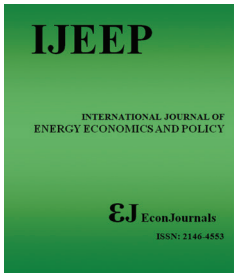

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Renewable Energy Consumption and SDG 7 Progress: The Case of MINT Countries

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ABSTRACT

In the context of Mexico, Indonesia, Nigeria, and Turkey (MINT) countries, this study investigates the relationship between renewable energy consumption and access to clean fuels and technologies for cooking as well as access to electricity. When control variables and time-fixed effects were taken into account, panel data regressions were utilized to investigate the effects of specific SDG 7 indicators from the data of Sustainable Development Report for years 2000-2021, such as renewable energy consumption, access to clean fuels and technologies for cooking, and access to electricity. For the indicators of access to clean fuels and technologies for cooking, panel data fixed effect regression as a best fit model for renewable energy consumption, access to clean fuels and technologies for cooking and access to electricity in MINT countries. Consumption of renewable energy is negatively and significantly impacted by access to clean fuels and technologies for cooking ($P < 0.01$). Then, although not statistically significant, access to electricity has a negative effect on the use of renewable energy ($P > 0.01$).

Keywords: Renewable Energy Consumption, SDG 7, Panel Data Regression, MINT Countries
JEL Classifications: Q43, Q01, C23

1. INTRODUCTION

A significant portion of the global population lacks access to power services and clean fuels for lighting and cooking (Byaro et al., 2024; Kapsalyamova et al., 2021). The impacted populations' economic and social development, as well as their health, the environment, and general social welfare, are all significantly impacted by this. Accordingly, expanding access to clean fuels, power, and the amount of renewable energy consumed per person are all major components of the Sustainable Development Goals set forth by the UN.

The United Nations' Sustainable Energy for All campaign exemplifies this concept. The goal of this effort, which was started in 2011, is to ensure that everyone has access to energy by 2030. Currently, 2.5 billion people lack access to clean cooking fuels, and around three billion people lack electricity. Two of the three primary goals are to double the proportion of renewable energy in the world's energy mix and ensure that everyone has access to contemporary energy services by 2030 (Heffron and McCauley, 2022; Biswas et al., 2022; Rahman, 2021).

An essential indication of a nation's level of development is the growing rate of access to electricity (González-Torres et al., 2022). Nearly 1.1 billion people in the developing world lack access to electricity at the moment, despite efforts to improve the lives of at least 500 million slum dwellers by 2020, primarily through access to energy services, and to supply 100 million of the 1.6 billion people without access to clean, modern fuels.

Access to energy services is widely acknowledged as a prerequisite for both social and economic advancement. In keeping with this strategy, a number of international projects have been launched in recent years to monitor the development of a global energy

infrastructure scale-up. The 193 United Nations members specifically agreed on a new set of development goals in September 2015 that are to be accomplished by 2030. For instance, the goals include making sure that everyone has access to modern, cheap, dependable, and sustainable energy.

Among other things, this goal's three aims aim to increase access to: (1) Modern and reasonably priced energy services; (2) Clean fuels and technology, including renewable energy sources; and (3) Energy efficiency at all levels. Additionally, nations are urged to monitor their development by submitting energy data and pertinent indicators. Based on model estimates and in accordance with globally accepted criteria, the 2014 edition of World Energy Outlook presents a number of indicators for more than 130 countries to aid in the monitoring process.

This endeavor seeks, among other things, to ensure that everyone has access to contemporary energy sources. A country that is a member of the World Bank or the International Development Association may be eligible to receive grants to create a sustainable energy program that aims to improve domestic energy consumption and process energy efficiency or increase the share of renewable energy in the domestic energy budget. Apart from the benefits to human health and the environment, widespread adoption of modern energy sources, or "clean-fuels," may also spur economical development.

