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Investments in renewable energy in the most developed OECD countries and the Western Balkan countries

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Abstract. The study analysed the trends in the development of the renewable energy sector and the possibilities of transferring the successful experience of the Organisation for Economic Co-operation and Development (OECD) to the Western Balkans. The methodological basis of the study included a comparative analysis of statistical data, the construction of dynamic tables of investments and energy consumption, and the generalisation of institutional and political mechanisms for stimulating the development of renewable energy sources. The study made a quantitative comparison of investments in the five leading countries the US, Germany, Japan, France and Canada. In the United States, investment grew from USD 4.2 billion in 2000 to a peak of USD 257.1 billion in 2024. Similarly, in Germany, this figure increased from USD 2.8 billion to USD 30.5 billion, and in Japan from USD 1.6 billion to USD 22.1 billion over the same period. The study demonstrated the presence of a general upward trend, despite certain fluctuations in years of economic crises or political instability. The report also analysed investments in renewable energy in the Western Balkan countries of Albania, North Macedonia, Serbia, Montenegro and Bosnia and Herzegovina. In 2000, the volume of investments in Albania was only EUR 20 million, and in 2024 it reached EUR 218 million. In North Macedonia, this figure grew from EUR 30 million in 2000 to EUR 218 million in 2024. Despite the overall positive dynamics, there is greater variability and volatility in investment across the region, which is indicative of structural problems. Based on the results obtained, the author formulated recommendations for adapting the policies of the OECD countries to the conditions of the Western Balkans. The study proposed to prioritise the stabilisation of the regulatory environment, the creation of effective government support programmes, the attraction of international financial institutions and the formation of a regional energy market. The importance of establishing regional cooperation and developing partnerships with developed countries to facilitate technology transfer was also stressed. The study can be used as an analytical basis for developing strategies for a sustainable energy transition and ensuring the region’s energy security in the long term

Keywords: infrastructure; cooperation; legislation; climate change; financing

Інвестиції у відновлювану енергетику в найбільш розвинених країнах ОЕСР та країнах Західних Балкан

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Анотація. У дослідженні проаналізовано тенденції розвитку сектору відновлюваної енергетики та можливості перенесення успішного досвіду Організації економічного співробітництва та розвитку (ОЕСР) на Західні Балкани. Методологічна основа дослідження включала порівняльний аналіз статистичних даних, побудову динамічних таблиць інвестицій та споживання енергії, а також узагальнення інституційних та політичних механізмів стимулювання розвитку відновлюваних джерел енергії. У дослідженні проведено кількісне порівняння інвестицій у п'яти провідних країнах – США, Німеччині, Японії, Франції та Канаді. У Сполучених Штатах інвестиції зросли з 4,2 млрд доларів США у 2000 році до піку в 257,1 млрд доларів США у 2024 році. Аналогічно, в Німеччині цей показник збільшився з 2,8 млрд доларів США до 30,5 млрд доларів США, а в Японії – з 1,6 млрд доларів США до 22,1 млрд доларів США за той самий період. Дослідження продемонструвало наявність загальної тенденції до зростання, незважаючи на певні коливання в роки економічних криз або політичної нестабільності. У звіті також проаналізовано інвестиції у відновлювану енергетику в країнах Західних Балкан – Албанії, Північній Македонії, Сербії, Чорногорії та Боснії та Герцеговині. У 2000 році обсяг інвестицій в Албанії становив лише 20 мільйонів євро, а у 2024 році досяг 218 мільйонів євро. У Північній Македонії цей показник зріс з 30 мільйонів євро у 2000 році до 218 мільйонів євро у 2024 році. Незважаючи на загальну позитивну динаміку, спостерігається більша мінливість та нестабільність інвестицій по всьому регіону, що свідчить про структурні проблеми. На основі отриманих результатів автор сформулював рекомендації щодо адаптації політики країн ОЕСР до умов Західних Балкан. У дослідженні запропоновано надати пріоритет стабілізації регуляторного середовища, створенню ефективних програм державної підтримки, залученню міжнародних фінансових установ та формуванню регіонального енергетичного ринку. Також було наголошено на важливості налагодження регіональної співпраці та розвитку партнерських відносин з розвиненими країнами для сприяння передачі технологій. Дослідження може бути використане як аналітична основа для розробки стратегій сталого енергетичного переходу та забезпечення енергетичної безпеки регіону в довгостроковій перспективі

Ключові слова: інфраструктура; співпраця; законодавство; зміна клімату; фінансування

Introduction

In the context of the global transformation of energy systems, the issue of transition to renewable energy sources (RES) is becoming particularly relevant. The global community, in particular the

countries of the Organisation for Economic Co-operation and Development (OECD), is actively implementing policies to decarbonise the economy and reduce dependence on fossil fuels. This process is accompanied by significant investments in solar, wind, hydro and bioenergy. At the same time, for the Western Balkan countries, which are undergoing structural reforms and integration into the European Union (EU), the development of renewable energy sources is not only an environmental issue but also a factor of energy security, economic growth and fulfilment of international obligations. Despite the positive dynamics in the implementation of RES, there is a significant disparity in the distribution of investments between developed OECD countries and the Western Balkans. This disparity is due to differences in political strategies, level of economic development, regulatory environment and access to financial resources. Exploring these aspects is crucial for formulating effective energy policies and facilitating a green transition in less developed regions.

