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**Article**

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# The Relationship between Renewable Energy Production and Employment in European Union Countries: Panel Data Analysis

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**ABSTRACT**

Renewable energy, which is the type of energy that plays a major role in the development and growth of countries, plays an important role in today's world, considering that the life of depleted energy resources is finite. Compared to fossil energy sources, except that its source is infinite, a noticeable difference in carbon dioxide emission is seen as the reason for preferring renewable energy sources. Many studies in the literature investigate the relationship between the consumption of renewable energy resources and economic growth. This study was conducted on renewable energy production in 27 European Union member countries explores its impact on employment. In the study, panel ARDL test was conducted with the data for the years 2006-2019. According to the results of the study, renewable energy generation has a positive effect on employment in European Union countries in the long term. In the long run, a 1% increase in renewable energy primary production increases employment by 0.08%. Increasing the use of renewable energy resources should go beyond being a policy recommendation in international conventions. The fact that these resources provide employment in large areas can be a good alternative today with high unemployment rates.

**Keywords:** Renewable Energy, Employment, Developed Countries, Panel Autoregressive Distributed Lag Model
**JEL Classifications:** O40, Q43, Q40

## 1. INTRODUCTION

The development of renewable energy alternatives, increasing energy efficiency and thus reducing the effects of energy consumption on climate change, increasing energy supply security and contributing to the economy, as well as its positive impact on employment have been a subject of study in recent years. Environmental, energy efficiency and renewable energy investments create thousands of job opportunities around the world. Environmental awareness, Kyoto protocol, carbon tax, renewable energy investments and energy security, international agreements and cooperation in energy trade enable the emergence of new employment areas defined as green professions (Lehr et al., 2008; Elfani, 2011; Lehr et al., 2012; Jaber et al., 2015; Muniyoor, 2020; Majid, 2020). Especially developed countries with high energy consumption in industry have increased their investments in technology to be used for renewable energy. As renewable energy technologies develop, both the cost of renewable energy will decrease and its useful life will increase. Investments made in the field of renewable energy will create new employment areas. According to the Renewable Energy and Employment Report published by the International Renewable Energy Agency (IRENA), the employment figure in the field of renewable energy was 11 million in 2018, compared to 10.34 million in 2017. On a sectoral basis, solar energy, biofuel energy and wind energy stand out. It is seen that most of the early studies and related institution reports in the field of renewable energy create positive and high employment expectations by taking into account the direct employment in the sector. However, directing macro policies by considering only direct employment may cause structural problems in the labor market in the long run (Markandya et al., 2016; Cameron and van der Zwaan, 2015).

The aim of this study is to investigate whether renewable energy consumption creates employment for EU countries, representing developed countries. When the relevant literature is examined, it is seen that there are fewer empirical applications despite many theoretical studies. It is striking that econometric analysis, which takes into account net employment in particular, is insufficient. With this study, it is aimed to contribute to these areas, which are indicated to be insufficient, and to make long-term political implications. At this point, the study consists of 5 parts. The following part of the study includes empirical literature on the subject. Then, the data set and model used in the analysis are explained. In the fourth part, the findings obtained as a result of empirical application are evaluated. The study ended with the conclusion part.

## 2. LITERATURE REVIEW

There are many studies in the literature on the relationship between renewable energy consumption and economic growth. Although different variables are used in studies, the most common variables are renewable energy production-consumption, gross domestic product or per capita gross domestic product, energy dependency, capital, labor power, carbon dioxide emission. While there is a causality relationship between variables in some studies (Tugcu et al., 2012; Al-Mulali et al., 2014; Paramati et al., 2017), there is no causality relationship in some studies (Jebli and Youssef, 2015; Chang et al., 2015).

In 2012, Tugcu et al. conducted a study for G-7 (Canada, France, Germany, Italy, Japan, United Kingdom, USA) countries. As a result of the study using ARDL (Autoregressive Distributed Lag Model) and Khatami Causality method, the bi-directional causality of renewable energy consumption to economic growth and economic growth to renewable energy consumption was found. Al-Mulali et al. (2014) examined the period between 1980 and 2011 of 18 Latin American countries. Renewable energy consumption, real gross domestic product, consumable energy consumption, labor force, foreign trade and fixed capital formation variables are used in the study. By using Pedroni Cointegration, DOLS (Dynamic Least Squares), Granger Causality method, bidirectional causality was found between renewable energy consumption and real gross domestic product. In Amri's 2016 study, he studied 75 different countries between 1990 and 2010. In the analysis made by using the variables of renewable energy consumption, real gross domestic product, consumable energy consumption, labor power, capital and foreign direct investment, the causality from renewable energy consumption to real gross domestic product has been reached with the GMM method.

