

RENEWABLE ENERGY AS A DRIVER FOR ECONOMIC GROWTH: THE CASE OF WESTERN BALKAN COUNTRIES

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Abstract

To examine the effect of consumption in renewable energy on the economy in Western Balkans, this paper covers period from 2010 to 2024. After the shift to clean energy becomes a state-level or regional goal, it remains vitally necessary to recognize whether the boost of renewable energy consumption is relevant to the growth of the economy over time. Furthermore, a panel dataset containing primary observations about the participating countries was collected through annual data obtained from the World Bank and the respective countries' Statistical Office. By employing the VECM econometric model, panel data covering five countries in the region and each variable below are selected: real gross domestic product (RGDP), share of renewable energy consumption in gross energy consumption (ERGC), labor force participation rate (FLPR), foreign direct investment (FDI) and net inflow, gross capital formation (GCF), and inflation. The final finding is that consumption of renewable energy not only has a strong positive impact on economic growth, but also a large share of the growth derives from renewables later in the period. The ultimate conclusion could prompt politicians to deploy more green investments for decreasing pollution and pushing sustainable growth. And our results furnish one type of support to existing literatures.

Keywords: Renewable energy consumption, Economic growth, VECM model, Long run.

Introduction

On a global scale efforts are being made to move towards cleaner and more sustainable forms of energy use. Countries in the Western Balkans are in the early stage in achieving this transition. In essence, several international organizations as well as academics working in the energy domain view renewable energy as a key contributor to lower CO₂ emissions, greater energy security, and more sustainable development (OECD/IEA, 2022). These scholars including Apergis and Payne (2010), highlight that, despite popular misconception, renewable energy may be both economically viable and an effective and productive means of production in many developing, and even some highly developed economies that rely on fossil fuel imports.

The countries of the Western Balkans are at an early stage of this transition. Their integration into the energy

networks of the region remain slow due to structural, regulatory and technological obstacles. These countries have similar structural characteristics, such as high energy intensity, dependence on fossil fuels and aspirations

for integration into the European Union, which includes commitments to decarbonization and green growth.

Energy shortages and high electricity costs are the biggest problems in the Western Balkan region and, as such, they have significant political implications. The current reliance on coal does not comply with the EU acquis or the Paris Agreement, which creates the risk of losing assets or slowing down EU accession negotiations (Frey 2024). Since the countries of the Western Balkans aim to integrate

into the European Union, the implementation of the EU objectives for clean energy and climate transition has become a necessity (European Commission, 2023). This makes it important to assess the impact that renewable energy can have on the economic growth of the region. The main purpose of this paper is to analyze the relationship between renewable energy consumption and economic growth in the countries of the Western Balkans.

Research questions

Is the consumption of renewable energy useful for economic development of Western Balkan countries both, in the long and the short run?

Hypotheses

H0: The utilization of renewable energy is unable to contribute to increasing the economic growth in terms of a statistic perspective for the states in Western Balkan region.

H1: Consumption of renewables benefits economic progress for western Balkan countries. Renewable energies are a part of the path for western Balkan countries toward a higher level of economy

Literature review

Western Balkan countries have been paying a lot more attention to renewable energy lately and are on a right shape with respect to adopting renewable energy concepts (Đurašković et al.2021). Air pollution in the WB region is the worst in Europe, which leads to significant health costs. Nevertheless, an increase in the use of renewable energy sources (other than hydropower) faces major legislative and political obstacles. Boosting energy efficiency would help to advance the transition to green energy, but it is largely underdeveloped. Regional integration would bring enormous benefits, but it is burdened by persistent political differences (Frey. B, 2024). Studies about the impact of renewable energy on economic growth have increased over the past decade, considering that clean energy sources provide green and sustainable growth. More studies have been done for developed and developing countries, while for the countries of the Western Balkans the number of studies is more limited, given that these countries are in an early period of transition towards renewable energy sources. Numerous studies indicate there is a positive correlation between renewable energy consumption and economic growth which occurs mostly by increasing investment, jobs and lower energy costs. Apergis and Payne (2010) from a study of 20 OECD countries for the period 1985-2005 found a bidirectional relationship between REC and GDP in both short and long-run. Apergis and Payne (2011) analyzed 16 emerging market economies and found Established long run equilibrium between GDP and renewable and nonrenewable electricity consumption; found unidirectional causality from GDP to REC in short run, and bidirectional in long run.