The study of investment in renewable energy sources has remained the focus of attention of the scientific community, especially in the context of the energy transition and climate policy. P. Bertoldi (2022) concluded that stable political support in OECD countries, through tax incentives and long-term energy strategies, provided a favourable environment for large-scale private capital attraction to RES projects. The analysis demonstrated that regulatory predictability is a key factor in building investor confidence. In turn, D. Marjanović & M. Đukić (2020) studied the situation in the Western Balkans and found that the investment climate there remained unstable due to frequent changes in legislation, weak control over the implementation of regulations and the lack of guarantees for foreign investors. The study emphasised that even if there was potential for the development of renewable energy, the poor quality of institutional mechanisms hindered the implementation of relevant projects.

D. Streimikiene (2024) highlighted the differences in the pace of implementation of green transformation tools: while in OECD countries, investments grew due to an integrated approach to energy policy, in the Western Balkans, fragmentation and lack of long-term vision were observed. J. Ignjatović *et al.* (2024) highlighted that the key barriers to investment in the region were not only economic factors but also the technical backwardness of energy systems, which made it difficult to integrate renewable sources into the general grid. C. Karakosta *et al.* (2012) supported these conclusions by analysing failed attempts to implement transnational energy projects in the Balkan region that did not receive adequate financial support from international organisations. The study also noted that the lack of financial guarantees combined with high risks made the region unattractive to investors.

J. Polcyn *et al.* (2021) highlighted examples of European countries where the state not only financed the development of RES but also actively shaped the market through feed-in tariff mechanisms, auctions and subsidies. The study found that such support not only stimulated the inflow of private capital but also helped to reduce the cost of technology. J. Liao *et al.* (2022) proved that OECD countries have formed a powerful ecosystem of innovation in the field of renewable energy, which included not only financing but also educational, research and technological components. This not only enabled import but also the development of domestic high-tech solutions.

B. Shang *et al.* (2022) emphasised the importance of interregional cooperation. As such, a key success factor could be the establishment of partnerships with developed countries that have experience, technology and access to global financial institutions. The study suggested that only by integrating into a broader European energy framework would the region's countries be able to overcome structural constraints. B. Hrnčić *et al.* (2021), analysing the comparative dynamics of investment, stressed that OECD countries have a significant advantage not only because of greater resources but also because of systematic risk management, including insurance, guarantees and public co-financing. The study by G. Bersalli *et al.* (2020) substantially contributed to the research on the role of regional coordination: the study demonstrated that the lack of a common energy strategy reduced the attractiveness of the region for large institutional investors.

Thus, the available studies point to deep structural differences in approaches to RES investments between the most developed OECD countries and the Western Balkan states, which necessitates further comparative analysis and adaptation of successful practices to the conditions of

less developed regions. There are several gaps in the existing literature. Most studies focus primarily on OECD countries, while the Western Balkans are considered superficially or only as case studies. A comparative analysis of the institutional, financial and policy mechanisms that influence the dynamics of RES investments in both regions remains understudied. There are almost no comprehensive assessments of the effectiveness of investment policies in the context of sustainable development, incorporating environmental, social and economic aspects.

The study aimed to conduct a comparative analysis of renewable energy investments in the most developed OECD countries and the Western Balkans to stimulate the green transition in less-developed regions. The objectives of the study were to analyse the specifics of the structure and volume of investments in renewable energy in the OECD countries and the Western Balkans; to identify key barriers and incentives to attract investments in each region, and to assess the possibility of adapting institutional solutions from developed countries to the conditions of the Western Balkans.

Materials and methods

A comprehensive approach to analysing investments in the renewable energy sector, covering both countries with a high level of economic development and countries with economies in transition, was used. The methodology is based on a comparative analysis of the statistical indicators of investments in renewable energy in the five leading member countries of the Organisation for Economic Co-operation and Development (OECD), the United States, Germany, Japan, France, and Canada for the period from 2000 to 2024, as well as in five countries of the Western Balkans region: Albania, North Macedonia, Serbia, Montenegro, and Bosnia and Herzegovina. The sources of information were official statistical databases, including Eurostat (n.d.), International Renewable Energy Agency (IRENA) (2024), and OECD (n.d.). Two main tables were created: the first with annual volumes of investments in renewable energy (in billions USD) in the mentioned OECD countries, and the second with similar indicators in the Western Balkan countries (in millions of euros). A table were created on renewable energy consumption as a share of total final energy consumption (%), which can be used to assess not only the absolute but also the relative scale of the industry's development. As part of the study, two additional figures were created to illustrate the growth rates of investments in renewable energy (%) over four-year periods for the countries of the OECD and the Western Balkans. The growth rates were calculated using the formula (1):

$$(\text{Investments at the end of the period} - \text{Investments at the beginning of the period}) / \text{Investments at the beginning of the period} \times 100\%. \quad (1)$$

