition from the government, professional associations, stakeholders in the industrial and building sector, and academics as buildings or industries that have successfully implemented energy efficiency and conservation efforts by producing results in reducing energy consumption without disrupting productivity. (Margono et al., 2022). This statement shows that the national energy efficiency award is a communication medium related to effective energy conservation (Muryani, 2020).

Resource

a. Human Resources

The Director General of EBTKE was authorized by the Minister of Energy and Mineral Resources to form an Energy Management Monitoring Team, but to date this has not been formed. The Director General of

Volume 9 Nomor 1 Edisi April 2024 ISSN. 2540 – 816X

EBTKE plans to form a team with private energy management experts as members. This shows that employees of the Conservation Directorate (Purnamasari et al., 2019).

b. Financial Resources

Implementation of Presidential Decree No.61/2011 for Reducing GHG Emissions is an effort with a broad scope & across sectors; requires large-scale costs that must be spent every year. The government has achieved its emission reduction target by 2020. From the 2012 APBN, the budget related to RAN-GRK activities reached around IDR 15.9 trillion. The Mitigation Fiscal Framework study shows that financing from APBN and APBD sources alone is not enough, because it can only reduce approximately 15% of emissions from the RAN-GRK target in 2020, the remaining 85% must be financed from other sources (Ampri, 2013).

The sources of funds from the central government:

- Sectoral funds for K/L expenditure from grant funds
- Deconcentration funds for K/L expenditure from grant funds
- Co-administration funds for K/L expenditure from grant funds

Sources of funds from domestic & foreign revenues:

- Special allocation funds (DAK) for the environment/GHG emissions
- Regional grants to finance certain activities
- Regional incentive funds (DID) for certain performance achievements

Monetary scheme for financing GHG emission reduction:

- Public funds

a. Limited government budget
b. Used to *"leveraging"* (baiting & encouraging) private investment

- Private funds

a. Required for investment in facilities & infrastructure
b. Fiscal and non-fiscal incentives are needed
c. The role of K/L regarding the formulation of criteria & indicators

Disposition

a. Performance Criteria and Greenhouse Gas (GHG) Emission Targets

As one of the strategies to achieve the target of reducing emissions from the energy sector, the Directorate General of New, Renewable Energy and Energy Conservation is presenting a new category of innovation at the Subroto Award for Energy Efficiency (PSBE) in 2021. Category C, Reducing and Trading Carbon Emissions in Power Plants which is a breakthrough as well as a tactic to meet the energy sector's emissions reduction target of 314 - 398 million tons of CO2e. This calculation refers to *Paris Agreement* which targets appropriate reduction in Green House Gas (GHG) emissions *Nationally Determined Contributions (NDC)* in 2030, namely 29% of *Business as Usual*/BaU (with its own capabilities) and 41% of BaU (with international assistance) (EBTKE Public Relations, 2022).

b. Incentives

The Ministry of Energy and Mineral Resources provides energy audit services through the energy conservation partnership program, which is a form of government incentive in the field of energy conservation. According to the Directorate of Energy Conservation (2014), the Ministry of Energy and Mineral Resources provided cost incentives for energy audits amounting to 91.9 billion rupiah to 786 energy users in the industrial and building sectors through this program during the period 2006 to 2012. 579 participants of this program during the period 2009 to 2012 has carried out investments based on the results of an energy audit with an investment cost of 982.4 billion rupiah. Based on the results of the energy audit, the total energy savings potential is 1,996.9 billion rupiah. This statement shows that the total energy savings potential is higher than investment costs and energy audit costs (EBTKE, 2021).

