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The Impact of Electricity Energy Production, Fossil Energy Consumption, Renewable Energy Consumption, Deforestation, and Agriculture towards Climate Change in Middle-Income Countries

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ABSTRACT

This study aims to determine the effect of electrical energy production, fossil energy consumption, renewable energy consumption, deforestation and agriculture on climate change in middle-income countries. The method of analysis uses the Fixed Effect Model Cross-section weight regression model. The results of the study found that the production of electrical energy, the consumption of fossil energy had a significant positive effect on climate change. The development of environmentally friendly technologies in the agricultural sector needs to be carried out so that the sector does not damage the climate in middle-income countries. Reducing deforestation and consumption of renewable energy in middle-income countries has a positive effect on efforts to cure climate change.

Keywords: Electrical Energy Production, Climate Change, Greenhouse Gas Emission, Fossil Energy, Renewable Energy, Deforestation
JEL Classifications: O44, Q56

1. INTRODUCTION

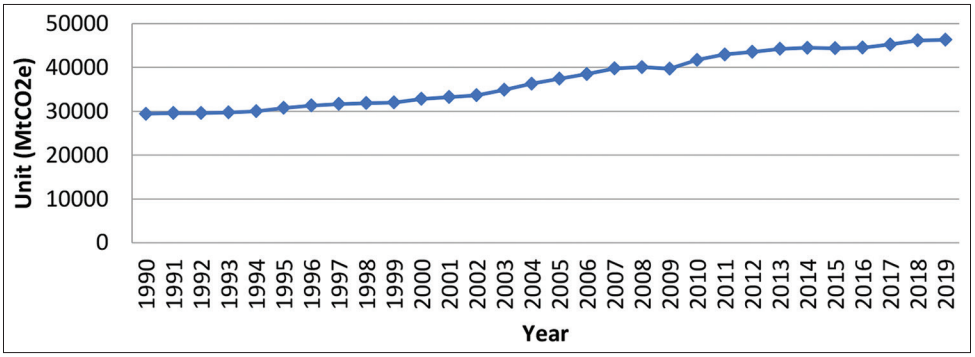
Since the 1990s, climate change caused by the high concentration of greenhouse gas emissions in the Earth's atmosphere has become a global issue that is widely discussed (Belloc and Molina, 2023; Jain, 1993). Since then, greenhouse gas emissions have continued to increase annually. Uncontrolled concentration of greenhouse gas emissions can lead to climate change on earth. Therefore, reducing the concentration of greenhouse gas emissions produced is one of the mitigation efforts in tackling climate change in the world.

Based on the empirical data in Figure 1, it can be seen that since 1990 greenhouse gas emissions have continued to increase every year. In 2019, greenhouse gas emissions in the world were recorded at 46287.62 $MtCO_2e$, or an increase of approximately 581.3 $MtCO_2e$ every year. Where in 1990, the resulting greenhouse gas emissions amounted to 29434.68 $MtCO_2e$. This increase in greenhouse gas emissions is due to an increase in human activities such as production activities, consumption of fossil energy, oil, coal and natural gas and deforestation (Islam and Abdul Ghani, 2018).

Based on the income group, middle-income countries are the largest contributors to greenhouse gas emissions in the world. From 2010 to 2019, middle-income countries have made a large contribution to global greenhouse gas emissions. This can be seen in Figure 2 below:

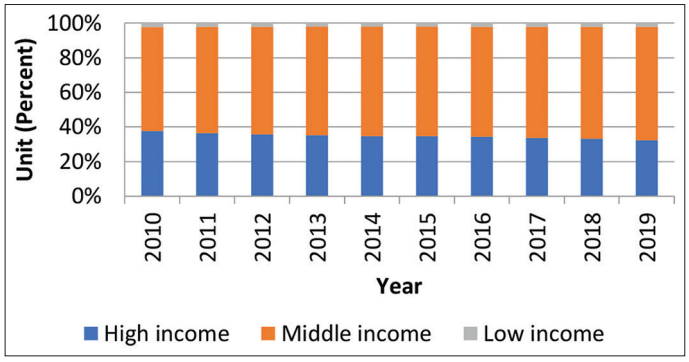
From Figure 2 it can be seen that most of the greenhouse gas emissions in the world come from middle-income countries. About 60% of the world's greenhouse gas emissions come from middle-