Hacımamoğlu and Sandalcılar (2020) conducted a Panel of 35 countries, finding long run positive relationship between REC and economic stability/growth in both developed & developing countries. Akar, B. G., (2016) found a negative but statistically significant relationship between GDP and REC in the panel for the Balkans from 1998 to 2011, with trade openness and natural gas rents influencing REC positively. Amazhekaj, G., et al. (2024) found that an increase in GDP per capita and consumption expenditure had positive impacts on renewable energy consumption, while RE/C were linked with growth through the institutions channel. Rac. A. Bilalli and R. Beka (2025) studied the effects of economic factors on the consumption of sustainable energy in 38 OECD countries and 6 western Balkan countries for the period 2010– 2022, concluding that, among others, that economic factors have a positive effect on the consumption of sustainable energy and that variables like foreign

direct investment, GDP per capita and trade show statistically positive and significant impacts on the consumption of sustainable energy both in western Balkan countries and in OECD nations. Sadiku and Alili (2024) evaluated the connection between the usage of renewables and CO2 levels across Western Balkan countries. Their results firmly demonstrated that raising the level of renewables used delivers major decreases in CO2 levels for those particular places within the region. The author mentions the significant part renewables play in fulfilling developmental requirements focused on sustainability. If the Western Balkan countries care about respecting the climate goals and are serious about ensuring a cleaner environment and achieving sustainable green growth, they should make more use of clean and renewable energy sources. It will initially have adjustment costs, but in the long term it will bring economic and social benefits for these countries.

Methodology

This paper has carried out a quantitative analysis on how much impact does the renewable energy consumption

have on the economic growth for the Western Balkan countries over the period 2010-2024; countries involved are Albania, North Macedonia, Montenegro, Serbia, and Bosnia and Herzegovina. To analyze the short- and long-term relationship between renewable energy consumption and economic growth in the Western Balkan countries, this study applies the Vector Error Correction Model (VECM) for panel data. The use of VECM is based on the fact that the main variables of the study turn out to be first-order integrated $I(1)$ and cointegrated, which justifies the dynamic model of adjustment towards equilibrium. The methodology is based on the theoretical approach of Engle and Granger (1987), who proposed the concept of cointegration and the error correction model, as well as on the later extensions of Johansen (1988; 1991), that provide a more robust multivariate framework. For panel data, the study relies on the contemporary approaches of Pedroni (1999; 2004) and Kao (1999), who developed panel cointegration tests and made it possible to build VECM models with combined data across countries and years. This model allows for the assessment of the short-term effect of changes in renewable energy, as well as the identification of the adjustment path towards long-term equilibrium among macroeconomic variables.

Data description:

This article adopts yearly data collected between the years of 2010 to 2024 from Albania, Bosnia and Herzegovina, North Macedonia, Montenegro, and Serbia. Data was retrieved from the World Bank World

Variables used are

REAL_GDP — Real Gross Domestic Product (constant 2015 US\$), representing economic growth.

REC — Renewable energy consumption (% of total final energy consumption).

SRE — Share of renewable energy in gross energy consumption.

LFP — Labor force participation rate (% of total population ages 15+).

FDI — Foreign direct investment, net inflows (% of GDP).

GCF — Gross capital formation (% of GDP).

INF — Inflation, consumer prices (annual %).

The long-run relationship between variables is expressed as:

$$REAL_{GDP} = \alpha_i + \beta_1 REC_{it} + \beta_2 SRE_{it} + \beta_3 LFP_{it} + \beta_4 FDI_{it} + \beta_5 GCF_{it} + \beta_6 INF_{it} + v_{it}$$

After verifying the stationarity of the variables through panel tests and confirming the existence of a long-run relationship through Pedroni and Kaos cointegration tests, and after determining the optimal number of lags according to AIC, the VECM panel model was applied to estimate the short-run and long-run effects. The results of the econometric analysis are presented below.

