# Effects of Climate Change on Energy Dynamics in Malaysia: an ARDL Analysis

Mochamad Suparmanto[1],Bambang Hadi Prabowo[2],Fina Amaliyah Hidayanti[3]
[1,2,3]STIE Jaya Negara Tamansiswa Malang,Indonesia

## Abstract

This study looks at how Malaysian energy availability and usage are affected by climate change. We use the World Bank as a complementary source of statistical data, namely data from 2000 to 2016, the variables we use are climate change, use of renewable energy, access to electricity, and use of electric power. We found that use of renewable energy has a positive and significant effect on climate change. That is, the higher the consumption of renewable energy, the lower the level of climate change. Renewable energy can help reduce greenhouse gas emissions which are the main cause of climate change. The factor of access to electricity also affects climate change. That is, the higher access to electricity, the higher the rate of climate change. The electricity consumption variable also has a positive and significant effect on climate change. That is, the higher the consumption of electricity, the higher the rate of climate change. Electricity consumption can also affect greenhouse gas emissions from the energy sector, depending on the energy mix used to generate electricity.

**Keyword :** Climate Change, Renewable Energy, Access To Electricity, Use Of Electric Power, Malaysia.
**JEL Classification :** C31, O10, O13.
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## Background

One of today's most urgent and difficult global challenges is climate change. Climate change can affect various aspects of human life and nature, including the supply and demand for energy. Energy is an important factor for economic, social and environmental development. However, the energy sector is also a major contributor to greenhouse gas (GHG) emissions which cause climate change. Therefore, in order to lessen the harmful effects of climate change and enhance human wellbeing, a sustainable and inclusive energy transition is required (Farabi, Abdullah, & Setianto, 2019; Rusminingsih, Askar,Mutia, Fitria, Wahyudi, 2023).

Malaysia is one of the countries potentially affected by climate change, such as rising temperatures, shifting rain patterns, increasing frequency and intensity of natural disasters, and rising sea levels. Climate change can affect energy production and consumption in Malaysia through various mechanisms, such as increasing the demand for air conditioners and fans in the household and commercial sectors due to rising temperatures, and increasing the potential for solar power generation due to increased solar radiation (Vaka, Walvekar, Rasheed, & Khalid, 2020; Irawan, Sasongko, Mukhlis, Yanto, & Wulandari, 2022).

On the other hand, energy consumption in Malaysia can also affect climate change through GHG emissions resulting from burning fossil fuels to produce electricity or transportation fuel. The majority of Malaysia's power is now produced from fossil fuels, mostly coal and natural gas. This causes high carbon dioxide emissions from the energy sector. In addition, the transportation sector in Malaysia also relies on petroleum fuels which also produce GHG emissions (Ridzuan, Marwan, Khalid, Ali, & Tseng, 2020; Priyanto, Widarni, & Bawono, 2022).

To reduce GHG emissions from the energy sector and adapt to the impacts of climate change, Malaysia needs to include more renewable energy (RE) into its overall energy mix. RE is a naturally renewable

source of energy, such as solar, wind, water, biomass and geothermal. RE can help reduce Malaysia's dependence on imported fossil fuels, improve energy security, diversify energy sources, and economic development. In addition, RE can also help reduce local and regional air pollution which can exacerbate the impact of climate change on human health and the environment (Ali, Razman, & Awang, 2020; Sasongko, Nehruddin, Musriyatun, Siswanto, 2023).

Malaysia has great potential to develop RE, especially geothermal, solar photovoltaic (PV), micro-hydro hydropower (MH), solid biomass (BP), biogas (BG), and biodiesel (BD). However, RE consumption in Malaysia is still low compared to other countries in Southeast Asia. According to International Renewable Energy Agency (IRENA) data, RE consumption in Malaysia was only around 6% of total final energy consumption in 2018, while the regional average was around 15%. This shows that there are still challenges and obstacles hindering RE development in Malaysia, such as the lack of consistent and long-term policies and incentives to encourage private investment and participation in the RE sector, and the lack of adequate and reliable infrastructure and power grid connectivity to integrate RE. into the national electricity system (Aeknarajindat, Suteerachai, & Suksod, 2020).

Apart from increasing RE consumption, Malaysia also needs to increase access to electricity (AKL) and energy efficiency (EE) to achieve a sustainable and inclusive energy transition. AKL is the ability to connect to a reliable and affordable power grid or other power source. AKL is an indicator of human development, because it can improve people's welfare, health, education, and productivity. AKL can also affect electricity consumption, because the more people who have access, the greater the demand for electricity (Brini, 2021).