Figure 1: Total of greenhouse gas emission worldwide in 1990-2019



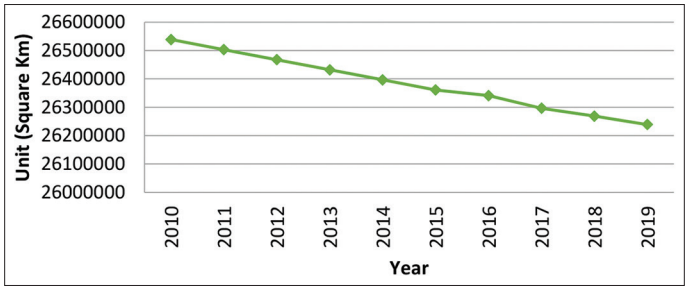
Source: World Bank, 2022

Figure 2: Contribution of greenhouse gas emission based on income in 2010-2019



Source: World Bank, 2022

Figure 3: Medium income state forest area in 2010-2019



Source: World Bank, 2022

income countries. This is the background why policy making in middle-income countries has an important role in climate change in the world.

Production activity is one of the factors thought to influence the resulting greenhouse gas emissions. In the modern era, energy consumption is important in driving the production process. This is because energy consumption plays an important role in increasing economic productivity in a country. As a result, energy consumption to increase economic growth continues to be carried out by middle-income countries until it reaches its maximum point. But on the other hand, energy consumption often has a negative impact on environmental quality (Al-Mulali and Che Sab, 2018; Sohag et al., 2017).

Land use, especially forests, is also important for climate change mitigation efforts. This is because forests are a means of climate change mitigation efforts due to increased greenhouse gas emissions. Forests are able to absorb greenhouse gas emissions, especially carbon dioxide in the earth's atmosphere (Khan et al., 2018). However, some middle-income countries continue to experience high levels of deforestation. The following is empirical data on the rate of reduction of forest land in middle-income countries.

Based on empirical data, Figure 3 shows that the area of forest owned by middle-income countries globally has continued to decrease from 2010 to 2019. It was recorded that in 2010 the forest area was 26538557.01 km^2, remaining 26238774.1 km^2 in 2019. In other words, during this time, the forest area in middle-income countries has decreased by 33309.1 km^2 each year. Based on the publication of the Food Association Organization (2020) it is known that Brazil is the country with the largest deforestation in the 2010-2020 period, namely 1496100 ha per year or 0.3% per year.

Apart from forests, the agricultural sector is thought to have contributed to greenhouse gas emissions produced by middle-income countries. This sector will be affected if climate change occurs. However, on the other hand, this sector is a major source of greenhouse gas emissions in the form of nitrogen and methane (Haider et al., 2022; Lynch et al., 2021). Therefore, it is necessary to adopt appropriate policies with the aim of developing middle-income countries. So that the policies taken have a good impact on climate change mitigation efforts due to the resulting greenhouse gas emissions.

Based on the background description above, this study was conducted to determine the effect of per capita income, electricity production, fossil energy consumption (natural gas, coal, oil), renewable energy consumption, deforestation, and agriculture on greenhouse gas emissions produced in low and middle-income countries medium term, 2010-2019 period. Based on the findings of this study, policy makers in middle-income countries can use it in formulating appropriate policies to reduce greenhouse gas emissions.

2. LITERATURE REVIEW

According to Islam and Abdul Ghani (2018) the increment of greenhouse gas emissions can cause climate change due to human

Table 1: The secondary data used in this study

Variable	Symbol	Data	Unit
Greenhouse Gas Emission	GHG	Total Greenhouse Gas Emission	Ton CO_2 equivalent
Income Per Capita	GDPK	PDB per capita	US$
Electricity Energy Production	ELECT	Total Electricity Energy Production	Watt per hour
Natural Gas Consumption	GAS	Total Gas Energy Consumption	Watt per hour
Coal Consumption	COAL	Total Coal Energy Consumption	Watt per hour
Oil Consumption	OIL	Total Oil Energy Consumption	Watt per hour
Renewable Energy Consumption	RE	Total energy consumption (water, air, solar, other renewable energy)	Watt per hour
Forest Area	FA	Forest Area	M per square
Agriculture Sector	AGR	Agriculture Sector Area	M per square

The units of BP fossil fuels in Our World in Data have been converted from Exajoules (EJ) to Sertat-hours (TWh) with a conversion factor of 1,000,000/3,600 (~277,778). In this study the data is then transformed into units of Watt-hour (Wh). Source: (Our World in Data, 2022; World Bank, 2022)