In light of this, the primary goals of the study are to assess how (i) access to clean cooking fuels and technology and (ii) access to electricity affect the amount and growth of renewable energy use. Based on cutting-edge techniques, we speculate that in this context, the availability of clean fuels and power and cooking technologies may have some immediate and delayed effects on the use of renewable energy. The purpose of this study is to examine the factors that influence access to electricity, clean cooking fuels and technology, and the use of renewable energy sources in the context of Mexico, Indonesia, Nigeria, and Turkey (MINT) Countries.

2. LITERATURE REVIEW

Renewable energy use is deemed significant due to the growing scarcity of energy sources and worries about the possible negative effects of energy resource exploitation, including the environment and the potential to reverse development (Wang and Azam, 2024; Ang et al., 2022; Mahapatra et al., 2021; Kanwal et al., 2022). The impact of using renewable energy devices is measured by the rate of domestic energy consumption. It is also stated that the manufacturing sector and fixed capital formation benefit from the usage of renewable energy. Resources with renewable consumption boost economics and innovation.

Renewable energy sources are resource-efficient, non-depletable, and environmentally benign. In order to address the issues of energy depletion and environmental degradation, the development and use of renewable energies on a global scale has become an unavoidable trend (Russo et al., 2022). The use of renewable energy should be taken into account. Markets for energy are usually quite interconnected. Numerous national economic, social, environmental, and political policies and conditions have an impact on national energy markets, and this is anticipated to continue for some time to come (Aszódi et al., 2021; Plazas-Niño et al., 2022; Hansen and Moe, 2022; Ali et al., 2021).

The two primary issues with energy access that households in developing nations deal with are the utilization of electric power and the availability of clean fuels and cooking technologies. Understanding the factors that influence energy access is essential to achieving these objectives. Most economists have concentrated on electricity availability.

Kanwal et al. (2022) mention that having access to contemporary energy services has an impact on people's total socioeconomic development in addition to their income. On the one hand, by lowering the time and expense of culinary tasks or by preventing accidents and premature deaths, the availability of clean fuels and technology might create new revenue-generating opportunities.

According to Mondejar et al. (2021), having access to electricity is a crucial first step toward modern energy and a higher standard of living. Households in developing nations are expected to abandon power due to supply unpredictability (Wassie et al., 2021). It is closely linked to the well-being and income of the household. Access to electricity is also claimed to be correlated with economic progress and the creation of amenities in a nation. International access to electricity is typically well-liked in developing nations, and metropolitan areas have a far greater access rate than rural ones. Conversely, better electrification is associated with higher-income homes and requires the installation of a permanent line.

Tamele et al. (2025) analyse that energy services in homes, such as lighting, television, radios, refrigeration, and the operation of appliances and other end uses, depend on electricity. Since increasing access to electricity is the first step in boosting economic development, improving access to electricity and its quality has been designated as a Millennium Development Goal (Sarkodie, 2022; Ali et al., 2021; Endris and Kassegn, 2022).

Destek et al. (2021), Deng et al. (2023), Alola and Adebayo (2023), and Chuvieco et al. (2021) investigate that biomass is the most widely used fuel in developing nations. Because solid fuels like wood, coal, and dung contain harmful chemicals, using them for cooking can have serious negative health effects. One potential remedy to lessen health issues is the use of clean fuels and technologies (Jaiswal et al., 2022). On the other hand, clean energy forms can generate positive externalities to human capital accumulation, such as the possibility of longer schooling hours for children and work hours for adults.

Residential renewable energy consumption as a percentage of total final consumption has been fluctuating quickly. In comparison to other homes, residential usage of renewable energy increases with household income. At home, rural dwellers typically use more renewable energy. Residents who currently use fuel wood would increase the amount of renewable energy consumed in their homes.

The more people living in a home, the higher the residential use of renewable energy.

The use of clean fuels and technologies has resulted in a faster change in the overall final consumption of renewable energy. One co-benefit of policies that encourage the use of clean fuels and technology is that they may accelerate the rate at which renewable energy is consumed in homes. Similar research are needed to examine the residential use of renewable energy after utilities, as developing nations are becoming more and more significant in decreasing environmental pollution and climate change.