Paramati et al. (2017) examined G20 countries in the period from 1991 to 2012. In their studies, they used the variables of renewable energy consumption, real gross domestic product, consumable energy consumption, carbon dioxide emission, fixed capital formation, foreign direct investment, energy efficiency, market capitalization. Through the Panel Cointegration and Dumitrescu-Hurlin Causality method, the conclusion of causality from renewable energy consumption to real gross domestic product for developing countries has been reached. Bhattacharya et al. (2016) examined 38 countries between 1991 and 2012. Renewable energy consumption, real gross domestic product, consumable energy consumption, labor force, fixed capital formation were used as variables. As a result of the analysis using Pedroni Cointegration, DOLS, Granger Causality methods, causality from renewable energy consumption to real gross domestic product was found.

Jebli and Youssef (2015) examined the period between 1980 and 2010 in 69 countries. Renewable energy consumption, real gross domestic product, consumable energy consumption, labor force, capital, foreign trade variables are used in the study. In the analysis made by using Pedroni Cointegration, DOLS and Granger Causality, causality between real gross domestic product and renewable energy consumption could not be reached in the panel. Al-Mulali et al. (2013) examined this relationship for 108 countries. Renewable energy consumption and real gross domestic product are used in the analysis that examines the period between 1980 and 2009. The result obtained from the FMOLS (Fully Modified Least Squares) method is a bidirectional relationship between renewable energy consumption and real gross domestic product for 85 countries, causality from real gross domestic product to renewable energy consumption in two countries, and any Causality was not found. Chang et al. (2015) analyzed G-7 countries. By using Emirmahmutoğlu-Köse Causality and Granger Causality method, from real gross domestic product to renewable energy consumption in two countries, from renewable energy to real gross domestic product in two countries, a two-way relationship was found in the total panel. In three countries, causality was not found. Mahmoodi (2017) examined the relationship between economic growth, renewable energy and carbon dioxide emissions for a panel of 11 developing countries. The results of the Kao and Pedroni panel cointegration test showed the existence of a long-term relationship between these variables. Panel causality results demonstrated bidirectional causality between renewable energy and CO2 emissions, bidirectional causality between GDP and CO2, and unidirectional causality from GDP to renewable energy. Burakov and Freidin (2017) investigated the causal relationship between financial development, economic growth and renewable energy consumption in the case of Russia. The results of the VEC model showed that the system of variables corrected the previous period imbalance at 22.98% in 1 year. The results of the Granger causality test showed that there is a bidirectional causality between economic growth and financial development in Russia, while renewable energy consumption does not cause economic growth or financial development.

There are relatively few studies investigating the relationship between renewable energy and employment empirically. Major studies in the literature investigating this relationship are Fragkos and Paroussos (2018), Rafiq et al. (2018), Hondo and Moriizumi (2017), Zhao and Luo (2017), Ge and Zhi (2016), Apergis and Salim (2015), Cai et al. (2014), Fanning et al. (2014), Rivers (2013), Lambert and Silva (2012), Cai et al. (2011), Tourkolias and Mirasgedis (2011), Frondel et al. (2010), Sastresa et al. (2010), Ozturk and Acaravci (2010), Payne (2009), Moreno and López (2008), Hillebrand et al. (2006), Ziegelmann et al. (2000).

In their study for EU countries, Fragkos and Paroussos (2018) combined the employment factor approach, which is a bottom-up approach, and the overall balance analysis, which is a top-down approach, to achieve a consistent result. Employment from energy expansion will be in the construction of PV installations, the production of advanced biofuels, the manufacture and installation of wind turbines. The transition to a low carbon economy will enable the reallocation of approximately 1.3% of jobs in EU countries in 2050. Rafiq et al. (2018) worked with data from 41 countries. According to the result; While non-renewable energy consumption reduces unemployment, renewable energy increases unemployment. In the linear panel estimation, government spending and trade deficit, while in the nonlinear panel estimation, industrialization and service sector unemployment decrease. In addition, agriculture increases unemployment. Hondo and Moriizumi (2017) investigated the employment creation characteristics of nine different renewable energy generation technologies. The total employment opportunities created over the life cycle range from 1.04 to 5.04 person-years per GWh, depending on the type of technology. In addition, for the total of nine sectors, the highest indirect contribution to employment is provided by the service sector. Zhao and Luo (2017) found a quadratic relationship between income and renewable energy generation for China. There is no significant relationship between renewable energy and delayed unemployment rate. Income and employment have a negative impact on renewable energy. In addition, regulation has positive effects on renewable energy.