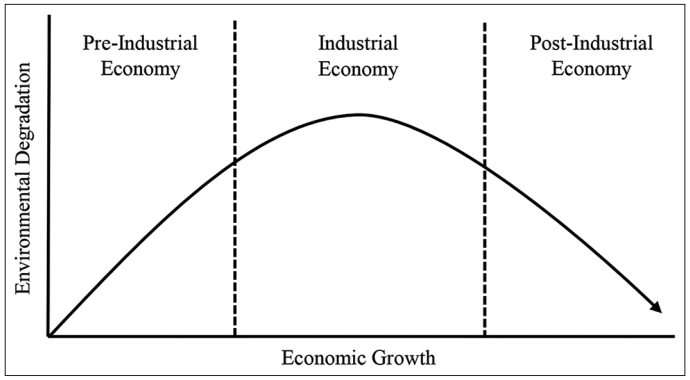
activities such as production activities, energy consumption, and deforestation. The Anthropogenic Global Warming (AGW) theory, also known as the AGW theory, explains that the emission of greenhouse gases, especially carbon dioxide, nitrogen and methane, will cause an increase in global temperature on earth which will lead to climate change (Bast, 2010). This can happen because the sunlight received to the earth should be reflected back into atmosphere. However, because the air on earth is dense due to greenhouse gases, it causes the sun's heat which must be reflected out of space to be stuck on earth so that the global average temperature increases. This phenomenon is known as the greenhouse effect which causes global warming. The existence of global warming that occurs continuously is what triggers climate change on earth.

When viewed from a socio-economic perspective, the relationship between economic activity and the environment can be explained by the Environmental Kuznet Curve (EKC) theory. The Environmental Kuznet Curve (EKC) theory is a theory used to explain the relationship between economic growth and environmental degradation (Shabestari, 2018). This theory states that there is an inverse U-shape relationship between environmental degradation and a country's income. In this case, a country's income is measured by GDP and GDP per capita. In the early stages of development, an increase in a country's income will be followed by an increase in environmental degradation. This can be seen in Figure 4 below:

Based on Figure 4, it can be explained that at the beginning of a country's economic growth will have a bad impact on environmental quality. This is because the economic growth that occurs only focuses on increasing production without considering the impact of economic growth on the environment. However, at a certain point, economic growth will reach its maximum point so that a country will slowly realize the impact of economic growth on its environment. So that at this point the economic growth that occurs is able to improve the quality of the environment in the country (Nikensari et al., 2019).

Several research has been conducted on the effect of economic activity, energy consumption on greenhouse gas emissions produced by a country (Adeleye et al., 2021; Islam and Abdul Ghani, 2018; Nguyen et al., 2022; Yusuf et al., 2020). From these studies, similar results were obtained where economic activity and energy consumption used had a positive influence on the resulting

Figure 4: Turning point process of EKC hypothesis



Source: (Alinor, 2013; Nikensari et al., 2019)

greenhouse gas emissions. The greater the energy consumption, the greater the economic activity carried out. However, the preference for selecting the energy used is one of the factors that influence the resulting greenhouse gas emissions. The use of fossil energy has a bad influence on environmental conditions. For this reason, several researchers suggest that the renewable energy transition can be a solution to reduce the resulting greenhouse gas emissions (Li and Leung, 2021; Lyeonov et al., 2019; Nguyen et al., 2022; Sterpu et al., 2018; Vasylieva, 2019; Yamaka et al., 2021).

In Begum et al.'s research, (2020); Khan et al. (2018); Pereira et al. (2022), forests have an important role in climate change mitigation efforts. Forests are able to absorb greenhouse gas emissions produced in a country. However, in some country's forests are often still deforested. From an economic standpoint, this deforestation can occur due to the utilization of forest commodities, bearing in mind that forests are a provider of raw materials to meet needs or increase economic growth. Rifa'i and Dewi (2018) analyzed the impact of environmental quality on economic growth in ASEAN countries, showing that the area of forest has a positive effect on economic growth. The existence of this positive influence relationship makes the forest exploited to increase economic growth. This becomes bad when not considering the environmental impact caused.

