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The Role of Credit, Urbanisation, and Growth in Renewable Energy Consumption: Evidence from Lower-Middle-income Countries

Büşra Şimşek [1] & Muhammet Sait Bozik [2]

[1] İstanbul Institute for Advanced Studies, İstanbul, Türkiye
[2] Haliç University, Department of Mathematics, İstanbul, Türkiye

Abstract The transition to renewable energy is of critical importance for the economic, environmental, and social development of nations. The accessibility and environmentally friendly nature of renewable energy sources play a vital role in achieving sustainable development goals, particularly in lower-middle-income countries. In this context, examining the potential of economic growth to increase energy demand, the impact of urbanisation on transforming energy consumption patterns, and the critical role of financial support in directing energy projects is essential for predicting the potential effects of the fundamental dynamics shaping renewable energy use. This study intends to analyse the impact of domestic credit, urbanisation, and per capita income on renewable energy consumption in lower-middle-income countries. The analysis uses annual data covering the period from 2000 to 2021. The results reveal that credit negatively affects renewable energy consumption. This indicates that financial resources are insufficiently directed towards renewable energy projects or that the existing financial infrastructure tends to favour investments in fossil fuel-based projects. Similarly, the increase in urbanisation also negatively affects renewable energy use. As urbanisation increases, energy consumption patterns tend to rely more on conventional energy sources. Moreover, economic growth, measured by GDP per capita, was found to reduce renewable energy consumption. These findings indicate that economic growth and energy consumption structures in lower-middle-income countries are still largely dependent on fossil fuels, emphasising the need for policy interventions to support the transition to renewable energy.

Keywords Renewable Energy · Credit · Urbanisation · Lower Middle Countries

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Corresponding author: Muhammet Sait Bozik muhammetsaitbozik@halic.edu.tr

The Role of Credit, Urbanisation, and Growth in Renewable Energy Consumption: Evidence from Lower-Middle-income Countries

Environmental pollution is a universal issue that affects both developed and developing countries within the global economic system. As income levels rise, so does the demand for environmental preservation, accompanied by increasing awareness of pollution. Technological advancements not only promote environmentally friendly production methods but also expand the use of renewable energy sources, minimising environmental damage and enabling the production of clean energy (Tatoglu and İçen, 2019). The transition to renewable energy is of vital importance for the economic, environmental, and social development of nations. The global pressure to increase the use of renewable energy primarily arises from the continuous depletion of non-renewable energy sources such as oil, coal, and natural gas. Renewable energy, with its various forms such as solar, wind, biomass, and hydropower, is sustainable, abundant, easily accessible, and environmentally friendly. It is particularly important for lower-middle-income countries to rely on renewable energy to ensure sustainable development. While the importance of renewable energy for economic growth and development is indisputable, renewable energy consumption patterns are influenced by numerous factors, such as domestic credit, urbanisation, and economic growth. The main objectives of this study are as follows: 1) to fill research gaps in the existing literature; 2) to contribute to the literature on renewable energy use in lower-middle-income countries; and 3) to provide researchers, academics, and policymakers with new perspectives on domestic credit, urbanisation, economic growth, and renewable energy use. This research seeks to answer two main questions: 1) Do domestic credit, urbanisation, and economic growth have a significant and positive impact on renewable energy consumption patterns in lower-middle-income countries? 2) What is the direction and degree of causality between renewable energy consumption patterns and explanatory factors such as domestic credit, urbanisation, and economic growth? To address these research questions, the study employs panel regression analysis. The validation of this methodology will increase the robustness, validity, and generalizability of the results obtained. Anwar et al. (2021) examined the relationship between domestic credit, renewable energy consumption, and carbon emissions in selected Asian countries. The study highlights that developed financial markets, supported by strong domestic credit mechanisms, play a crucial role in facilitating investments in renewable energy technologies. As capital becomes more accessible, domestic credit reduces financial barriers for green energy projects, supporting the transition of economies to renewable energy and indirectly reducing carbon emissions. This research emphasises the vital role of financial development in promoting environmentally sustainable economic growth through renewable energy. Adebayo et al. (2023) provided evidence supporting the Environmental Kuznets Curve (EKC) hypothesis in BRICS countries, showing that economic growth initially increases carbon emissions when based on fossil fuel energy sources. However, this trend reverses when renewable energy is adopted, and economic growth is decoupled from environmental degradation. The study emphasises the importance of access to domestic credit for financing renewable energy infrastructure, which plays a key role in ensuring sustainable economic growth.