Table 1. Long-run results of the VECM model (Long-Run Cointegration Equation)

VARIABLE	COEFFICIENT	STANDARD ERROR	T-STATISTIC	SIGNIFICANCE
REC (-1)	0.1688	(0.05626)	[3.00]	Significant (p<0.01)
SRE (-1)	-0.3520	(0.07423)	[-4.74]	Significant (p<0.01)
LFP (-1)	0.1217	(0.11198)	[1.08]	Not significant (p > 0.90)
INF (-1)	0.7368	(0.13850)	[5.32]	Significant (p<0.01)
GCF (-1)	-0.4175	(0.10456)	[-3.99]	Significant (p<0.01)
FDI (-1)	0.3750	(0.11832)	[3.17]	Significant (p<0.01)

Source: Author calculations

Long-run equation:

$$REAL_GDP_{t-1} = 2.6579 + 0.1688 REC_{t-1} - 0.3520 SRE_{t-1} + 0.1217 LFP_{t-1} + 0.3750 FDI_{t-1} + 0.4175 GCF_{t-1} + 0.7368 INF_{t-1}$$

The model results show that there is a statistically significant long-term relationship between renewable energy consumption and economic growth in the Western Balkan countries in the period 2010-2024. From the long-term equation we see that REC has a positive and statistically significant coefficient that lets us understand that renewable energy consumption has a positive long-term relationship with economic growth. So, with an increase in renewable energy consumption by 1%, real GDP will increase by 0.1688%. SRE has a negative long-term relationship with economic growth. With an increase in SRE by 1%, real GDP will decrease by 0.3520%. LFP has no statistically significant long-term relationship with economic growth. With an increase in INF by 1%, real GDP will increase by 0.7368%. With an increase in GCF by 1%, real GDP will decrease by 0.4175 and with an increase in FDI by 1%, real GDP will increase by 0.3750% in the long run in the Western Balkan countries. The positive and significant coefficient of renewable energy (REC) confirms that renewable energy consumption contributes to economic growth in the long run, consistent with sustainable development theory. (REC) the long-term economic growth relies on REC, FDI and low GCF while high dependence of SRE weakens the benefits brought by the former two factors.

Table 2. Short-run results of the VECM model (Short-Run Cointegration Equation)

Dependent variable	Variable	Coefficient	Std.Error	t-statistic
Δ GDP-REAL	COINTEQ1(-1)	-0.520985	0.29568	-1.76196
Δ GDP-REAL	D(REAL-GDP (-1))	-0.335281	0.28078	-1.19410
Δ GDP-REAL	D(REAL-GDP (-2))	-0.134901	0.20845	-0.64715
Δ GDP-REAL	D(REC (-1))	-0.199297	0.23908	-0.83360
Δ GDP-REAL	D(REC (-2))	-0.586310	0.21550	-2.72066
Δ GDP-REAL	D(SRE (-1))	0.387939	0.31893	1.21637
Δ GDP-REAL	D(SRE (-2))	0.364236	0.29395	1.23912
Δ GDP-REAL	D(LFP (-1))	-0.558611	0.42955	-1.30044
Δ GDP-REAL	D(LFP (-2))	-0.288636	0.39990	-0.72176
Δ GDP-REAL	D(INF (-1))	0.304936	0.24354	1.25210
Δ GDP-REAL	D(INF (-2))	0.104519	0.28182	0.37088
Δ GDP-REAL	D(GCF (-1))	-0.009039	0.28694	-0.03150
Δ GDP-REAL	D(GCF (-2))	-0.507242	0.29331	-1.72934
Δ GDP-REAL	D(FDI (-1))	0.106207	0.25714	0.41303
Δ GDP-REAL	D(FDI (-2))	-0.006338	0.23764	-0.02667
Δ GDP-REAL	C	0.548386	0.65431	0.83812