Research by Boke Olén et al. (2021) and Pereira et al. (2022), shows that the expansion of the agricultural sector has an adverse effect on climate change. Where the increasing deforestation and expansion of the agricultural sector can increase the greenhouse gas emissions produced. In some cases, the agricultural sector is one of the factors driving deforestation. Management of the

agricultural sector in the traditional way is one of the factors that causes deforestation. In addition, naturally the agricultural sector is also a major sector contributing to greenhouse gas emissions in the form of nitrogen and methane (Haider et al., 2022; Lynch et al., 2021; Vetter et al., 2017; Khatri-Chhetri et al., 2022). The excessive use of fertilizers to increase the productivity of the agricultural sector is the cause of this sector having a negative impact on climate change (IPCC, 2019).

3. RESEARCH METHODS

This study uses a descriptive analysis method with an econometric model to determine the effect of the independent variables on the dependent variable. The data used in this study is panel data for 26 middle-income countries from 2010 to 2019. The 26 countries are: Algeria, Argentina, Azerbaijan, Bangladesh, Belarus, Brazil, Bulgaria, China, Colombia, Ecuador, Egypt, India, Indonesia, Iran, Malaysia, Mexico, Morocco, North Macedonia, Pakistan, Peru, Philippines, South Africa, Thailand, Ukraine, Uzbekistan and Vietnam. The secondary data used in this study are as presented in Table 1.

In this study, the consumption of fossil energy includes: natural gas, coal energy consumption, and oil energy consumption. Meanwhile, renewable energy consumption includes: The total energy consumption of water, wind, solar, and other renewable energy. Following the EKC equation model, the equation model used in this study is as follows:

$$GHG = f(GDPK, GDPK2, ELECT, GAS, COAL, OIL, RE, FA, AGR) \quad (1)$$

$$GHG_{it} = \beta_0 + \beta_1 GDPK_{it} + \beta_2 GDPK2_{it} + \beta_3 ELECT_{it} + \beta_4 GAS_{it} + \beta_5 COAL_{it} + \beta_6 OIL_{it} + \beta_7 RE_{it} + \beta_8 FA_{it} + \beta_9 AGR_{it} + e_{it} \quad (2)$$

$$LnGHG^{it} = \beta_0 + \beta_1 LnGDPK_{it} + \beta_2 LnGDPK2_{it} + \beta_3 LnELECT_{it} + \beta_4 LnGAS_{it} + \beta_5 LnCOAL_{it} + \beta_6 LnOIL_{it} + \beta_7 LnRE_{it} + \beta_8 LnFA_{it} + \beta_9 LnAGR_{it} + e_{it} \quad (3)$$

Table 2: Model fitment test result

Test	Hypothesis	Prob.	Details
Chow test	H_0=CEM (prob. >0.05)	0.0000	Prob. <0.05
	H_1=FEM (prob. <0.05)		FEM best model
Hausman test	H_0=REM (prob. >0.05)	0.0000	Prob. <0.05
	H_1=FEM (prob. <0.05)		FEM best model

Source: Eviews 10, 2023

Description:
GHG=greenhouse gas emission; GDPK=GDP percapita; GDPK2=GDP per capita in square; Elect=Production of electrical energy; Gas=Natural gas; Coal=Coal; Oil=Oil; RE=Renewable energy; FA=Forest area; Agr=Agriculture area; Ln=logaritma natural; β_0=Contant; β_1, β_2, β_3, β_4, β_5=Coefficient each independent variable; It=Panel data; and e=Error term.

4. RESULTS AND DISCUSSION

4.1. Result

In the data testing panel, there are three types of test models, namely Common Effect Model (CEM), Fixed Effect Model (FEM), and Random Effect Model (REM). Based on the three models, a model suitability test was carried out, to determine the appropriate model regression panel in explaining sales in research. The data in Table 2 below are the results of the model suitability test in this study:

Based on the results of the Chow and Hausman tests in Table 2, it can be seen that the probability value produced in the Chow test is <α=5%, so it can be concluded that FEM is more appropriate for explaining equation models, compared to CEM. The Hausman test results show that FEM is also a more appropriate model in explaining the equation compared to REM. This can be seen from the probability value of the Hausman Test which is less than the value of α=5%. Based on these two tests, it can be concluded that FEM is the most appropriate model in explaining the equation model in this study.

