

Original Article

Effect of Literacy Level on Renewable Energy Consumption: The Case of Azerbaijan and Türkiye

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Abstract: *The demand for energy is increasing day by day in different areas of production and life. Various studies are being carried out in different countries to meet this demand for renewable energy sources. However, this research was designed considering that people's literacy level also plays a role in energy consumption. In this study, the relationship between literacy levels and renewable energy consumption was analyzed in two countries that both export and import energy. In the study, the relationship between literacy level and renewable energy consumption was empirically analyzed using annual data for the period 2007-2019 in Türkiye and Azerbaijan. The findings obtained using the Granger causality test yielded different results for the two countries. While a two-way relationship was detected between the variables within the framework of Azerbaijan, it was concluded that there was no relationship between the variables for Türkiye.*

Keywords: *Literacy level, Renewable energy, Granger causality, Azerbaijan, Türkiye.*

I. INTRODUCTION

As a result of the increasing population and production diversity in the world, the energy requirements and energy utilization of resources are increasing rapidly. On the other hand, as a result of the concentration of the population in cities around the world, especially in developed countries, energy has become an indispensable element for humanity [1]. Nowadays, when human and animal power are replaced by machines in production, energy resources have become a prerequisite for almost all economic activities and constitute an important factor in production costs.

The most basic substance needed to carry out all kinds of production and consumption activities is energy. Human beings have used a wide variety of elements as energy sources, especially their own (human) power, from the day they existed until today, in order to survive and produce. While energy resources were mainly human and animal power in the early periods, elements such as wood, waterpower and wind were also added to these resources over time.

Today, when the energy supply is limited, and the need is increasing, the management, energy supply, transfer and consumption of energy resources have become a strategic element. In this respect, energy resources cause some economic, political, and environmental problems on a regional and global scale [2, 3]. Economic growth is a significant aspect of a country's development and well-being. Economic development is a goal that every nation strives towards. Therefore, a range of macroeconomic factors will impact economic growth. Any country must consider economic growth, which is one of the key metrics demonstrating an increase in the country's economic share. [4, 5]. However, economic growth in some countries develops depending on natural resources in some countries and human activities in others [6-9]. In this context, the level of literacy of knowledgeable individuals or the public, especially in humanitarian activities, may also have an impact on this process.

When evaluated from an economic perspective, the most basic cost element in the functioning of production activities in the recent past and today is energy. On the other hand, in terms of physics, the potential energy that exists in the natural structure of every substance does not mean much to human beings unless it can be used. Because the important element is to make the energy needed by human beings ready for use with existing technological means and at an acceptable cost [10].

In an environment where the need for energy increases and environmental conditions worsen due to energy consumption, there is a need for qualified and conscious societies that will ensure the conscious consumption and selection of energy resources. To achieve this, the average citizen must have the ability to make appropriate energy-related choices.

Due to both economic and environmental concerns, human beings must use energy economically, efficiently, and effectively. For this purpose, the society needs to gain energy literacy. A person with a sufficient level of energy literacy will be able to understand the production, storage, transfer, and consumption of energy from energy sources, energy saving, renewable and non-renewable energy sources, etc. Must have basic concept knowledge. According to Zografakis et al. [11], in



order to gain energy literacy skills in society, steps should be taken at all levels of education through energy saving and energy education programs, starting from early childhood.

Gaining energy literacy should not only be limited to concepts such as knowledge/attitude/value but should also include actions and behaviors. Energy literacy consists of knowledge, attitudes, and behaviors. These three components are affected by the geographical environment and cultural structure [12]. Energy literacy is not only about the efficiency we get from white goods, which are considered the technologies of the last century. In the age of portable, wearable and even drivable technologies, we can easily access thousands of innovations that enter our lives at any time. We can become the power that uses and controls energy, one of the most important values in the world, by adopting just one habit and starting its spread from ourselves.

Energy literacy, in terms of content, includes knowledge (cognitive), sensitivity, attitude (emotional) and behaviors [13]. In order to sustain energy, society must be energy literate [14]. Therefore, raising awareness about the concept of energy, which exists in every aspect of our lives, and ensuring the efficient use of energy are achievements that can only be achieved in school environments where students study [15].