The relationship between renewable energy consumption and economic factors has been examined in various studies. Apergis and Payne (2010), in their study on OECD countries, found a bidirectional causality between renewable energy consumption and economic growth. Bhattacharya et al. (2016), in their study covering 38 countries, demonstrated that renewable energy consumption positively affects economic growth in the long term. Conversely, Menegaki (2011) found no significant relationship between renewable energy consumption and GDP in European countries. Inglesi-Lotz (2016) showed that renewable energy

consumption has positive effects on economic growth in low- and middle-income countries. The impact of financial development on renewable energy consumption has also attracted increasing interest recently. Anton and Nucu (2020) found that financial development increases renewable energy consumption in the European Union countries. Charfeddine and Kahia (2019) revealed a positive relationship between financial development and renewable energy consumption in MENA countries, whereas Burakov and Freidin (2017) did not find a significant relationship in their study focused on Russia. The effect of urbanisation on renewable energy consumption is complex and varies across different contexts. Salim and Shafiei (2014) showed that urbanisation decreases renewable energy consumption in OECD countries. Atems and Hotaling (2018) highlighted the negative impact of urbanisation on renewable energy consumption in low- and middle-income countries. Panel data analysis is a commonly used method in studies examining the relationship between renewable energy consumption and economic growth. Omri and Nguyen (2014), in their study covering 64 countries, explored the complex relationships between economic growth, CO2 emissions, and renewable energy consumption. Kahia et al. (2017), using panel data analysis in MENA countries, found significant connections between renewable energy consumption and economic growth. Apergis and Payne (2012) confirmed bidirectional causality in their panel analysis of 80 countries. The literature on the relationship between renewable energy consumption and economic factors generally presents complex and country-specific findings. It is evident that this relationship has been less studied in low- and middle-income countries, and more in-depth analyses in this area could contribute to the literature. Furthermore, the impact of financial development and urbanisation on renewable energy consumption needs to be examined in greater detail, and the use of long-term panel data analyses will be a critical focus for future research. Many studies have examined the interactions among domestic credit, economic growth, urbanisation, and energy consumption. The literature on renewable energy typically focuses on the determinants of renewable energy consumption. However, fewer studies have focused on the determinants of renewable energy consumption in lower-middle-income countries and geographically relevant regions where renewable energy sources hold great promise. Moreover, very few recent studies have explored the interactions between domestic credit and the variables. Nevertheless, an increasing number of studies have begun to examine one form of the determinants of renewable energy consumption at a macro level or through an unconditional convergence model. These studies used an autoregressive model and included a panel Granger causality test; some studies also use Bayesian factor segmentation. These studies propose main determinants such as population size, economic growth, energy consumption, foreign direct investment, trade openness, urban population, total GDP, youth dependency ratio, CO2 emissions, rural population, non-renewable energy consumption, human development index, and income. Furthermore, the countries of interest are diverse: some studies cover industrialised and developed countries, while a few examine lower-middle-income countries, and a subset focuses on geographically relevant regions. The reviewed literature reveals that existing studies employ various methodological approaches and different frameworks, enabling the identification of specific comparisons and theoretical starting points. Methodologies range from autoregressive distributed lag to fully modified ordinary least squares, autoregressive, and generalised autoregressive distributed lag methods. Some studies use the Keynesian aggregate consumption function, whereas others employ structural equation modelling and three-stage least squares regression. Additionally, some researchers focus solely on electricity production, while others are concerned only with energy consumption. Most studies, however, concentrate on Africa, where urbanisation and domestic credit levels vary. Thus far, the predictors of renewable energy consumption have been limited to historical consumption. Most of these studies use annual data. The contributions within this literature are invaluable for hypothesis formation, the integration and application of various techniques and approaches for model-based policy analysis, drawing on the broader literature, and measuring the robustness of model indicators or configurations. However, the vali-