According to Tao et al. (2024) and Lucchi et al. (2024), energy consumption is a crucial input for production activities and contributes to the improvement of human capital through lighting in economic operations. Increasing the number of hours that energy is available will enable the growth of economic activity (Gorman, 2022). The danger of infectious diseases brought on by indoor air pollution is decreased by clean fuels and technology (Patial et al., 2022; Raqib et al., 2023). The purpose of the policies is to create a retail market for high-efficiency electrical equipment. People will be more inclined to utilize electricity as sales of electrical products rise and the quality of the electrical network improves (Spurlock and Fujita, 2022).

3. DATA, METHODOLOGY AND RESULTS

The dataset of Sustainable Development Goals 7 Affordable and Clean Energy Report comprises information on access to clean fuels and technologies for cooking and electricity, as well as renewable electricity consumption, from a total of four low and middle-income countries. These are disaggregated at the level of the different states of Mexico, Indonesia, Nigeria, and Turkey respectively from 2000 to 2021, which are known as the MINT (Mexico, Indonesia, Nigeria, Turkey) countries. The econometric specification of a panel dataset is an adequate instrument of analysis with software EViews 12. Moreover, panel data regressions were used to examine the effects of certain SDG 7 indicators such as access to clean fuels and technologies for cooking, access to electricity, and renewable energy consumption.

$$Y_{it} = \alpha_{oi} + \beta_1 x_{1it} + \beta_2 x_{2it} + \varepsilon_{it} \quad (1)$$

Renewable energy consumption = α_{oi} + Access to clean fuels and technologies for cooking + Access to electricity + ε_{it} (2)

The results of the panel data regression analysis for the indicators of access to clean fuels and technologies, which is measured by the percentage of population using clean fuels and technologies for cooking and the percentage of population using efficient cooking devices, are presented. Table 1 displays the results of a common effect regression on panel data. Table 1 shows how access to clean fuels and technologies for cooking and access to electricity affect the use of renewable energy consumption when control variables and time common effects are present. The consumption of renewable energy in the four MINT nations is negatively and significantly impacted by both access to clean fuels and technologies for cooking and access to electricity, as Table 1 illustrates.

Table 1: Panel least squares (common effect)

Variable	Coefficient	Standard error	t-statistic	Prob.
C	134.572	2.989	45.022	0.000
Access to clean fuels and technologies for cooking	−0.270	0.025	−10.520	0.000
Access to electricity	−0.975	0.048	−20.225	0.000
R-squared		0.977		
F-statistic		1882.958		

Table 2 displays the results of the panel data fixed effect regression. Table 2 shows that access to clean fuels and technologies for cooking has a negative and significant impact on the use of renewable energy consumption when control variables and time-fixed effects are included. The four MINT countries' usage of renewable energy consumption is negatively impacted by access to electricity, but not statistically significant ($P > 0.01$).

To determine which of the common effect and fixed effect models better fits the data, we must do a Chow test. The best model is fixed effect, as indicated by the Chow test's Cross-section Chi-square result with $P < 0.01$ (Table 3). Therefore, next analysis and comparison with random effect are necessary.

The outcomes of a random effect regression on panel data are shown in Table 4. When control factors and time random effects are included, Table 4 illustrates the impact access to clean fuels and technologies for cooking and access to electricity on the adoption of renewable energy consumption. Table 4 shows that access to clean fuels and technologies for cooking and access to electricity have a negative and significant impact on the utilization of renewable energy consumption in the four MINT countries.

To determine which of the fixed effect and random effect models best fits the data, we must do a Hausman test. The fixed effect model is the best one, according to the cross-section random outcome of the Hausman test with $P < 0.01$ (Table 5).