Once the best panel regression model is known, then the selected model needs to be tested with classical assumptions. The following are the results of testing the classical assumptions:

4.1.1. Multicollinearity test

Based on the results of the multicollinearity test in Table 3, it can be seen that the value of the multicollinear matrix between variables in general has a value lower than 0.8, meaning that the independent variables in the model are not correlated with one another. The model is said to have no multicollinearity problem when the correlation value between the independent variables is not more than 0.8 to 0.9 (Kim, 2019). From the test results it was concluded that the equation model in this study did not have a multicollinearity problem even though the LnGDPK and $LnGDPK^2$ variables were correlated. Based on the

Table 3: Multicollinearity test result

Variable	LnGDPK	$LnGDPK^2$	LnELECT	LnGAS	LnCOAL	LnOIL	LnRE	LnFA	LnAGR
LnGDPK	1	0.999	0.150	−0.010	−0.046	0.155	0.135	0.388	0.149
LnGDPK2	0.999	1	0.161	0.003	−0.040	0.163	0.144	0.397	0.161
LnELECT	0.150	0.161	1	0.225	0.404	0.382	0.363	0.501	0.401
LnGAS	−0.010	0.003	0.225	1	0.354	0.689	0.368	0.272	0.585
LnCOAL	−0.046	−0.040	0.404	0.354	1	0.616	0.590	0.538	0.602
LnOIL	0.155	0.163	0.382	0.689	0.616	1	0.727	0.595	0.780
LnRE	0.135	0.144	0.363	0.368	0.590	0.727	1	0.652	0.621
LnFA	0.388	0.397	0.501	0.272	0.538	0.595	0.652	1	0.745
LnAGR	0.149	0.161	0.401	0.585	0.602	0.780	0.621	0.745	1

Source: Eviews 10, 2023

EKC theory, multicorrelation problems in this theory cannot be avoided considering that LnGDPK^2 is another form (quadratic) of LnGDPK, in other words structural multicollinearity occurs (Nikensari et al., 2019).

4.1.2. Heteroscedasticity test

From the Glejser test results in Table 4, it can be seen that the average probability value for each variable is >α=0.05, so it can be concluded that the regression model in this study has no heteroscedasticity problem.

4.1.3. Autocorrelation test

Based on the Durbin-Watson test result in Table 5, the Durbin Watson value generated in this equation model is 0.627426. This value is smaller than the lower Durbin-Watson limit, which means there is autocorrelation in the model. To overcome the autocorrelation problem that occurs, the model will be estimated using the Generalized Least Squares or GLS method where in this method it is assumed that the model is free from autocorrelation problems (Damodar, 2011; Lassoued, 2021; Shaikh et al., 2021).

4.1.4. Normality test

Based on the results of the normality test in Table 6, it can be seen that the equation model has a normal distribution of residuals. This can be seen from the resulting Jarque-Berra probability value of 0.468219, <α=5%, so it can be concluded that the residuals are normally distributed.

4.1.5. Fixed effect model test results

Based on the results of Chow and Hausman's test that FEM is more appropriate to explain the effect of the independent variable on the dependent variable. The FEM test results are presented in Table 7 below.

Based on the independent variable test result on the dependent variable (Table 7), it is presented in the final equation as follows:

Table 4: Glejser heteroscedasticity test result

Independent variable	t-statistic	Prob.	Details
LnGDPK	−0.786194	0.4326	Not significant
LnGDPK^2	0.853676	0.3942	Not significant
LnELECT	1.7295	0.0851	Not significant
LnGAS	−0.649225	0.5169	Not significant
LnCOAL	−0.09122	0.9274	Not significant
LnOIL	−0.523775	0.601	Not significant
LnRE	0.121795	0.9032	Not significant
LnFA	−1.554724	0.1214	Not significant
LnAGR	−0.096737	0.9230	Not significant

Source: Eviews 10, 2023

Table 5: Autocorrelation test result

Durbin-Watson stat	0.627426

Source: Eviews 10, 2023

Table 6: Normality test result

Jarque-Berra	1.517637
Probability	0.468219

Source: Eviews 10, 2023

$$\begin{aligned} LnGHG_{it} &= 3.229405 - 0.167230 LnGDPK_{it} + 0.007542 LnGDPK^2{}_{it} \\ &+ 0.340945 LnELECT_{it} + 0.036934 LnGAS_{it} \\ &+ 0.029016 LnCOAL_{it} + 0.254752 LnOIL_{it} \\ &- 0.012691 LnRE_{it} - 0.314548 LnFA_{it} \\ &+ 0.147177 LnAGR_{it} + e_{it} \end{aligned} \quad (4)$$