dated findings point to the following key treatment avenues: (i) the integration of domestic credit, financial development, financial market functionality, and structural equation modelling coefficients; (ii) addressing the dynamics of lower-middle-income, middle-income, upper-middle-income, or high-income countries in a complementary manner; (iii) integrating urbanisation with domestic credit or financial development; (iv) testing the generalised autoregressive distributed lag hypotheses with thresholds; and (v) selecting combinations of econometric indicators to estimate threshold levels.

Theoretical Framework

The theoretical relationship between domestic credit, urbanisation, economic growth, and renewable energy consumption can be shaped within the context of the Sustainable Development Theory (SDT) and its extensions, which highlight the dynamics between financial, social, and environmental systems globally. First defined in the 1987 Brundtland Report, this theory considers sustainable development as development that meets the needs of the present without compromising the ability of future generations to meet their own needs. This theory has evolved significantly, especially following the increased focus on green energy in the early 21st century, within the context of financial systems, urbanisation trends, and energy consumption. A notable extension of this theory was proposed by Bretschger (2017), who argued that integrating economic growth with environmental sustainability depends on a financial framework that supports renewable energy consumption. Bretschger's work emphasises the need to harmonise economic growth, traditionally fuelled by fossil energy, with ecological principles. This redirection requires robust financial mechanisms, particularly in urban areas, that facilitate investments in renewable energy technologies. Mazzucato and Perez (2014) support this idea, arguing that strategically deployed state-backed domestic credit systems can accelerate renewable energy consumption by providing the capital needed to overcome market failures in energy innovation. Urbanisation plays a dual role in this context. On the one hand, it creates energy demand due to growing populations and industrialisation; on the other hand, as Zhao et al. (2019) noted, it offers economies of scale in energy distribution and consumption, making urban centres ideal locations for implementing sustainable energy transitions. Bilbao-Ubillos (2013) argues that the assumption that domestic credit can uniformly promote renewable energy adoption overlooks the financial access inequalities between different urban regions, especially in developing economies. His critique demonstrates that in some contexts, urbanisation may intensify inequality and hinder energy transitions rather than promote them fairly. Similarly, Smil (2017) contends that economic growth models that rely heavily on financial instruments such as domestic credit may not be sustainable in the long term. While he acknowledges the importance of renewable energy, Smil argues that its integration into current economic systems requires a more fundamental restructuring rather than merely increasing credit flows. Conversely, Kanger et al. (2020), advocates of this theory, emphasise that recent advancements in financial technologies and smart urbanisation strategies could mitigate the risks highlighted by critics. They argue that the digitalisation of urban infrastructure powered by renewable energy creates new synergies not present in earlier models between credit markets and sustainable growth. Schmidt et al. (2019) supported this view, noting that well-designed financial systems, integrating public and private credit, have been key elements in advancing renewable energy projects in countries like Germany and Denmark. The relevance of this theoretical framework in the context of the study lies in its ability to bridge the gap between the financial, urban, and environmental dimensions of sustainable development. When effectively deployed in urban areas, domestic credit systems can provide the capital necessary for large-scale renewable energy investments, supporting economic growth while reducing environmental impacts. This is particularly important for economies undergoing rapid urbanisation, where energy demand exceeds supply and long-term growth sustainability faces challenges. In this context, understanding the interaction between domestic credit, urbanisation, and renewable energy