According to the literature review by Ge and Zhi (2016), there are some gaps in the literature such as lack of information about new energy types and the results obtained are not based on a clear theory. In addition, while the green economy has positive effects on employment in countries such as China, South Africa, USA and France; For some countries such as Spain, Germany and Italy, it may create unemployment, not employment. Apergis and Salim (2015) discuss the dynamic link between renewable energy consumption and unemployment for 80 countries. Overall, although renewable energy consumption has a positive effect on unemployment, certain regions such as Asia and Latin America show that the impact of renewable energy consumption on job creation depends on the cost of adopting renewable energy technologies and energy efficiency that differs between regions.

Jaraitė et al. (2015) made an analysis for EU countries with the data for the years 1990-2012. According to the findings, solar energy has a positive effect on employment in machinery and equipment manufacturing, but it is not at a level that will affect the overall economy level. In addition, wind energy has a positive effect on overall employment in the short term at the overall economy level, but not at the level of the manufacturing and machinery sector. Again, Ortega et al. (2015) investigated the net employment effect of renewable energy in both member countries and specifically in each member country, unlike the previous literature on European Union member countries. The study covers the period 2008-2012. It is seen that solar PV technology and wind energy (land type-marine type) technologies are taken into consideration. In the study, a new kind of dynamic analytical method is presented that takes into account the do-learning effect, the current industrial structure of the countries and regional trade data. As a result of the analysis, they determined that 548 019 new jobs were created by the PV and wind energy sectors in 2012. It is stated that 45.7% of new employment originates from the land-type wind energy sector, 45.6% from the solar energy sector and 8.7% from the marine-type wind energy sector. In addition, it was seen that 56% of the total new employment emerged during the production phase. 27% was revealed during the installation phase and 17% during the operation-maintenance phase. The ranking in terms of countries is Germany, Denmark, Italy, Spain and England.

Fortes et al. (2015) focused on Portugal, which is the third country with the highest unemployment rate among EU countries. Although the results are not comparable because their assumptions and inputs are not the same, two different simulation methods have been used: HyBGEM (Hybrid Bottom-up General Equilibrium Model) and HYBTEP (Hybrid Technological-Economic Platform). In this study, the effects of high financing costs of renewable energy investments on employment and welfare have been investigated. The results show that whether the financing is reflected to households with lump-sum taxes or when it is reflected to employers through insurances, it negatively affects employment. In short, negative net employment result was obtained in all scenarios applied in the study.

## 3. DATA AND METHODOLOGY

### 3.1. Data Set and Model

The analysis was made using the annual data of EU (27) countries between 2006 and 2019. The following model has been established to investigate the contribution of renewable energy generation to employment for EU countries:

$$emp_{it}=\beta_0+\beta_1\ rep_{it}+\beta_2\ gdp_{it}+\beta_3\ fcapf_{it}+\varepsilon_{it} \quad (1)$$

In equation number 1, *emp* variable is the dependent variable and expresses employment. Independent variables are *rep* - renewable energy production, *gdp* - gross domestic product per capita, and *fcapf* are fixed capital formation variables, respectively.

Renewable energy primary production includes primary production of solar energy, biomass energy and wastes, geothermal energy, hydraulic energy, wind energy and marine energy, and the data are taken from Eurostat's data base ten00081. The Ktoe unit, equivalent to one thousand tons of oil, is used as the primary renewable energy production criterion. Gross domestic product per capita, gross fixed capital formation data and employment data were obtained from the World Bank database. Employment variable has been selected and taken as total labor force on the basis of person. All variables are used in logarithmic form.