Bureaucratic Structure

a. Standard Operational Procedures (POB)

Knowing energy management methods is very important for implementing energy conservation policies through energy management. Therefore, PP no. 70/2009 and Minister of Energy and Mineral Resources

Volume 9 Nomor 1 Edisi April 2024 ISSN. 2540 – 816X

Regulation No. 14/2012 already includes standard operating procedures without POB guidelines. POB regarding energy management is listed in articles 12 to 13 of PP No. 70/2009 and articles 3 to 11 PP no. 14/2012; POB incentives are listed in article 15 of Minister of Energy and Mineral Resources Regulation No. 14/2012; and POB disincentives are listed in articles 22 to 26 PP No. 70/2009 and article 16 of Minister of Energy and Mineral Resources Regulation no. 14/2012. This POB has not been implemented to date.

b. Coordination Between Organizations Regarding Green House Gas (GHG) Emissions

The government's seriousness in reducing greenhouse gas emissions is demonstrated by building a partnership with one of the international energy organizations, namely the International Renewable Energy Agency (Irena).(EBTKE, 2021). Based on the signed agreement, Irena will prepare a comprehensive energy transition roadmap, identifying key policy actions, technological solutions and industrial development programs to achieve medium and long-term renewable energy goals and targets, as well as decarbonization goals in Indonesia. The cooperation also includes an assessment of the socio-economic benefits of the energy transition with an emphasis on the creation of new value chains, job creation and enhancement. Under the partnership, Irena and Indonesia will work closely on a new ambitious roadmap in line with the Paris Agreement's goals for a clean global economy by 2050. Irena will also facilitate access to climate finance and investment in renewable energy through discussions and dialogue on investment de-risking, development of project networks, support for project preparation, including through the Coalition for Sustainable Energy Access and the Climate Investment Platform Initiative (Ridwan, 2011).

Conclusion and future direction

With the Presidential Decree of the Republic of Indonesia number 61 of 2011 concerning the National Action Plan for Reducing Greenhouse Gas Emissions, it was issued by the government as a policy and real action target in the field to support a reduction in emission levels of 26% or for the forestry sector 14% by 2020. This Presidential Decree 61 needs to be supported because quantitative targets for reducing emissions for each sector have been determined, where the forestry sector is grouped into the forestry and peatland sectors. Thus, RAN-GRK is a binding regulation and contains work plans for implementing various activities that directly and indirectly reduce greenhouse gas emissions in accordance with national development targets.

Thus, the implementation of policies to reduce greenhouse gas emissions is running as it should. This can be seen from several indicators of policy implementation put forward by Edwards III, namely communication, resources, disposition and bureaucratic structure.

Implication

Based on the results of the discussion above, the researcher suggests the following, namely;

1. It is necessary to increase the number of companies targeted for mandatory implementation of energy management as outlined in the National Action Plan for Reducing GHG Emissions to increase indications of GHG emission reduction targets, and increase the efficiency of energy consumption in the industrial and commercial sectors
2. It is necessary to increase the electrification ratio as quickly as possible to optimize the efficiency of final energy consumption according to the household sector
3. It is necessary to reduce fuel subsidies to overcome the problem of energy wastage in the transportation sector
4. It is necessary to increase the use of new, renewable energy in electricity production to reduce greenhouse gas emissions and overcome the problem of limited fossil energy.
5. It is necessary to implement energy conservation policies through perfect energy management as quickly as possible in accordance with relevant laws and regulations to increase the efficiency of energy consumption in the industrial and building sectors.
6. It is necessary to increase the number of target objects for implementing the energy conservation partnership program as outlined in the National Action Plan for Reducing GHG Emissions to provide cost incentives for energy audits to many energy users

Volume 9 Nomor 1 Edisi April 2024 ISSN. 2540 – 816X

Conflict of Interest

The conflicts of interest in this research are:

a. Economic interest

The government may have an interest in strengthening certain industries that are major contributors to GHG emissions, such as the coal industry or the oil and gas industry. This could result in rejection or delay in implementing policies that reduce GHG emissions because it could disrupt the industry's profits.

b. Political Interests

Political parties or government officials who have close ties to industries that contribute to GHG emissions may not want to take actions that threaten their political support or relationships. Political interests in maintaining popularity or public image can also be an obstacle if GHG emission reduction policies are deemed inappropriate. popular or controversial by society.

c. Industrial Interests

Large industries that depend on fossil fuels for their operations may oppose GHG emission reduction policies because it could disrupt their business models or incur additional costs in switching to renewable energy sources. Companies with large investments in the fossil fuel industry may have an interest in in maintaining the status quo rather than confronting major changes in environmental regulations.

d. Community Interests

Some communities who depend on industries that contribute to GHG emissions may worry about losing their jobs or sources of income if emissions reduction policies are implemented without adequate mitigation measures. Community interests in protecting the environment and the welfare of future generations may conflict with the sector's interests. -industrial sectors that produce GHG emissions.