Malaysia has a high level of AKL compared to other countries in Southeast Asia. According to World Bank data, AKL in Malaysia reached 100% in 2018, while the regional average is around 85%. This shows that Malaysia has succeeded in providing universal electricity services to all of its citizens. However, there are still challenges and opportunities to improve the quality and reliability of electricity services in Malaysia, such as Overcoming the problem of frequent power supply interruptions in some areas, especially in Sabah and Sarawak, and increasing the power transmission and distribution capacity to accommodate increased electricity demand and integration ET (Raihan & Tuspekova, 2022).

EE is the ratio between the output or result of energy use with the input or amount of energy used. EE can help reduce energy consumption without compromising performance or quality of service. EE can also help reduce GHG emissions from the energy sector, save operational costs, increase productivity, and improve competitiveness. EE can be applied in various energy end-use sectors, such as industry, transportation, building, agriculture, etc. Malaysia has great potential to increase EE in various energy end-use sectors. According to the study, Malaysia can save up to 25% of its energy consumption by 2030 by implementing various economical EE measures. This is equivalent to saving around 60 million tons of carbon dioxide per year. However, the implementation of EE in Malaysia is still low compared to other countries in Southeast Asia (Raihan, 2023).

Several studies have discussed the impact of climate change which is influenced by consumption of renewable energy, access to electricity, and consumption of electricity. One of the studies analyzed the effect of economic indicators, consumption of renewable energy, and access to electricity on CO2 emissions in 11 developing countries with high economic growth. This study found that these variables have different effects on CO2 emissions in various countries. This research also provides several policy implications for reducing CO2 emissions by taking into account the specific conditions of each country (Ahmad, Du, Lu, Wang, & Zaman, 2019).

Another research looked into how the economies of the Gulf Cooperation Council (GCC) nations' power use and growth. According to this analysis, there is no consistent correlation between GCC country economic development and power usage. Additionally, this study discovered that economic growth and power consumption have a one-way link but not the other way around (Wesseh, Lin, & Appiah, 2018).

This study attempts to analyze the impact of climate change on energy access and consumption in Malaysia. This topic is interesting because climate change can affect the supply and demand for energy, as well as the choice of energy sources used by society. This topic is also relevant because energy is an important factor for economic and social development, as well as mitigation and adaptation to climate change.

## Research Method

We use the World Bank as a complementary source of statistical data, namely data from 2000 to 2016, the variables we use are climate change, use of renewable energy, access to electricity, and use of electric power. We use the following econometric model:

$CL_t = \beta_0 + \beta_1 CL_{t-1} + \beta_2 CL_{t-2} + \beta_3 AE_t + \beta_4 EPC_t + \beta_5 REC_t + e_t$

Where the Climate change is CL, AE is access to electricity, use of electric power is EPC, and use of renewable energy is REC, the error term is e, and time series is t.

Result and Discussion

**Table 1.** ADF 1st stationary tets

| Variable | ADF Test stat. | Signif. | Description |
|---|---|---|---|
| Climate change (CL) | -10.94819 | 0.0000 | Stationer |
| Use of renewable energy (REC) | -5.857999 | 0.0004 | Stationer |
| Access to electricity (AE) | -4.678482 | 0.0027 | Stationer |
| Use of electric power (EPC) | -3.960150 | 0.0100 | Stationer |

Table 1 shows the results of the stationarity test. The data for CL, REC, AE, and EPC are stationary in the first difference data, as can be seen from the table above. We may continue with the ARDL estimate because all the data are steady.