### 3.2. Methodology

In this study, panel data analysis was applied to investigate the relationship between renewable energy production and employment in EU countries. Panel data is created by combining the time series of economic individuals with the cross-sectional dimension (Baltagi, 2008). In the study, after checking the stationary properties of the variables, static panel data analysis was applied, and then the error correction coefficient of the panel ARDL model was calculated. Panel ARDL (distributed delay autoregressive model) boundary test approach Pesaran et al. (2001) has been developed by. This approach makes it possible to examine the cointegration relationship when the explanatory variables are stationary at different levels such as level [I (0)] and first difference [I (1)]. But if the unit root degree of one of the variables is greater than I (1), Pesaran et al. (2001) and Narayan and Narayan (2005) cannot use the critical values. These critical values are based on I (0) and I (1). For this reason, at the first stage of the analysis, it is necessary to check whether the ARDL boundary test approach complies with the assumptions by performing unit root test to the variables.

The ARDL method is based on the standard Least Squares method in which both the dependent variable and the delayed values of the independent variables are used as explanatory variables. The most important advantage of this approach is that it does not require a comprehensive data set and analysis can be made with a small data set. Also, in this approach, the optimal lag levels of variables at different levels can be taken into account. Finally, although the ARDL approach can be applied to single equation systems, long-term relationships in traditional cointegration techniques can only be calculated with the help of system equations (Ozturk and Acaravci, 2010a).

## 4. ANALYSIS FINDINGS

### 4.1. Panel Cross-section Dependence Test

Firstly, cross section dependency was checked with *LM* tests in the study. The dependency of the cross section units means that a shock to one of them will affect the other section units as well (Syzdykova et al., 2020). Testing the cross section dependency is important in choosing the unit root tests to be applied. Because there are two generations of unit root tests, first generation unit root tests may give incorrect results in case of cross-sectional dependency between series (De Hoyos and Sarafidis, 2006). Three *LM* tests were applied to check the cross-sectional dependence. One of these, *LM*1, was developed by Breusch and Pagan (1980). Other *LM* tests are *LM*2 and *LM* tests developed by Pesaran (2004). The results obtained from the *LM* tests are shown in Table 1. The null hypothesis for *LM* tests is that there is no cross-sectional dependency.

As can be seen from Table 1, the null hypothesis that argues that there is no cross-sectional dependency has been rejected, so there is a cross-section dependence between the European Union countries included in the analysis in the selected series. Considering that the economies of the countries today are in close relationship with each other, it is a realistic approach that the countries that make up the panel are affected by a shock coming to one of the countries.

**Table 1: Cross section dependency test results**

| Variables | $CD_{LM1}$ | $CD_{LM2}$ | $CD_{LM}$ |
|---|---|---|---|
| *emp* | 373.06** | 18.88** | –3.97* |
| *rep* | 396.09* | 14.30** | 4.71*** |
| *gdp* | 385.36** | 13.02** | –3.87* |
| *fcapf* | 309.65*** | 12.09*** | 3.61* |

*, ** and *** show that the null hypothesis is rejected and the significance level of 10%, 5% and 1% respectively

### 4.2. Panel Unit Root Test

Since there is a cross sectional dependency in the series used in the study, the second generation unit root test, which takes this situation into account, was applied. Pesaran's CADF test was used for this type of analysis. Pesaran (2007) proposed a simple method to eliminate the correlation between units instead of estimating factor loads. Instead of a unit root test based on taking the difference from the estimated common factors, he added the cross section averages of the lagged levels and first differences of the individual series as factors to the DF or ADF regression. Therefore, in this method, the extended version of the ADF regression with lagged cross-section means is used, and the first difference of this regression eliminates the inter-unit correlation. Cross-sectional augmented Dickey-Fuller (CADF) test results are reported in Table 2.

As a result of the unit root test, it is seen that the level values of the series both on individual country basis and throughout the panel are stable and carry an I (0) process.

### 4.3. Panel ARDL Test

The ARDL test is based on the estimation of the least-squares estimator and the unconstrained error correction model. The cointegration relationship of equation (1) can be determined by estimating the unconstrained error correction model with the boundary test approach. In this context, the equation (1) can be expressed in ARDL form as follows:

$$\Delta emp_{it} = \alpha_i + \varphi_i emp_{i,t-1} + \delta_i rep_{it} + \theta_i gdp_{it} + \omega_i fcapf_{it} + \sum_{j=1}^{pi-1} \beta_{ij} **\Delta emp_{i,t-j} + \sum_{j=0}^{qi} \delta_{ij} **\Delta rep_{i,t-j} + \sum_{j=0}^{ki} \theta_{ij} **\Delta gdp_{i,t-j} + \sum_{j=0}^{fi} \omega_{ij} **\Delta fcapf_{i,t-j} + u_{it} \quad (2)$$

Where;

$$\varphi_i = -\left(1 - \sum_{j=1}^{pi} \beta_{ij}\right), \delta_i* = \sum_{j=0}^{qi} \delta_{ij}, \theta_i* = \sum_{j=0}^{ki} \theta_{ij}, \omega_i* = \sum_{j=0}^{fi} \theta_{ij},$$

$i = 1, 2, \ldots 27$; $t = 2006, 2007, \ldots, 2019$.