Based on the tests that have been carried out, it is known that per capita income has no effect on climate change. This can be seen from the t-statistic value of the LnGDPK variable which is smaller than the t-table value ($-1.053498_{\text{t-stat}} < 2.254936_{\text{t-table}}$). In addition, the Environmental Kuznert Curve theory was not proven in this study, the t-statistic value produced by the LnGDPK2 variable is greater than the t-table value ($0.8198_{\text{t-stat}} > -2.254936_{\text{t-table}}$). Electrical energy production has a significant positive effect on climate change in middle-income countries ($13.37458_{\text{t-stat}} > 2.254936_{\text{t-table}}$). Natural gas energy consumption has a significant positive effect on climate change ($2.351076_{\text{t-stat}} > 2.254936_{\text{t-table}}$). Coal energy consumption has a significant positive effect on climate change ($3.548947_{\text{t-stat}} > 2.254936_{\text{t-table}}$). Oil energy consumption has a significant positive effect on climate change ($9.715449_{\text{t-stat}} > 2.254936_{\text{t-table}}$). Renewable energy consumption has a significant negative effect on α=5% ($-1.870547_{\text{t-stat}} > -2.254936_{\text{t-table}}$). Forest area has a significant negative effect on climate change ($-4.980228_{\text{t-stat}} < -2.254936_{\text{t-table}}$). The agricultural sector has a significant positive influence on climate change ($3.154178_{\text{t-stat}} > 2.254936_{\text{t-table}}$).

5. DISCUSSION

This research was conducted to analyze the effect of per capita income, electrical energy production, fossil energy consumption, renewable energy consumption, deforestation and agriculture on climate change in middle-income countries in 2010-2019.

Based on the results of previous tests, per capita income has no effect on climate change and the Environmental Kurznet Curve (EKC) theory in this study is not proven. This can be seen from the magnitude of the coefficient value produced by the LnGDPK variable which is greater than LnGDPK2 which shows a U-shaped curve. So it can be concluded that in this study the EKC hypothesis did not occur. This finding is in accordance with research conducted by Azam and Khan (2016), Nikensari et al. (2019) Li and Li (2021) which states that the EKC theory is not proven in middle-income countries.

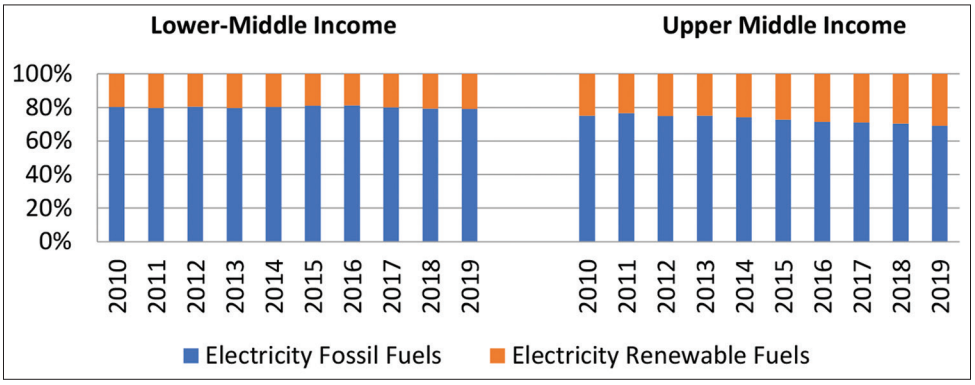
Meanwhile, the production of electrical energy has a positive and significant impact on climate change. Where every 1% increase in electrical energy production in middle-income countries will increase greenhouse gas emissions by 0.340945%. This can happen because the production of electrical energy in middle-income countries is still dominated by fossil energy. Meanwhile, as is known, fossil energy tends to be a pollutant. Based on empirical data in Figure 5, it is known that around 70% of middle-income countries tend to still use fossil energy to generate electricity. Therefore, the production of electrical energy in middle-income countries results in high greenhouse gas emissions. This is in

Table 7: FEM test result

Variable	Coefficient	t-statistic	Prob.		
C	3.229405	2.086953	1.547426	*R-squared*	0.999569
LnGDPK	−0.167230	−1.053498	0.2932	*Adjusted R-squared*	0.999504
$LnGDPK^2$	0.007542	0.819807	0.4132	*F-statistic*	15350.27
LnELECT	0.340945	13.37458	0.0000***	*Prob (F-statistic)*	0.000000
LnGAS	0.036934	2.351076	0.0196**		
LnCOAL	0.029016	3.548947	0.0005**		
LnOIL	0.254752	9.715449	0.0000***		
LnRE	−0.012691	−1.870547	0.0627*		
LnFA	−0.314548	−4.980228	0.0000***		
LnAGR	0.147177	3.154178	0.0018**		