References

A.Kenji. (2021). Indonesia renews energy efficiency labels and MEPS for energy consuming equipment'. *Enviliance ASIA*.

Ambodo, T., Saputro, G. E., & ... (2022). Implementasi Kebijakan Pengembangan Teknologi Industri Pertahanan Dalam Mendukung Kemandirian Alat Peralatan Pertahanan. *NUSANTARA: Jurnal Ilmu ...*, *9*(3).

Amheka, A., & Higano, Y. (2015). An introduction to regional government in Indonesia to success RAD-GRK program: Literature review of GHG emission trends in Indonesia. *Regional Science Inquiry*, *7*(1).

Ampri, I. (2013). Berbagai Opsi Pembiayaan Rencana Aksi Daerah untuk Penurunan Emisi Gas Rumah Kaca (RAD-GRK) : Peluang& Tantangan. *Seminar Nasional Pembiayaan Perubahan Iklim*.

Anggraeni, D. Y. (2015a). PENGUNGKAPAN EMISI GAS RUMAH KACA, KINERJA LINGKUNGAN, DAN NILAI PERUSAHAAN. *Jurnal Akuntansi Dan Keuangan Indonesia*, *12*(2). https://doi.org/10.21002/jaki.2015.11

Anggraeni, D. Y. (2015b). Pengungkapan Emisi GRK, Kinerja Lingkungan, Dan Nilai Perusahaan. *Jurnal Akuntansi Dan Keuangan Indonesia*, *12*(2).

Ayu Arsita, S., Eko Saputro, G., & Susanto, S. (2021). Perkembangan Kebijakan Energi Nasional dan Energi Baru Terbarukan Indonesia. *Jurnal Syntax Transformation*, *2*(12). https://doi.org/10.46799/jst.v2i12.473

Ayuvitari, R. S., & Wijayanti, P. (2022). Potensi Reduksi Emisi GRK dan Kelayakan Finansial dari Teknologi Hidrotermal untuk Pengolahan Sampah di Kabupaten Tangerang. *Jurnal Ilmu Lingkungan*, *20*(1). https://doi.org/10.14710/jil.20.1.1-12

Chaerul, M., Dirgantara, G. G., & Akib, R. (2016). PREDICTION OF GREENHOUSE GASSES EMISSION FROM MUNICIPAL SOLID WASTE SECTOR IN KENDARI CITY, INDONESIA (Prediksi Emisi Gas Rumah Kaca dari Sektor Sampah di Kota Kendari, Indonesia). *Jurnal Manusia Dan Lingkungan*, *23*(1). https://doi.org/10.22146/jml.18772

Chaerul, M., Febrianto, A., & Tomo, H. S. (2020). Peningkatan Kualitas Penghitungan Emisi Gas Rumah Kaca dari Sektor Pengelolaan Sampah dengan Metode IPCC 2006 (Studi Kasus: Kota Cilacap). *Jurnal Ilmu Lingkungan*, *18*(1). https://doi.org/10.14710/jil.18.1.153-161

Danar, D., & Wahyu, A. (2019). Pengaruh Perubahan Tutupan Lahan Terhadap Emisi GRK pada Wilayah Cepat Tumbuh di Kota Semarang. *Jurnal Penginderaan Jauh Indonesia*, *1*(1).

Dewa, D. D., & Sejati, A. W. (2019). Pengaruh Perubahan Tutupan Lahan Terhadap Emisi GRK pada Wilayah Cepat Tumbuh di Kota Semarang. *Jurnal Penginderaan Jauh Indonesia*, *1*(1).