Panel ARDL results were calculated with Stata 11.0 and estimates are given in Table 3.

As a result of Hausman test, PMG regression was preferred instead of MG. The coefficient of the variable rep has a positive sign. This means that renewable energy generation has a positive effect on employment in European Union countries in the long run. The sign of the gross domestic product per capita variable,

**Table 2: CADF unit root test results**

| Countries | *emp* | | *rep* | | *gdp* | | *fcapf* | |
|---|---|---|---|---|---|---|---|---|
| | Cadf Stat | Lag | Cadf Stat | Lag | Cadf Stat | Lag | Cadf Stat | Lag |
| Austria | –8.06*** | 1 | –4.01** | 1 | –2.7* | 2 | –3.8** | 3 |
| Belgium | –2.99* | 1 | –3.91** | 1 | –3.02* | 5 | –5.41*** | 2 |
| Bulgaria | –2.47 | 2 | –3.03** | 3 | –2.98* | 1 | –3.29* | 1 |
| Croatia | –3.33* | 1 | –4.04** | 5 | –2.10 | 2 | –3.76** | 2 |
| Cyprus | –3.08* | 1 | –3.49** | 1 | –3.12* | 1 | –3.13* | 2 |
| Czech Republic | –5.4*** | 1 | –1.12 | 1 | –3.01* | 2 | –1.39 | 2 |
| Denmark | –4.03** | 2 | –3.65** | 3 | –2.76 | 3 | –2.81 | 1 |
| Estonia | –2.05 | 1 | –3.07* | 2 | –3.43** | 1 | –3.46** | 1 |
| Finland | –3.12** | 1 | –1.90 | 2 | –1.23 | 2 | –4.01*** | 1 |
| France | –3.06** | 3 | –2.32 | 1 | –3.23 | 1 | –2.76 | 2 |
| Germany | –3.13** | 2 | –5.29*** | 1 | –3.88** | 3 | –3.71** | 3 |
| Greece | –3.11**** | 1 | –1.44 | 1 | –4.12 | 1 | –8.13* | 2 |
| Hungary | –2.12 | 1 | –3.81* | 3 | –5.85*** | 1 | –2.98 | 3 |
| Ireland | –1.45 | 1 | –3.06** | 2 | –3.23 | 1 | –3.67** | 2 |
| Italy | –3.02* | 3 | –5.78*** | 1 | –4.21*** | 2 | –2.55 | 4 |
| Latvia | –2.78 | 2 | –4.10** | 1 | –4.72** | 3 | –1.23 | 1 |
| Lithuania | –3.20* | 1 | –5.22*** | 3 | –3.01* | 3 | –2.78 | 1 |
| Luxembourg | –1.98 | 1 | –3.02* | 2 | –2.87 | 2 | –3.03* | 1 |
| Malta | –3.45** | 1 | –3.26* | 2 | –3.23** | 2 | –3.18* | 2 |
| Netherlands | –5.81*** | 2 | –6.65** | 2 | –2.56 | 1 | –2.09** | 2 |
| Poland | –3.03* | 2 | –3.08* | 1 | –3.23* | 1 | –3.20* | 1 |
| Portugal | –1.28 | 1 | –3.67** | 1 | –3.37* | 2 | –2.04 | 4 |
| Romania | –4.13*** | 2 | –4.13*** | 1 | –2.34 | 1 | –1.99 | 2 |
| Slovakia | –4.02*** | 1 | –2.95 | 1 | –2.01 | 1 | –2.67 | 2 |
| Slovenia | –2.04 | 1 | –3.09* | 3 | –3.23** | 3 | –4.60*** | 1 |
| Spain | –1.19 | 3 | –3.78** | 2 | –2.31 | 1 | –4.01** | 1 |
| Sweden | –3.24* | 1 | –3.04* | 2 | –2.10 | 3 | –3.62** | 3 |
| Panel geneli (CIPS) | –3.32*** | | –2.87*** | | –2.29** | | –2.13** | |