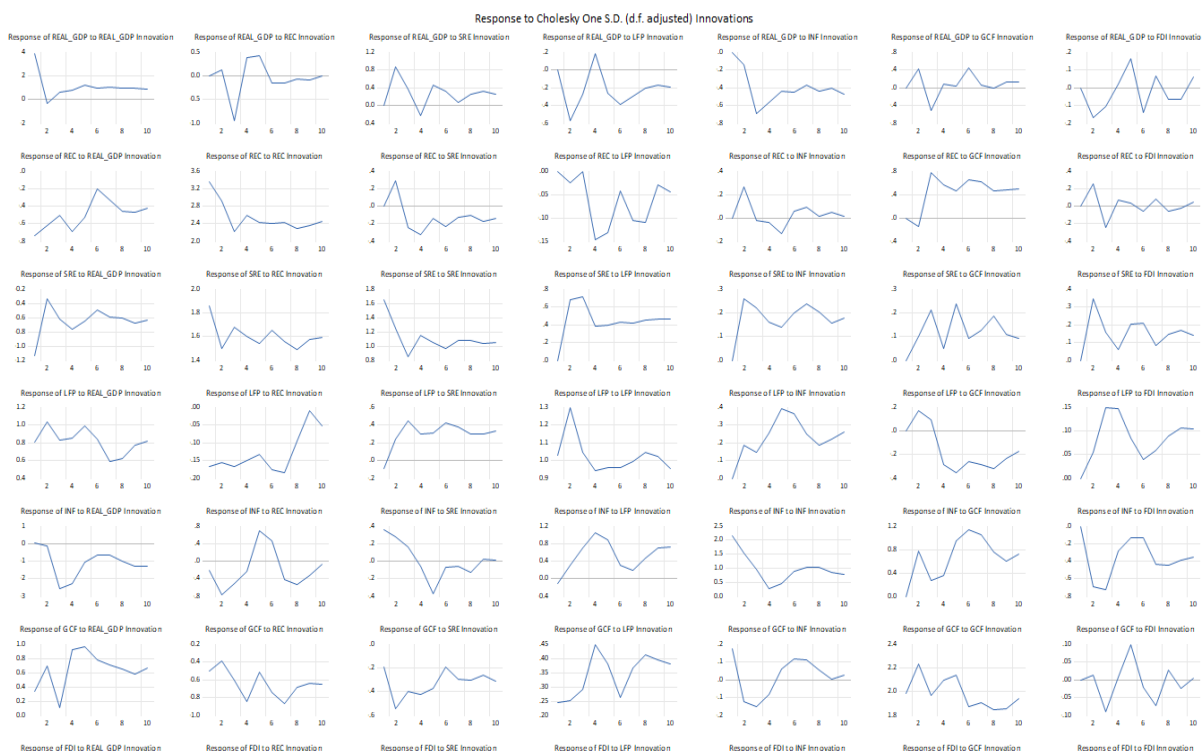
Source: Author calculations

The -0.52 sign of the error-correction term of GDP indicates a moderate significance level at which 52% of

short-run disequilibrium is corrected after 1 time period; thus, we can say that renewable energy plays an essential role in long-term economic growth, whereas short-run changes are mainly caused by fluctuations in FDI and inflation. In the short run, the VECM model shows that changes in renewable energy consumption and some macroeconomic variables affect changes in real GDP and other variables. The coefficient of the error correction term (COINTEQ1) shows that the long-run equilibrium is gradually restored after the disturbance, although most of the immediate effects (first lags) are not statistically significant for GDP. Only a few variables, such as D(REC(-2)), show a significant effect on economic growth in the short run. This indicates that the link between renewable energy and economic growth appears more clearly with a lag and that the long-run equilibrium plays a crucial role.

Impulse responses

Impulse responses show how a shock to one variable affects all other variables over ten periods:



The results of the response functions show that changes in renewable energy, consumption, investment and FDI have different effects on real GDP and other variables in the short run. In general, GDP responds positively to some changes in renewable energy and investment, while the effects of inflation and government spending appear more unstable. This indicates dynamic relationships and interdependence between macroeconomic variables in the short run.

Variance Decomposition

Variance Decomposition shows how much of the forecast error variance of a variable is explained by shocks to itself and other variables at each period.

PERIOD	REAL_GDP	REC	SRE	LFP	INF	GCF	FDI
1	100%	0	0	0	0	0	0
2	91.77%	0.11	4.75	2.00	0.12	1.08	0.17
5	79.81%	5.66	5.33	2.29	4.59	2.00	0.30
10	77.80%	4.53	5.26	2.98	6.72	2.35	0.36

Source: Author calculations

Based on variance decomposition, we see that in period 1, all the fluctuations of REAL_GDP (100%) are

explained by itself. In period 2, most of the variability (91.77%) remains explained by REAL_GDP, while small parts come from REC (0.11%), SRE (4.75%), LFP (2.00%), INF (0.12%), GCF (1.08%) and FDI (0.17%). In period 5, REAL_GDP contributes 79.81%, and other parts come from REC (5.66%), SRE (5.33%), LFP (2.29%), INF (4.59%), GCF (2.00%) and FDI (0.30%). In period 10, REAL_GDP explains 77.80% of its variability, while the impacts of REC, SRE, LFP, INF, GCF and FDI increase slightly, reflecting that over time the economy is increasingly influenced by factors other than gross domestic product itself.