consumption is a crucial element in understanding how to promote economic growth without jeopardising environmental sustainability. However, the theory shows weaknesses, especially regarding unequal financial access in different urban regions. While domestic credit systems are critical for energy transitions in wealthy urban centres, this may not be the case in low-income regions where access to credit is limited. This indicates that future research on more inclusive financial frameworks should focus on addressing these inequalities. Additionally, the theory assumes policy coherence, which is not always present in practice, particularly in developing economies where alignment between urbanisation, financial systems, and energy policies may be lacking. Addressing these gaps is vital for bringing the theoretical relationship between domestic credit, urbanisation, economic growth, and renewable energy consumption into practical reality. The theoretical foundations explaining the relationships among domestic credit, urbanisation, economic growth, and renewable energy consumption suggest that these factors are critical for increasing renewable energy investments in lower-middle-income countries. Although agreement on the necessity of these factors is sometimes lacking, better probability explanations show that theoretical assumptions become a basis upon which empirical debate can later be constructed. The theoretical argument indicates that domestic credit is an important way to finance renewable projects without the constraint of foreign currency shortages. Urbanisation drives the increasing energy demand from fossil fuels to power cities, but at the same time, rising macroeconomic income levels in any country, combined with technological possibilities, have enabled many countries to utilise significant amounts of renewable energy resources and grow to this extent. This will increase the availability of renewable resources. However, economic growth can also act as a limiting factor in adopting renewable resources. In the case of lower-middle-income countries, efforts to escape poverty stand out among the limitations in developing other micro-structural factors. In this case, investing in expensive renewable energy sources such as wind farms, solar energy, and waste-to-energy recovery may incur a cost much greater than generating more income.

Domestic Credit and Renewable Energy Consumption

Domestic credit, as a fundamental component of financial support, can have a significant positive impact on renewable energy consumption. This type of credit plays a critical role at all stages of the development of the renewable energy sector. Domestic credit can create different financial mechanisms and instruments that can be used to support renewable energy investments. Universal access to financial products and services can ensure the initiation, improvement, and sustainability of local renewable energy businesses. In terms of credit instruments in the renewable energy industry, financial structures and market-level financing opportunities are extremely important. Even successful businesses may need credit for cash flow, machinery investment, and other essential costs. In this regard, access to credit provides individual consumers and small- and medium-sized enterprises the opportunity to participate in profitable renewable investments, while a reduction in access to credit can have devastating consequences. Studies show that increased credit opportunities for businesses can promote the development of renewable energy and enable rapid technological changes for green energy services. Banks often provide credit to renewable energy projects or other greenhouse gas reduction investments. However, in countries where banks operate at a certain commercial scale, credit may not reach small communities to finance renewable energy technology. Village-based renewable energy technology in the Asia-Pacific region has been shown to be successful with bank support. Additionally, banks are implementing renewable energy projects in industrial and commercial enterprises.

Urbanisation and Renewable Energy Consumption

Rapid urban growth has various effects on energy and demand-side management. Energy demand in urban areas is increasing due to both population growth and economic expansion, and rising household incomes can further increase overall urban consumption. Consequently, cities are facing an increasing demand to expand their energy infrastructure and often strive to enhance accessibility. Population growth also raises concerns about resource allocation, especially when this growth is not managed properly with supportive development policies. In developing countries, urban areas are often unable to meet the needs of this additional urban population. The expectations of the urban poor regarding urban development programs related to energy supply are generally low, and local off-grid energy solutions, such as solar stoves and lighting systems, are widely used in these regions. Energy policies are developed to go beyond cities in countries experiencing energy shortages and aim to achieve equity. Even in advanced urban areas, energy access for the urban poor is often neglected. In parallel, urban areas are seen as major contributors to resource losses and declines in environmental quality. This has led to the idea that the urbanisation process needs to be improved in line with sustainability goals. Much of these goals are based on the efficient use of resources, particularly energy, and therefore "urban energy efficiency" has become a primary goal of sustainable urban development. Therefore, urban areas have become areas where large-scale implementation of energy use policies takes place, contributing to significant reductions in overall energy use and pollutant emissions. Many of these area-specific policies are aimed at increasing the share of renewable energies in the energy supply, thus increasing renewable energy consumption in urban areas. Renewable energy portfolio standards are often mandated at the urban or smaller geographic level rather than the national level. The evolution of these policies and regulations in the renewable energy sector has not only alleviated challenges related to renewable energy resources but also evolved to address city-specific factors or demand more technological innovations and further integration at the energy grid level. The relationship between renewable energy and growth gains importance from another perspective in terms of the relationship between energy consumption, income, and price. In their study, İçen and Tatoğlu (2022) focused on the relationship between renewable energy, price, and income, claiming that the relationship between price and income is asymmetric. Asymmetric effects were incorporated into the model to overcome the restrictive assumptions of the traditional panel data models. The findings reveal that changes in both income and price have asymmetric effects on energy consumption. In particular, the response of oil consumption to increases and decreases in income differs, with a higher response to income reductions due to Keynesian expansionary policies implemented during economic downturns. The income elasticities of renewable energy consumption vary by energy source: wind and solar energy exhibit income elasticities greater than one, while hydroelectric and geothermal energy consumption elasticities are less than one. Additionally, the response of renewable energy consumption to increases in oil prices is higher than its response to price decreases. These findings emphasise that price and income effects should be addressed asymmetrically when constructing energy consumption models. Particularly in the formulation of energy policies, it is crucial to consider that the impact of price increases is stronger than that of price decreases. In this context, the study offers valuable guidance for policymakers to develop more effective and sustainable energy strategies.