Constant term and trend are included from the deterministic components. *, ** and *** show that the null hypothesis is rejected and the significance level of 10%, 5% and 1% respectively. The critical values of CADF statistics are taken from Table 1b in Pesaran (2007). Critical values indicate the significance levels of –4.11***, –3.36** and –2.97*, respectively 1%, 5% and 10%. CIPS statistics critical values are taken from Table 2b in Pesaran (2007). Critical values show the significance levels of 1%, 5% and 10%, respectively, as –2.57***, –2.33** and –2.21*

**Table 3: Panel ARDL forecast results**

| Pooled mean group regression | | | Mean group regression | | |
|---|---|---|---|---|---|
| Independent variables | Coefficient | Std. Error | Independent variables | Coefficient | Std. Error |
| *rep* | 0.0898** | 0.0176 | *rep* | –0.3743 | 3.2200 |
| *gdp* | –0.0717** | 0.0103 | *gdp* | –0.0201 | 0.7302 |
| *fcapf* | 0.0135*** | 0.0048 | *fcapf* | 0.0876 | 0.6831 |
| *EC* | –0.483*** | 0.0741 | *EC* | –0.486*** | 0.0622 |
| Δ*rep* | 0.224** | 0.0611 | Δ*rep* | 0.213*** | 0.0568 |
| Δ*gdp* | 0.0474 | 0.0104 | Δ*gdp* | 0.0209 | 0.0126 |
| Δ*fcapf* | 0.1209 | 0.1108 | Δ*fcapf* | 0.4532 | 0.7651 |
| *Constant* | 1.517*** | 0.0431 | *Constant* | 1.487*** | 0.3806 |
| Hausman test results: $Chi^2$ (2) = 1.98 and Probability value > $Chi^2$ 0.37 | | | | | |

*, ** and *** show the significance level of 10%, 5% and 1% respectively

which is considered as economic growth, is negative, while the variable of fixed capital formation is positive. As a result, while a 1% increase in primary production of renewable energy in the long term increases the workforce by 0.08%, in the long term increase of 1% in the formation of fixed capital increases the labor force by 0.13%, while the 1% increase in per capita gross product decreases the workforce by 0.07% in the long term. The negative effect can be explained by the income effect and technological unemployment in economic theory. In general, all three explanatory variables are statistically significant in the model established.

In addition, the error correction coefficient was statistically significant and negative, indicating that the ARDL model is working correctly. According to the error correction model coefficient, approximately 48% of the deviations that occur in the short term reach the long term balance by leveling in the next period. It takes 2.08 periods for the deviations in the model in the short run to reach long-term equilibrium. Since the data used in the analyzes are annual, it takes approximately 2 years for short-term deviations to reach long-term equilibrium.

## 5. CONCLUSION

In this study, the effect of the shift towards renewable energy use due to environmental degradation and energy supply security in the world on employment in EU countries was examined. Investments to be made in the field of renewable energy and the positive externalities that these investments will create provide significant support to economic growth and development by causing an increase in domestic production, creating more employment and decreasing import bills. In this study, unlike many other studies, the relationship between renewable energy primary production and employment was revealed by panel ARDL method. For this purpose, the gross domestic product per capita and fixed capital formation variables are also included in the model established in the study as control variables.

Within the scope of the analysis results, the long-term effects of renewable energy primary production and other variables on employment in European Union countries were found to be significant and interpreted. In this context, capital investments of countries in renewable energy technologies should increase, the use of fossil fuels should be reduced, and suitable lands for renewable energy resources facilities should be determined. Collaborations, statistical transfers, support projects and joint projects should be intensified among EU countries on renewable energy. On the other hand, if countries reduce the dependency of imported fossil fuels, the prices of consumable energy resources will decrease and the emission strategy will be supported. Reproduction of studies and analyzes on renewable energy will help countries determine their policies in line with the results to be obtained.

## REFERENCES

Al-Mulali, U., Fereidouni, H.G., Lee, J.Y. (2014), Electricity consumption from renewable and non-renewable sources and economic growth: Evidence from Latin American countries. Renewable and Sustainable Energy Reviews, 30, 290-298.