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In order to prove the stability of this model, various tests were carried out, which are presented below. The results of the VEC Residual Serial Correlation LM Test show that for lag 1 (Prob.=0.6626), lag 2 (Prob.=0.6285) and lag 3 (Prob.=0.0679), the null hypothesis of no autocorrelation is not rejected, as all p- values are above the 0.05 level. Even the cumulative tests for lags 1–3 (Prob.=0.6626; 0.6977; 0.4766) confirm the absence of serial dependence. This indicates that the model residuals are not autocorrelated and the VEC model is consistently specified.

The results of the Pedroni Cointegration Test show that both the Panel PP-statistic ($p=0.0027$) and the Group PP-statistic ($p=0.0000$) are highly significant, causing the null hypothesis of no cointegration to be rejected.

This implies that the variables have stable long-term relationships and the continuation with VECM or PMG-ARDL analysis is justified. The results of the VEC Residual Heteroskedasticity Test show that the common test (Chi-sq = 809.92, df = 840, $p = 0.7662$) is not statistically significant, not rejecting the null hypothesis of the absence of heteroskedasticity. Even the individual components for each residual and their interactions show very high p- values (all above 0.10), such as res1res1 ($p = 0.8643$), res4res4 ($p = 0.7287$) and res6*res2 ($p = 0.1802$). These results confirm that the model residuals do not suffer from heteroscedasticity and the VEC is consistently specified.

Conclusions

This study aimed to analyze the relationship between renewable energy, macroeconomic factors and economic growth in the Balkan countries, using econometric models such as VECM, impulse response and variance decomposition. Through this approach, it was evaluated how changes in the energy sector and investments affect the short-term and long-term dynamics of GDP. The results show that renewable energy, investments and macroeconomic variables play an important role in shaping the economic development of the region. The VECM model emphasizes that renewable energy has a positive and stable impact in the long term, while short-term effects appear more volatile. Capital investment and foreign direct investment are important sources of growth, but their impact varies over time. The analysis of impulse response and variance decomposition shows that over time GDP is increasingly influenced by energy factors, inflation and the labor market, beyond its internal dynamics. Although the relatively short time period and differences between countries present limitations to the full generalizability of the results, the findings highlight the potential of renewable energy and sustainable investment as engines of long-term growth. In this context, policies that promote innovation, macroeconomic stability and regional cooperation appear essential for strengthening the energy transition and promoting sustainable economic development

in the Western Balkans countries. Renewable energy offers both economic and environmental benefits for the Western Balkan region. While the transition may involve short-term adjustment costs, the long-term gains in productivity, sustainability, and energy independence make it a strategic imperative for future growth.

Recommendation

Some of the recommendations that can be given from this paper related to the researched topic are presented below. First, strengthening investment policies in renewable energy through tax incentives and subsidies is essential to accelerate the energy transition. Then, the modernization of the energy infrastructure remains equally important to enable the efficient integration of renewable resources into the grid. In addition, investments in research, development and human capital drive innovation and improve clean energy technologies. Maintaining macroeconomic stability creates a stable environment to attract long-term investments, while increasing regional cooperation contributes to the harmonization of policies and more effective sharing of energy resources.

Limitations of the study

As a limitation of this paper, it can be considered that the period 2010–2024 represents a short period to fully assess the economic effects of the transition to renewable energy, since this process is long-term and requires more time to generate sustainable results. Comparison between Balkan countries presents difficulties due to large differences in their energy structure, regulatory policies and economic size, while aggregating data may hide country-specific influences. Moreover, the study does not fully capture the impact of external factors, such as energy crises, geopolitical tensions and changes in EU policies, which may have significantly affected both the level of investment and the economic growth of the region.

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