Dhillon, R. S., & von Wuehlisch, G. (2013). Mitigation of global warming through renewable biomass. In *Biomass and Bioenergy* (Vol. 48). https://doi.org/10.1016/j.biombioe.2012.11.005

EBTKE. (2021). *Strategi Capai Target Penurunan Emisi melalui Kategori Baru Penghargaan Efisiensi Energi 2021*. Https://Ebtke.Esdm.Go.Id.

ESDM. (2020). Inventarisasi emisi GRK bidang energi. *Inventarisasi Emisi Gas Rumah Kaca Sektor Energi Tahun 2020*.

Humas EBTKE. (2022). *Implementasi Peraturan Menteri ESDM tentang PLTS Atap*. Direktur Jenderal Energi Baru Terbarukan Dan Konversi Energi (EBTKE).

Juliana, J., & Saputro, G. E. (2022). The Policy of PT Len As a Main Integrator on Increasing National Income. *JMKSP (Jurnal Manajemen, Kepemimpinan, Dan Supervisi Pendidikan)*, *7*(2). https://doi.org/10.31851/jmksp.v7i2.8923

Kementerian Energi dan Sumber Daya Mineral. (2020). Inventarisasi emisi GRK bidang energi. In *Inventarisasi Emisi Gas Rumah Kaca Sektor Energi Tahun 2020*.

Kementerian Energi dan Teknologi Informasi. (2020). Inventarisasi Emisi GRK Bidang Energi. *Inventarisasi Emisi Gas Rumah Kaca Sektor Energi Tahun 2020*.

Kementerian ESDM. (2016). Data Inventory Emisi GRK Sektor Energi. In *Pusat Data dan Teknologi Informasi Energi dan Sumber Daya Mineral Kementerian Energi dan Sumber Daya Mineral*.

KLHK. (2020). Laporan Inventarisasi GRK 2020 dan Monitoring, Pelaporan, Verifikasi (MPV). *Kementerian Lingkungan Hidup Dan Kehutanan*.

Kramawijaya, A. G., & Dewi, K. (2017). Potensi Mitigasi Emisi Gas Rumah Kaca dari Kegiatan Eksplorasi dan Produksi Minyak dan Gas Bumi di PT. XYZ. *Journal of Env. Engineering & Waste Management, Vol. 2, No. 1, April 2017: 1-12*, *2*(1).

Kurnia W., A., Handayani, F. S., & Setyawan, A. (2022). Analisis Emisi GRK dengan metode LCA pada Pekerjaan Konstruksi Jembatan Simpang Susun Rangkasbitung. *Matriks Teknik Sipil*, *10*(3). https://doi.org/10.20961/mateksi.v10i3.61215

Margono, M., Sudarmanto, K., Sulistiyani, D., & Sihotang, A. P. (2022). Keabsahan Pengenaan Pajak Karbon Dalam Peraturan Perpajakan. *JURNAL USM LAW REVIEW*, *5*(2). https://doi.org/10.26623/julr.v5i2.5918

Minister of Energy and Mineral Resources Republic of Indonesia. (n.d.). Regulation of the Minister of Energy and Mineral Resources No. 14/2021 on Application of Minimum Energy Performance Standards to Energy Consuming Equipment. *2021*.

Miniter of Energy and Mineral Resources (MEMR) Republic of Indonesia. (n.d.). Decree of the Minister of Energy and Mineral Resources Republic of Indonesia No. 134.K/EK.07/DJE/2022 on Minimum Energy Performance Standard and Sign Labels Save Energy for Energy Using Equipment Lights - Emitting Diodes (LED). *2022*.

Mulyani, Saputro, E. G., & Deksino, G. R. (2022). Peningkatan Ekonomi Pertahanan Negara Melalui Implementasi Kebijakan Produksi Kendaraan Tempur Anoa PT PINDAD (Persero). *Jurnal Inovasi Penelitian*, *2*(9).

Muryani, M. (2020). Produksi bersih dan model kerjasama sebagai upaya mitigasi emisi gas rumah kaca pada sektor industri. *Jurnal Sosiologi Dialektika*, *13*(1). https://doi.org/10.20473/dk.v13i1.2018.48-65

Peraturan Presiden Republik Indonesia No. 61 Tahun 2012 Tenang Rencana Aksi Nasional Penurunan Emisi Gas Rumah Kaca, Sekretariat Negara : Jakarta (2011).