Al-Mulali, U., Fereidouni, H.G., Lee, J.Y., Sab, C.N.B. (2013), Exploring the relationship between urbanization, energy consumption, and $CO_2$ emission in MENA countries. Renewable and Sustainable Energy Reviews, 23, 107-112.

Apergis, N., Salim, R. (2015), Renewable energy consumption and unemployment: evidence from a sample of 80 countries and nonlinear estimates. Applied Economics, 47(52), 5614-5633.

Baltagi, B.H. (2008), Forecasting with panel data. Journal of Forecasting, 27(2), 153-173.

Bhattacharya, M., Paramati, S.R., Ozturk, I., Bhattacharya, S. (2016), The effect of renewable energy consumption on economic growth: Evidence from top 38 countries. Applied Energy, 162, 733-741.

Breusch, T.S., Pagan, A.R. (1980), The Lagrange multiplier test and its applications to model specification in econometrics. The Review of Economic Studies, 47(1), 239-253.

Burakov, D., Freidin, M. (2017), Financial development, economic growth and renewable energy consumption in Russia: A vector error correction approach. International Journal of Energy Economics and Policy, 7(6), 39-47.

Cai, W., Mu, Y., Wang, C., ve Chen, J. (2014), Distributional employment ımpacts of renewable and new energy a case study of China. Renewable and Sustainable Energy Reviews, 39, 1155-1163.

Cai, W., Wang, C., Chen, J., Wang, S. (2011), Green economy and green jobs: Myth or reality? The case of china’s power generation sector. Energy, 36(10), 5994-6003.

Cameron, L., van der Zwaan, B. (2015), Employment factors for wind and solar energy technologies: A literature review. Renewable and Sustainable Energy Reviews, 45, 160-172.

Chang, T., Gupta, R., Inglesi-Lotz, R., Simo-Kengne, B., Smithers, D., Trembling, A. (2015), Renewable energy and growth: Evidence from heterogeneous panel of G7 countries using Granger causality. Renewable and Sustainable Energy Reviews, 52, 1405-1412.

De Hoyos, R.E., Sarafidis, V. (2006), Testing for cross-sectional dependence in panel data models. The stata Journal, 6(4), 482-496.

Elfani, M. (2011), The impact of renewable energy on employment in Indonesia. International Journal of Technology, 2(1), 47-55.

Fanning, T., Jones, C., Munday, M. (2014), The regional employment returns from wave and tidal energy: A welsh analysis. Energy, 76, 958-966.

Fragkos, P., Paroussos, L. (2018), Employment creation in EU related to renewables expansion. Applied Energy, 230, 935-945.

Frondel, M., Ritter, N., Schmidt, C.M., Vance, C. (2010), Economic ımpacts from the promotion of renewable energy technologies: The German experience. Energy Policy, 38(8), 4048-4056.

Ge, Y., Zhi, Q. (2016), Literature review: The green economy, clean energy policy and employment. Energy Procedia, 88, 257-264.

Hillebrand, B., Buttermann, H.G., Behringer, J.M., Bleuel, M. (2006), The expansion of renewable energies and employment effects in Germany. Energy Policy, 34(18), 3484-3494.

Hondo, H., Moriizumi, Y. (2017), Employment creation potential of renewable power generation technologies: A life cycle approach. Renewable and Sustainable Energy Reviews, 79, 128-136.

IRENA. (2019), Renewable Energy and Jobs. Annual Review 2019. Abu Dhabi, United Arab Emirates: International Renewable Energy Agency. Available from: https://www.is.gd/klbDWp. [Last access on 2020 Jul 20].

Jaber, J.O., Elkarmi, F., Alasis, E., Kostas, A. (2015), Employment of renewable energy in Jordan: Current status, SWOT and problem analysis. Renewable and Sustainable Energy Reviews, 49, 490-499.

Jaraitė, J., Karimu, A., Kažukauskas, A., Kazukauskas, P. (2015), Renewable energy policy, economic growth and employment in EU countries: Gain without pain? Economic growth and employment in EU countries: Gain without pain. SSRN Electronic Journal, 2015, 2615894.

Jebli, M.B., Youssef, S.B. (2015), Output, renewable and non-renewable energy consumption and international trade: Evidence from a panel of 69 countries. Renewable Energy, 83, 799-808.

Lambert, R.J., Silva, P.P. (2012), The challenges of determining the employment effects of renewable energy. Renewable and Sustainable Energy Reviews, 16(7), 4667-4674.