Economic Growth and Renewable Energy Consumption

It can be argued that economic growth has a positive relationship with renewable energy consumption through a potential Environmental Kuznets Curve (EKC). Generally, there is a widespread belief that economic growth requires increased energy consumption, which often leads to environmental and health-related abnormalities and that the increase in current energy consumption contributes to climate change. If economic

growth requires increased energy consumption, the nature of this relationship can provide clues about the drivers of the transition to renewable energy. A simple correlation does not explain the direction of the relationship between economic growth and renewable energy use, and both variables may cause each other. Overall, there are two additional "channels" through which economic growth can increase renewable energy consumption. As countries grow through sectoral shifts, per capita energy consumption also increases, and some evidence suggests that individuals report increased consumption of renewable energy. Some studies include country-level case comparisons showing that economic growth increases the development rates of renewable energy systems. For example, in Iran, potential oil shortages due to sanctions are seen as a factor encouraging the use of renewable energy. Azerbaijan, the poorest country in this study, is highly dependent on oil and gas for its economic development. To balance its declining oil and gas reserves, increase the value of its raw materials, and create new job opportunities, the Azerbaijani government has turned to the renewable energy sector and offered incentives for foreign investors. However, there is an obstacle to the growth of the renewable energy sector known as "Dutch disease" (natural resource dependence).

Data and Methodology

The dataset used in this study covers the period from 2000 to 2021 and consists of annual data. The study uses data from lower-middle income countries which gives Table 1 below. In the research model, renewable energy consumption is the dependent variable, while domestic credit to the private sector, urban population, and gdp per capita are the independent variables. All data were obtained from the World Development Indicators (WDI) database.

Table 1

Selected countries

		Lower-Middle Income Countries		
Bangladesh	Ghana	Mongolia	Pakistan	Ukraine
Bolivia	India	Morocco	Philippines	Vietnam
Cambodia	Indonesia	Bangladesh	Senegal	Zambia
Cote d'Ivoire	Iran	Nepal	Sri Lanka	Zimbabwe
Egypt. Arab Rep.	Kenya	Nicaragua	Tanzania	
El Salvador	Kyrgyz Republic	Nigeria	Tunisia	

The details of the variables used in the study are shown in Table 2.