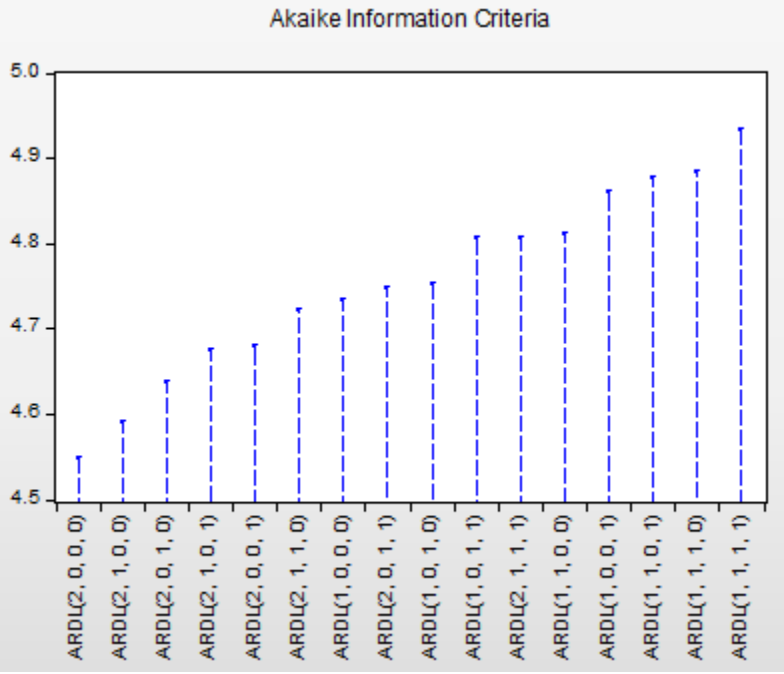


**Figure 1**. Optimum Lag Test

The lag test findings indicate that lag 2,0,0,0 is the ideal latency. Now that the ideal latency has been identified, and next we perform an ARDL analysis.

**Tabel 2**. ARDL analysis results

| | Coeff. | Std. Er | t-Stat. | Prob.* |
|---|---|---|---|---|
| CL(-1) | -0.452699 | 0.277833 | -1.629395 | 0.1377 |
| CL(-2) | -0.532541 | 0.289336 | -1.840560 | 0.0988 |
| AE | -10.95315 | 8.310490 | -1.317990 | 0.2201 |
| EPC | 6.28E-05 | 0.005101 | 0.012316 | 0.9904 |
| REC | 1.537887 | 0.977300 | 1.573608 | 0.1500 |
| C | 1153.195 | 813.5864 | 1.417422 | 0.1900 |
| R-sq. | 0.766843 | Adj. R-sq. | | 0.637312 |

From the estimation results of the ARDL model it is known that adj R-sq. and R-sq. values varied between 0.63 and 0.76. With an R-squared of 0.76, the ARDL model's independent variable can account for fluctuations in the dependent variable, climate change, by 76 percent. This demonstrates the suitability of this research model for usage in studies.

Use of renewable energy variable has a positive beneficial influence climate change with a coefficient value of 1.537887. The access to electricity factor represented by the AE variable also influences climate change, with a coefficient value of -10.95315. the use of electric power variable also has a positive beneficial influence on climate change.

**Table 3**. The long term and short term test

| | Coef. | Std. Error | t-Stat. | Prob. |
|---|---|---|---|---|
| C | 1153.195 | 813.5864 | 1.417422 | 0.1900 |
| CL(-1)* | -1.985240 | 0.455501 | -4.358368 | 0.0018 |
| AE** | -10.95314 | 8.310490 | -1.317990 | 0.2201 |
| EPC** | 6.28E-05 | 0.005101 | 0.012316 | 0.9904 |
| REC** | 1.537887 | 0.977300 | 1.573608 | 0.1500 |
| D(CL(-1)) | 0.532541 | 0.289336 | 1.840560 | 0.0988 |

As seen in the table above, use of renewable energy has a positive beneficial influence on climate change. The factor of access to electricity also affects climate change. That is, the higher the access to electricity, the higher the rate of climate change. The electricity consumption variable also has a positive beneficial influence on climate change.

## Conclusion

The use of renewable energy has a positive beneficial influence on climate change. This means that the higher the use of renewable energy, the lower the level of climate change. Solar, wind, water, biomass, and geothermal energy are examples of naturally renewable energy sources that are reflected in the utilization of renewable energy variables. The biggest contributor to climate change, greenhouse gas emissions, may be decreased with the use of renewable energy. The factor of access to electricity also influences climate change. This implies that the rate of climate change will increase the more people have access to electricity. The variable access to electricity reflects the ability to connect to the grid or other sources of electricity that are reliable and affordable. Access to electricity can improve people's welfare, health, education, and productivity. However, access to electricity can also increase the demand for electricity, which can result in greenhouse gas emissions if the energy source comes from fossil fuels. The electricity consumption variable also has a positive beneficial influence on climate change.

Electricity consumption can also affect greenhouse gas emissions from the energy sector, depending on the energy mix used to generate electricity.

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