Lehr, U., Lutz, C., Edler, D. (2012), Green jobs? Economic impacts of renewable energy in Germany. Energy Policy, 47, 358-364.

Lehr, U., Nitsch, J., Kratzat, M., Lutz, C., Edler, D. (2008), Renewable energy and employment in Germany. Energy Policy, 36(1), 108-117.

Mahmoodi, M. (2017), The Relationship between economic growth, renewable energy, and $CO_2$ emissions: Evidence from panel data approach. International Journal of Energy Economics and Policy, 7(6), 96-102.

Majid, M.A. (2020), Renewable energy for sustainable development in India: Current status, future prospects, challenges, employment, and investment opportunities. Energy, Sustainability and Society, 10(1), 2-10.

Markandya, A., Arto, I., González-Eguino, M., Román, M.V. (2016), Towards a green energy economy? Tracking the employment effects of low-carbon technologies in the European Union. Applied Energy, 179, 1342-1350.

Moreno, B., Lopez, A.J. (2008), The effect of renewable energy on employment. The case of asturias (Spain). Renewable and Sustainable Energy Reviews, 12(3), 732-751.

Muniyoor, K. (2020), Is there a trade-off between energy consumption and employment: Evidence from India. Journal of Cleaner Production, 255, 120262.

Narayan, S., Narayan, P.K. (2005), An empirical analysis of Fiji’s import demand function. Journal of Economic Studies, 32, 158-168.

Ortega, M., Del Río, P., Ruiz, P., Thiel, C. (2015), Employment effects of renewable electricity deployment. A novel methodology. Energy, 91, 940-951.

Ozturk, I., Acaravci, A. (2010), $CO_2$ emissions, energy consumption and economic growth in Turkey. Renewable and Sustainable Energy Reviews, 14(9), 3220-3225.

Ozturk, I., Acaravci, A. (2010a), The causal relationship between energy consumption and GDP in Albania, Bulgaria, Hungary and Romania: Evidence from ARDL bounds testing approach. Applied Energy, 87(6), 1938-1943.

Paramati, S.R., Mo, D., Gupta, R. (2017), The effects of stock market growth and renewable energy use on $CO_2$ emissions: Evidence from G20 countries. Energy Economics, 66, 360-371.

Payne, J.E. (2009),On the dynamics of energy consumption and employment in ıllinois. Journal of Regional Analysis and Policy, 39, 126-130.

Pesaran, M.H. (2007), A simple panel unit root test in the presence of cross-section dependence. Journal of Applied Econometrics, 22(2), 265-312.

Pesaran, M.H., Shin, Y., Smith, R.J. (2001), Bounds testing approaches to the analysis of level relationships. Journal of Applied Econometrics, 16(3), 289-326.

Rafiq, S., Salim, R., Sgro, P.M. (2018), Energy, unemployment and trade. Applied Economics, 50(47), 5122-5134.

Rivers, N. (2013), Renewable energy and unemployment: A general equilibrium analysis. Resource and Energy Economics, 35(4), 467-485.

Sastresa, E.L., Usón, A.A., Bribián, I.Z., Scarpellini, S. (2010), Local ımpact of renewables on employment: Assessment methodology and case study. Renewable and Sustainable Energy Reviews, 14(2), 679-690.

Syzdykova, A., Azretbergenova, G., Massadikov, K., Kalymbetova, A., Sultanov, D. (2020), Analysis of the relationship between energy consumption and economic growth in the commonwealth of ındependent states. International Journal of Energy Economics and Policy, 10(4), 318-324.

Tourkolias, C., Mirasgedis, S. (2011), Quantification and monetization of employment benefits associated with renewable energy technologies in Greece. Renewable and Sustainable Energy Reviews, 15(6), 2876-2886.

Tugcu, C.T., Ozturk, I., Aslan, A. (2012), Renewable and non-renewable energy consumption and economic growth relationship revisited: Evidence from G7 countries. Energy Economics, 34(6), 1942-1950.

Zhao, X., Luo, D. (2017), Driving force of rising renewable energy in China: Environment, regulation and employment. Renewable and Sustainable Energy Reviews, 68, 48-56.

Ziegelmann, A., Mohr, M., Unger, H. (2000), Net employment effects of an extension of renewable-energy systems in the federal republic of Germany. Applied Energy, 65(1-4), 329-338.