Table 2

Explanations of the variables

Variables	**Abbreviation**	**Unit**
Renewable energy consumption (% of total final energy consumption)	REC	Ratio
Domestic credit to the private sector (% of GDP)	DCRP	Ratio
Urban population (% of total population)	URB	Ratio
GDP per capita (constant 2015 US$)	LNGDPP	US Dollars

Note: LN indicates the natural logarithms of the variables

Panel data analysis was employed as the research methodology in this study. Panel data techniques allow for the simultaneous analysis of both cross-sectional and time series data, helping to mitigate multicollinearity concerns. This method enhances the validity of the estimates generated by the analysis while also increasing the number of observations and the degrees of freedom.(Tatoğlu, 2013: 9). Moreover, panel data analysis offers distinct advantages over alternative analytical approaches, primarily due to its

ability to account for heterogeneity across observations. By controlling for individual differences between units, this method enables the derivation of more robust and generalisable results. In this study, panel data analysis was employed to enhance the reliability and robustness of the econometric model. Its capacity to simultaneously capture both temporal and spatial variations provides a more comprehensive and nuanced perspective, ultimately strengthening the validity of the findings. This holistic approach ensures that the model better reflects the complexity and diversity inherent in the data.

The research model established is presented as follows.

$$\mathrm{YREC_{it}} = \alpha_0 + \alpha_1\ \mathrm{DCRP_{it}} + \alpha_2 \mathrm{URB_{it}} + \alpha_3\ \mathrm{LNGDPP_{it}} + \mathrm{u_{it.}} \quad (1)$$

Empirical Findings

The model was initially assessed for unit and time effects using the LR test, confirming the appropriateness of the two-way model. Following this, the F test is applied to evaluate the unit and time effects separately, with the results presented in Table 3 below.

Table 3

Test Results of Time and Unit Effects

	Hypotesis	Results
Unit Effect	$H0 = \mu 1 = \mu 2 = ... = \mu N - 1 = 0$	686.36 [0.000]
Time Effect	$H0 = \lambda 1 = \lambda 2 = \cdots = \lambda T - 1 = 0$	0.40 [0.9924]

The null hypothesis that the unit effects are zero (H0: μi=0) was tested using the F-test, and the results showed the rejection of the null hypothesis. This confirms the presence of unit effects in the model. After determining the existence of unit effects, the time effects were tested with the F-test. According to the test results, the null hypothesis (H0: λt=0) could not be rejected, indicating that there is no time effect in the model. Consequently, it was concluded that there are unit effects in the model, but no time effects.

The research model was examined using both fixed effects (FE) and random effects (RE) models, with the results presented in Table 4. To assess whether the unit effect found in Table 3 is correlated with the independent variable, the Hausman test was conducted. The null hypothesis, which posits no correlation between the unit effect and the explanatory variable, was rejected. Therefore, it was concluded that fixed-effects model was valid. The results of the test led to the rejection of the null hypothesis, and it was concluded that fixed-effects model was valid. Following the validation of the fixed effects model, additional diagnostic tests were conducted to identify deviations from the assumptions. Initially, heteroscedasticity was examined using the Modified Wald Test across the units within the fixed effects framework. The test results led to the rejection of the null hypothesis (H0), indicating heteroscedasticity arş units. Subsequently, the Durbin-Watson and Baltagi-Wu LBI tests were employed to detect the autocorrelation. As both test statistics were below the critical value of 2, the presence of autocorrelation was confirmed in the model. Finally, cross-sectional dependence tests were conducted. In this regard, the Pesaran (2004) and Friedman (1937) tests were applied. Based on the results, no evidence of cross-sectional dependence was found in the model. The test results are detailed in Table.

Table 4

Panel Regression Results

Dependent Variable: REC	FE	RE	Robust Standard Errors
DCRP	-0.063*	-0.268*	-0.063*
URB	-0.468*	-0.741*	-0.468*
LNGDPP	-14.118*	-13.859*	-14.118*

Dependent Variable: REC	FE	RE	Robust Standard Errors
Constant	171.944*	189.158*	171.955*
R2		0.71	
Hausman		8.11[0.043]	
Modified Wald		2074.03[0.000]	
Modified Bhargava et al. Durbin-Watson		0.361< 2	
Baltagi-Wu LBI		0.551< 2	
Pesaran		1.214 [0.224]	
Friedman		17.257[0.924]	

Note: *, showed significance at the 1% level

In the fixed effects model, the estimation was conducted using robust standard errors to account for the presence of heteroscedasticity and autocorrelation. In the model where all variables are statistically significant, the results indicate that a 1% increase in domestic credit to the private sector leads to a 0.06% decrease in renewable energy consumption in lower-middle-income countries. Similarly, a 1% rise in urban population leads to a 0.5% reduction in renewable energy consumption, while a 1% increase in GDP per capita is associated with a 0.1% decline in renewable energy consumption.