Panel data fixed effect regression as a best fit model for renewable energy consumption, access to clean fuels and technologies for cooking and access to electricity in MINT countries. Consumption of renewable energy is negatively and significantly impacted by access to clean fuels and technologies for cooking ($P < 0.01$). Then, although not statistically significant, access to electricity has a negative effect on the use of renewable energy ($P > 0.01$). With a positive constant of 56.954, the R-squared result is 99.7%.

The idea that access to clean fuels and technologies for cooking has a large impact on the consumption of renewable energy is supported by the panel data regression results, which are a more reliable statistical study. Therefore, the growing use of renewable energy is a contributing factor to the gradual decline in access to clean fuels and cooking methods. The greatest advancements were seen in the availability of clean technologies

Table 2: Panel least squares (fixed effect)

Variable	Coefficient	Standard error	t-statistic	Prob.
C	56.954	5.610	10.151	0.000
Access to clean fuels and technologies for cooking	−0.287	0.016	−17.168	0.000
Access to electricity	−0.060	0.073	-0.829	0.409
Cross-section fixed (dummy variables)				
R-squared		0.997		
F-statistic		6736.512		

Table 3: Chow test

Effects test	Statistic	d.f	Prob.
Cross-section F	221.091	(3.82)	0.000
Cross-section Chi-square	194.218	3	0.000

Table 4: Panel EGLS (cross-section random effects)

Variable	Coefficient	Standard error	t-statistic	Prob.
C	69.212	5.914	11.702	0.000
Access to clean fuels and technologies for cooking	−0.269	0.016	−16.415	0.000
Access to electricity	−0.215	0.068	−3.155	0.002
Weighted statistics				
R-squared		0.869		
F-statistic		282.868		

Table 5: Hausman test

Test summary	Chi-square statistic	Chi-square d.f	Prob.
Cross-section random	36.778	2	0.000

and fuels. This is because only wealthier households can purchase cleaner technology, which are typically more expensive. Strong complementarity and substitutability effects are demonstrated.

In less developed nations, a well-built infrastructure may encourage the use of cleaner fuels and technologies, whereas in more developed nations, the reverse impact is seen. The negative and substantial coefficient further supports this conclusion. High natural resource endowment nations tend to rely more on their natural resources because it is more costly to provide cleaner energy sources. Access to clean fuels and technologies is increased by policies that are more supportive of the aforementioned items. Because impoverished conditions are so persistent, the initial circumstances are important.

4. CONCLUSION

Addressing the problem of global climate change requires innovative policies, and the energy sector frequently serves as both a focal point and a major contributor to these policies. Given that improved health, time savings, and a decrease in the usage of conventional fuel sources can lead to higher living standards, access to clean cooking fuels and technology is a crucial energy access indicator that has a significant impact on development (Byaro et al., 2024).

As the planning and comprehension of grid expansion and off-grid or mini-grid projects also need to understand how the adoption and penetration of renewable generation can be targeted to those regions with less energy access, this can have a significant impact on the adoption and implementation of renewable energy technologies for a nation's energy provision. Lastly, the literature's lack of coverage of the United Nations Assembly's most recent announcement of the 2030 Agenda and SDG. SDG 7, which calls for universal access to modern energy services by 2030-including electricity-as well as clean fuels and cooking technology, is of special relevance. The optimal instruments that national policymakers can use to accomplish these objectives are still up for debate (Stanton and Roelich, 2021; Hansen, 2022; Ehlers et al., 2022).

A widespread and dependable energy supply has not always been guaranteed by centralized energy infrastructures in the MINT countries, a need that is closely connected to their rapidly expanding economies and populations. Access to contemporary fuels and technologies, whether restricted to residential use or expanded to include commercial energy applications, enables greater energy consumption efficiency, which has major positive effects on both human health and climate change (Murshed et al., 2022; Trinh and Chung, 2023). Carbon-rich sources and low-quality coal, which emits the most pollution, have been the main sources of energy used to produce power (Abbas et al., 2025). More recently, efforts have been made to increase the diffusion of renewable energies, particularly in light of climate concerns and declining costs for renewable energy (Magazzino et al., 2022; Iskandarova et al., 2021).

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