Details: ***α=0 persen; **α=5 persen; *α=10 persen

Figure 5: Percentage of electrical energy production based on energy sources in middle-income countries 2010-2019



Source: World Bank, 2022

accordance with research conducted by Noorpoor and Kudahi (2015), where the production of electrical energy that utilizes fossil energy tends to increase greenhouse gas emissions, especially carbon dioxide. For this reason, the development of environmentally friendly energy sources can minimize pollution resulting from the production of electrical energy, so that extreme climate change can be prevented (Anastacio, 2017).

Research by Sterpu et al. (2018) shows that increased energy consumption can increase the resulting greenhouse gas emissions. But it is different with the consumption of renewable energy. Consumption of renewable energy can reduce the resulting greenhouse gas emissions. This statement supports the findings in this study, where increased consumption of fossil energy can increase greenhouse gas emissions. Every 1% increase in coal energy consumption will increase greenhouse gas emissions by 0.029016%. Meanwhile, every 1% increase in oil energy consumption will increase greenhouse gas emissions by 0.254752%. A 1% increase in natural gas energy consumption will increase greenhouse gas emissions by 0.036934%. This is in accordance with research conducted by Begum et al. (2020); Islam and Abdul Ghani, (2018); Nguyen et al. (2022); Pereira et al. (2022); Yusuf et al. (2020), where the consumption of fossil energy can increase the resulting greenhouse gas emissions.

Renewable energy consumption has a significant negative effect on controlling greenhouse gas emissions in middle-income countries in 2010-2019. Consumption of renewable energy has a good influence on mitigation efforts to control greenhouse gas emissions. This is in accordance with research conducted by (Li and Leung, 2021; Lyeonov et al., 2019; Nguyen et al., 2022; Sterpu et al., 2018; Vasylieva, b2019; Yamaka et al., 2021).

Forest area has a good influence on efforts to control greenhouse gas emissions. Where when there is a 1% increase in forest area in middle-income countries, it will be able to absorb the greenhouse gas emissions produced by 0.314548%. This is because forests play an important role in absorbing the resulting greenhouse gas emissions. The findings of this study are in line with the results of research conducted by: Begum et al. 2020; Khan et al. 2018; Pereira et al. 2022, whereby reducing the rate of deforestation can reduce the resulting greenhouse gas emissions so that extreme climate change can be prevented. In this case forests have an effective influence on climate change mitigation efforts.

The results of his subsequent research show that the agricultural sector has a positive influence on greenhouse gas emissions in middle-income countries. Where every 1% increase in the agricultural sector can increase greenhouse gas emissions by 0.147177%. This is in accordance with research conducted by Pereira et al. (2022) where an increase in the agricultural sector was followed by an increase in the resulting greenhouse gas emissions. The agricultural sector is also a sector that contributes to greenhouse gas emissions in the form of nitrogen and methane (Haider et al., 2022; Lynch et al., 2021; Vetter et al., 2017). Agricultural development programs that are maintained such as forest management, agriculture and livestock management have a good influence on programs to reduce greenhouse gas emissions (Khatri-Chhetri et al., 2022). Therefore, the success

of agricultural sector policies in efforts to reduce greenhouse gas emissions plays an important role in efforts to mitigate climate change.

6. CONCLUSION

Based on the analysis that has been done, it can be seen that controlling greenhouse gas emissions needs to be done to minimize the occurrence of extreme climate change which has the potential to cause disaster for sustainable development in the world. Production of electrical energy, consumption of fossil energy, consumption of renewable energy together has a significant influence on climate change as measured by greenhouse gas emissions in middle-income countries in 2010-2019.

Electrical energy production, fossil energy consumption (energy consumption of natural gas, coal, oil) has a significant positive effect on climate change. The development of environmentally friendly technologies for the agricultural sector needs to be carried out so that the sector does not exacerbate climate change in middle-income countries. In addition, reducing the rate of deforestation and consumption of renewable energy in middle-income countries has a positive effect on climate change mitigation efforts.

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