Prasetyo, A. W., & Windarta, J. (2022). Pemanfaatan Teknologi Carbon Capture Storage (CCS) dalam Upaya Mendukung Produksi Energi yang Berkelanjutan. *Jurnal Energi Baru Dan Terbarukan*, *3*(3). https://doi.org/10.14710/jebt.2022.14509

Purnamasari, E., Sudarno, & Hadiyanto. (2019). Inventarisasi emisi gas rumah kaca sektor pertanian Di Kabupaten Boyolali. *Prosiding Seminar Nasional Geotik*.

Ramdhani, M., Yani, M., & Ismayana, A. (2019). Analisis Emisi GRK dan Konversi Energi pada Produksi Minyak Jarak (Ricinus communis L.) dengan Metode Life Cycle Assessment (LCA). *Jurnal Pengelolaan Sumberdaya Alam Dan Lingkungan (Journal of Natural Resources and Environmental Management)*, *9*(3). https://doi.org/10.29244/jpsl.9.3.680-691

Ridwan, W. (2011). Analisis Perubahan Tingkat Kenyamanan Kota Malang. In *Jurnal Agrisistem* (Vol. 4, Issue 1 dan 2).

Saharjo, B. H. (2022). Penelitian Penilaian Emisi GRK di Indonesia dari Kebakaran Hutan dan Lahan. *Journal of Tropical Silviculture*, *13*(01). https://doi.org/10.29244/j-siltrop.13.01.14-22

Saputro, G. E. (2022). Kerjasama Industri Pertahanan Indonesia dan Korea Selatan Dalam Perspektif Ekonomi Pertahanan. *Journal Education and Development* , *10*(2).

Sasongko, N. A., Noguchi, R., & Ahamed, T. (2018). Environmental load assessment for an integrated design of microalgae system of palm oil mill in Indonesia. *Energy*, *159*. https://doi.org/10.1016/j.energy.2018.03.144

Swastika, B. A. (2014). Upaya Pemerintah China Dalam Penurunan Emisi Gas Rumah Kaca Melalui Cdm (Clean Development Mechanism) Sebagai Bentuk Implementasi Protokol Kyoto. *UNEJ Journal*, *1*(1).

Tomo, B. D., & Brunner, I. M. I. (2022). Pengaruh Biodiesel Terhadap Penurunan Emisi Gas Rumah Kaca dengan Aplikasi APPLE-GATRIK (Studi Kasus PLTD Talaga Sulawesi Tenggara). *Jurnal Serambi Engineering*, *7*(3). https://doi.org/10.32672/jse.v7i3.4430

Utami, I., Yoesgiantoro, D., & Sasongko, N. A. (2022). Implementasi Kebijakan Kendaraan Listrik Indonesia Untuk Mendukung Ketahanan Energi Nasional Implementation Of Battery-Based Electric Motor Vehicle Policies To Support National Energy Security. *Jurnal Ketahanan Energi*, *Volume 8 N*(1).

Utaminingsih, W., & Hidayah, S. (2019). Mitigasi emisi gas rumah kaca melalui penerapan irigasi intermittent di lahan sawah beririgasi. *Jurnal Irigasi*, *7*(2). https://doi.org/10.31028/ji.v7.i2.132-141

Wicaksono, A. P., & Nugroho, A. (2023). Kesiapan Komitmen Indonesia Dalam Paris Agreement Melalui Investasi Di Sektor Energi Baru Terbarukan. *MARTABE*, *6*(1).

Wieddya, W. (Wieddya), Nugraha, W. D. (Winardi), & Andarani, P. (Pertiwi). (2017). Potensi Penurunan Emisi Gas Rumah Kaca Dan Penggunaan Energi Dalam Sistem Produksi Minyak Kelapa Sawit Mentah (Crude Palm Oil-cpo) Studi Kasus: PT. Sinarmas Agro Resources and Technology Tbk. *Jurnal Teknik Lingkungan*, *6*(1).