Energy literacy is seen as a basic tool that sensitizes individuals to create habits regarding sustainable energy consumption. It has extensive content information about energy and also covers emotional and behavioral characteristics. It also involves people making appropriate choices regarding energy and having positive attitudes in their habits of using and consuming energy. An energy-literate individual exhibits correct energy-related behaviors throughout his daily life [16]. The issue of energy which is often referred to as having knowledge about energy use under the title of environmental literacy. Today, with the increasing need for energy, facing global climate change, and energy consumption gaining importance, it has begun to be used as a separate term for energy literacy [17].

To guarantee long-term progress, literacy and education are essential for comprehending concerns that might have an impact on the nation and the environment [18]. There is a strong relationship between the development levels of countries and energy consumption. Especially in countries such as the United States (USA), Germany, England, France, and Japan, which are industrialized and a large part of the population lives in cities, annual energy consumption per capita is well above the world average. In addition, countries need energy to increase production in every field. While the per capita consumption of energy, which is an element that increases people's comfort as well as production activities, is high in developed countries, it is quite low in countries that have not yet industrialized and developed.

In this study, research was conducted on Azerbaijan and Türkiye, which are among the developing countries. An attempt was made to measure the relationship between the literacy levels of countries and the consumption of renewable energy in these countries. When we analyze the literacy rate among countries, we can see that both countries have been at the forefront in recent years. Namely, according to data obtained from the World Bank, as of 2019, the literacy level in Türkiye is around 96.7, while for Azerbaijan this value is 99.8.

II. LITERATURE REVIEW

Due to the increasing energy need in the world, energy consumption also increases in parallel. Energy has become an indispensable element, especially with the rapid concentration of the population in cities led by developed countries and the widespread industrialization around the world. However, the most important impact and result of intense energy consumption has manifested itself in the environment in which human beings live. In an environment where energy supply is limited, the demand for energy resources is constantly increasing due to factors such as developing industry, rapid urbanization, and population growth, which is important for the sustainability of energy.

In order to use energy efficiently, which is one of the most crucial and essential needs of today, and to acquire an energy-saving culture (habit), it is important for individuals to gain energy literacy in a programmed way in order to know this important need closely and use it consciously.

Energy needs have increased in most countries due to the acceleration of population growth, industrialization, and advances in technology [19]. Due to the increase in energy consumption due to the use of technologies developed for a comfortable life, countries have turned to different energy sources to meet their energy deficits. These resources are generally classified as nuclear and renewable energy resources today. As a result of scientists' research, trends in meeting energy needs are changing, and studies are concentrated in those areas [20]. The fact that many energy sources used today cause environmental pollution and that there are wars for these energy sources is another indicator that the need for energy is increasing [21]. In order for the developments in industry and technology to be sustainable, energy resources must be renewable and not harmful to the environment [22].

Renewable energy is defined as the energy source that is constantly present in nature itself, where energy flows that are constantly repeated in the natural environment are used without changing their properties [23]. This energy of nature is one of the types of energy that does not run out, constantly renews itself and can be quickly replaced even if consumed [24]. Renewable energy sources can be listed as wind, solar, biomass and biogas, geothermal, hydraulic and wave energies. Renewable energy is a highly sustainable and environmentally friendly technology that will eventually replace fossil fuels. It does not release harmful gasses into the atmosphere or negatively impact local communities. Solar, wind, hydropower, biomass, geothermal, and tidal are all examples of renewable energy sources capable of generating electricity [25].

Energy literacy can be defined as the adoption of energy saving behaviors by being aware of the effects of energy production and consumption on the natural environment and how it is used in daily life. Accordingly, the concept of energy literacy has an impact on an individual's knowledge, attitudes, and behaviors [16]. However, many countries still do not offer energy-specific literacy courses. For this reason, the general literacy level in these countries is used as an indicator to show sensitivity to energy. Energy consumption is a crucial aspect of everyday life and has a substantial impact on several sectors, such as business, transportation, and residential domains. Furthermore, the use of renewable energy resources is hindered by the detrimental impact of conventional energy sources on the environment and the challenges posed by sustainable development [26].