The results of the analysis reveal several key insights into the dynamics between domestic credit, urbanisation, economic growth, and renewable energy consumption in lower-middle-income countries. Contrary to expectations, the study finds that an increase in domestic credit to the private sector results in a slight decline in renewable energy consumption. A 1% increase in domestic credit corresponds to a 0.06% reduction in renewable energy use. The availability of financial resources does not necessarily ensure sufficient investment in renewable energy projects, as the existing financial infrastructure may favour non-renewable energy sectors. The effect of urbanisation on renewable energy consumption is similarly negative. A 1% increase in the urban population leads to a 0.5% reduction in the renewable energy consumption. This could indicate that as cities expand, their energy consumption patterns tend to rely more on conventional energy sources unless there is explicit policy support for the integration of renewable energy. The study also finds that economic growth, as measured by GDP per capita, negatively affects renewable energy consumption. A 1% increase in GDP per capita results in a 0.1% reduction in renewable energy use. This finding suggests that economic growth in lower-middle-income countries may still be linked to higher consumption of fossil fuels, which hinders the transition to renewable energy.

Conclusion

This study sheds light on the unexpected and complex interactions among domestic credit, urbanisation, economic growth, and renewable energy consumption in lower-middle-income countries. The findings reveal that despite the increasing financial resources and urbanisation processes worldwide, these factors fail to sufficiently promote renewable energy usage. Moreover, in the specific context of these countries, the expansion of domestic credit, rising urbanisation, and economic growth are found to negatively affect renewable energy consumption. This situation highlights the inadequacy of directing financial resources towards renewable energy projects and the misalignment of urbanisation dynamics with sustainable energy goals.

The connection between economic growth and energy demand underscores that the energy consumption structures in these countries are predominantly based on traditional energy sources, with the transition to renewable energy still falling short of the desired levels. Increasing economic activities and the associated energy demand often lead to a preference for fossil fuels over renewable energy sources. This indicates

the urgent need for economic growth to be managed in alignment with environmental sustainability. In this context, comprehensive and targeted policy interventions are of critical importance to support the transition to renewable energy in lower-middle-income countries. Financial systems must be restructured to support and incentivize renewable energy investments, provide long-term financing for renewable energy projects, and create attractive mechanisms for investors. Urbanisation policies must be redesigned to promote the use of sustainable energy in urban development processes. This includes modernising urban infrastructure to support renewable energy sources and prioritising sustainable energy use in new urban projects.

Additionally, public policies must integrate the renewable energy perspective not only into the energy sector but also into other areas of the economy to ensure sustainable growth. Encouraging environmentally friendly technologies, developing educational programs to increase the use of renewable energy, and raising public awareness can further accelerate the transition to renewable energy. Such policies and strategies will not only enhance the adoption of renewable energy but also enable these countries to sustain economic growth in harmony with their environmental responsibilities and contribute to global sustainable development goals. Ultimately, lower-middle-income countries must view the transition to renewable energy not only as an environmental imperative but also as a strategic opportunity for long-term economic development. These structural transformations will play a critical role in ensuring energy security and addressing global climate change challenges.

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Author Details

Büşra Şimşek (Dr.)
[1] İstanbul Institute for Advanced Studies, İstanbul, Türkiye
0000-0001-5295-375X busrasimsek02@gmail.com

Muhammet Sait Bozik (Lecturer)
[2] Haliç University, Department of Mathematics, İstanbul, Türkiye
0000-0002-5793-4352 muhammetsaitbozik@halic.edu.tr

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