Sigova et al. [27] investigated the association between home power usage and energy efficiency and the population's financial literacy. Khan and Gunwant [28] used time series data from 1990 to 2021 to examine the long-term implications of remittance inflows, literacy rates, energy imports, government spending, and urban population expansion on South Asia's output of renewable energy. With its distinctive features and the pressing need for the conservation of energy and carbon reduction, China needs to vigorously promote the carbon reduction effect of the internet-based economy by actively supporting the development of digital facilities, realizing green digital technology innovation, improving social, digital literacy, and increasing the proportion of energy from renewable sources application before 2035. [29].

The effect of the sanctions and incentives created by the legal and legal regulations put forward by the legislators on energy is limited, and the most important step that can be considered permanent is to provide individuals with energy literacy. Societies must have energy literacy in order to make energy sustainable in the world, especially by using energy consciously and efficiently, and to leave a more livable world to future generations [14].

Martins, Madaleno, and Dias [30] tried to reveal the importance of energy literacy for society and individuals. In the same study, it was emphasized that financial literacy is necessary for individuals to comprehend energy literacy fully. It is stated that more research should be done on the connection between energy literacy and financial awareness for the energy-saving habits of individuals, which are desired to develop together with energy literacy.

III. RESEARCH METHODOLOGY

The data included in the analysis consists of annual data covering the years 2007-2019. The data set was obtained from the World Bank. People with a literacy level of 15 years and above were included in the analysis. It consists of percentage data. Likewise, renewable energy consumption is taken as a percentage of total energy consumption. The data included in the analysis is limited because it is drawn from data available on the World Bank platform.

IV. ANALYSIS AND RESULTS

The variables required for the analysis are included in Equation 1. In this context, literacy level and renewable energy consumption constitute the basis of the model to be established for analysis (Equation 1).

$$\text{Variables} = f(\text{Literacy level}, \text{Renewable energy consumption}) \quad (1)$$

After the necessary variables were determined, our models were established as in Equations 2 and 3. Thus, within the framework of both countries, variables were considered dependent and independent, and the effects on each other were tried to be measured.

$$\text{Literacy level} = \beta_0 + \beta_1 \text{Renewable energy consumption} \quad (2)$$

$$\text{Renewable energy consumption} = \beta_0 + \beta_1 \text{Literacy level} \quad (3)$$

In order to conduct causality analysis, the data must meet certain criteria. The first of these is to ensure stationarity of unit roots. As a result of the ADF test, it was observed that the variables were not stationary at the level level. Level values related to stationarity are given in Table 1.

Table 1: Level Values of Series

Türkiye				
ADF test result	Literacy level		Renewable Energy Consumption	
	t-statistics	Possibility	t-statistics	Possibility
ADF testing statistics	0.541079	0.8165	-0.210655	0.5853
Test Critical Values	%1	-2.792154		-2.816740
	%5	-1.977738		-1.982344
	%10	-1.602074		-1.601144
Azerbaijan				
ADF test result	Literacy level		Renewable Energy Consumption	
	t-statistics	Possibility	t-statistics	Possibility
ADF testing statistics	1.661255	0.9774	-1.414783	0.1391
Test Critical Values	%1	-2.771926		-2.771926
	%5	-1.974028		-1.974028
	%10	-1.802922		-1.602922

As can be seen from Table 1, the stationarity condition is not met in terms of level. In order to make the series stationary, the ADF unit root test was applied again, and it was observed that only the second-level data became stationary. Information on second-order stationarity is given in Table 2.

Table 2: Stationarity Level of Second Order Series

Türkiye				
ADF test result	Literacy level		Renewable Energy Consumption	
	t-statistics	Possibility	t-statistics	Possibility
ADF testing statistics	-3.155772	0.0052	-4.078303	0.0014
Test Critical Values	%1	-2.816740		-2.886101
	%5	-1.982344		-1.995865
	%10	-1.601144		-1.599088
Azerbaijan				
ADF test result	Literacy level		Renewable Energy Consumption	
	t-statistics	Possibility	t-statistics	Possibility
ADF testing statistics	-14.69437		-3.473144	0.0026
Test Critical Values	%1	-2.816740		-2.792154
	%5	-1.982344		-1.977738
	%10	-1.601144		-1.602074

After the ADF test results were obtained, appropriate lag lengths for the variables were determined. In both countries, the most optimal delay lengths were determined as four. Information on suitable delay lengths is given in Table 3.

Table 3: Appropriate Delay Length

Türkiye						
Lag	LogL	LR	FPE	AIC	SC	HQ
0	-22.67560	NA	0.826592	5.483468	5.527295	5.388888
1	-9.060621	18.15331	0.102695	3.346805	3.478288	3.063065
2	2.295658	10.09447*	0.025214*	1.712076	1.931214	1.239176
3	6.173699	1.723574	0.055643	1.739178	2.045972	1.077118
4	408.2028	0.000000	NA	-86.71173*	-86.31728*	-87.56295*
Azerbaijan						
Lag	LogL	LR	FPE	AIC	SC	HQ
0	32.15877	NA	4.22e-06	-6.701949	-6.658121	-6.796529
1	44.82998	16.89495*	6.47e-07	-8.628885	-8.497402	-8.912625
2	52.34987	6.684344	3.72e-07	-9.411082	-9.191944	-9.883982
3	65.79037	5.973556	9.81e-08*	-11.50897	-11.20218	-12.17103
4	301.4334	0.000000	NA	-62.98521*	-62.59076*	-63.83643*

*Indicates the appropriate lag length for the relevant test.

After the necessary assumption tests were performed and appropriate lag lengths were determined, my Granger analysis was started. Information regarding the Granger test is given in Table 4.

Table 4: Granger Causality Test

Türkiye			
Hypotheses	F-value	Probability value (p)	Decision at 1% significance level
Changes in renewable energy consumption affect the level of literacy changes in the level of literacy affect the consumption of renewable energy	0.961268	0.6184	Rejected
Changes in renewable energy consumption affect the level of literacy changes in the level of literacy affect the consumption of renewable energy	4.539245	0.1034	Rejected
Azerbaijan			
Hypotheses	F-value	Probability value (p)	Decision at 1% significance level
Changes in renewable energy consumption affect the level of literacy changes in the level of literacy affect the consumption of renewable energy	19.71910	0.0001	Accepted
Changes in renewable energy consumption affect the level of literacy changes in the level of literacy affect the consumption of renewable energy	0.0000	0.0000	Accepted

If we interpret the results obtained from the Granger test, different results were obtained within countries. Namely, when examined from Azerbaijan, a very solid and strong result was obtained. The level of relationship between variables is bidirectional. Therefore, renewable energy consumption in this country has an impact on the level of literacy. Likewise, a possible change in literacy levels would have a significant impact on renewable energy. H_1 hypothesis is accepted for both models. When we examined the test results in Türkiye, it was determined that there was no relationship between the variables.

V. DISCUSSION AND CONCLUSION

Increasing energy consumption increases harmful gas emissions into the environment. At the same time, the fact that many countries do not have energy reserves is a serious cost factor. That is why, today, states are turning to renewable energy sources to reduce energy dependency, save on costs and prevent environmental pollution. Of course, increasing renewable energy resources is possible with a good education structure and technological investments. Some countries have started to focus on areas such as energy literacy in order to increase the trend in this regard. Whether it is specifically about energy or in a general context, increasing the literacy rate means increasing the rate of conscious people in that country. The more conscious a person becomes, the more sensitive he becomes to the environment. Based on this, an attempt was made to test the relationship between renewable energy consumption and literacy level in a country.

Sigova et al. [27] discovered that in nations with greater living standards, there is a stronger correlation between energy use and financial literacy. According to Khan, Thaheem, and Ali's [31] research, which had 354 prospective house buyers participating in a survey, demographic variables, including age, gender, and reading level, were shown to be positively correlated with willingness to spend. The findings of Khan and Gunwant [28] showed that literacy rates had a favorable and noteworthy impact on the generation of renewable power.

The application was made for Azerbaijan and Türkiye, countries that import energy and export energy. According to the results obtained, a double-sided effect was detected between renewable energy consumption and literacy rates in Azerbaijan, which is an energy-exporting country. That is, both variables affect each other. For Türkiye, which is a country dependent on energy imports, the analysis results concluded that there is no relationship between the variables.

Renewable energy sources have a very important place in today's world because the demand for energy and energy consumption increases day by day. On the other hand, empirically proving whether energy consumption has a relationship with literacy will also contribute to the opening of a new research area in the academic field. Considering that there are very few studies on literacy level and renewable energy consumption in the literature, we hope that this study will shed light on more comprehensive studies to be conducted in the future.

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