In addition to quantitative analysis, the government policies that shaped the conditions for investment in the analysed countries were studied. In Germany, the key element was the long-term strategy "Energiewende" (Germany's energy transition…, n.d.), which provides for a gradual phase-out of fossil fuels and the development of solar and wind energy. In the United States, the Inflation Reduction Act of 2022 (2022), which provides for multibillion-dollar tax breaks and subsidies for green energy, was a decisive factor in the growth of investment in the 2020s. In Japan, after the Fukushima nuclear power plant accident in 2011, the government relied on the gradual decarbonisation of the energy sector by 2050 (Together for action…, 2024), which gave impetus to investments in solar energy. France actively uses green finance instruments, including bonds to raise funds for environmental projects (Green OATs Obligations Assimilables du Trésor) (Green OATs, n.d.). In Canada, the emphasis is on expanding interregional interconnections and supporting local initiatives through the government's Smart Renewables and Electrification Pathways Program (n.d.).

As for the Western Balkan countries, the analysis covered both the overall investment dynamics and individual projects. In Albania, the construction of the Karavasta Solar Project (n.d.) with a capacity of 140 megawatts, implemented with the support of international financial institutions, was noted. In North Macedonia, the new Energy Law (New Energy Law…, n.d.) and a project in the Ovče Pole region (Reconstruction of SS Shtip…, n.d.) to install wind turbines played a key role. In Serbia,

examples of large wind farms were studied, including Cibuk 1 (Power plant profile…, 2024a) (158 megawatts) and Kovacica (Power plant profile…, 2024b) (104 megawatts), which were implemented with the participation of international investors. In Montenegro, the Krnovo (n.d.) wind farm, the first large wind energy project in the country, was analysed. In Bosnia and Herzegovina, the development of a solar park in Trebinje (Power plant profile…, 2024d) and the construction of the Mesihovina wind farm (Power plant profile…, 2024c) with a capacity of more than 50 megawatts were considered. All these projects assessed the extent to which the infrastructure and regulatory environment in these countries meet the requirements of investors.

Thus, the research methodology combined quantitative and qualitative analysis, comparison of international and regional experience, and evaluation of political strategies and real projects, which formulated reasonable conclusions about the potential for transferring effective practices from developed countries to the Western Balkans region.

Results

In the context of global climate challenges and growing dependence on energy resources, investments in renewable energy have become a key tool not only for energy transformation but also for economic development. This type of investment plays a central role in the transition to sustainable energy systems by reducing greenhouse gas emissions, enhancing energy security and stimulating innovation. Renewable energy investment is generally understood as the investment of financial, material or intellectual resources in the development, production, installation and operation of energy facilities that use renewable energy sources in the short term. These sources include solar, wind, hydropower (especially small hydropower), geothermal, bioenergy and ocean energy. Investments can be both private (e.g., venture capital funds, institutional investors, energy corporations) and public (budget financing, loans from state-owned banks, subsidies) (Egli, 2020).

Investments in renewable energy can be classified according to several criteria. One of the main ones is the type of energy source to which resources are directed. There are investments in solar energy (photovoltaic or concentrating), wind energy (onshore or offshore), biomass, geothermal, etc. Another criterion is the stage of project implementation. At the research and development (R&D) stage, investments are aimed at improving technologies and increasing efficiency; capital investments (CAPEX) provide financing for the construction of new energy facilities; and operating investments (OPEX) cover maintenance, management, and modernisation of existing facilities (Ang *et al.*, 2022). At the same time, it is important to distinguish between direct investment, when an investor is directly involved in the implementation of a project or owns assets, and portfolio investment, which is made through the purchase of securities of companies involved in the RES sector.

Green bonds are unique in the modern financial system, efficient for mobilising capital for projects with a low carbon footprint. In addition, investments in renewable energy can be classified by geography into domestic investments, which are made within a single country, and transnational investments, which are especially important for regions with insufficient domestic funding, such as the Western Balkans (Li *et al.*, 2022). Thus, investments in renewable energy are a multifaceted phenomenon that encompasses a variety of financial instruments, sources of origin and stages of implementation. Their growing importance in the global economy requires a clear structure, functioning and impact of these investments on energy policies and sustainable development strategies in different regions of the world.

Investments in renewable energy in OECD countries are an important aspect of the global energy transformation. The OECD unites the most developed economies, and these countries play a leading role in the development and implementation of renewable energy technologies. These countries have become leaders in investing in the green sector, driven not only by the need to ensure energy security but also by the desire to reduce greenhouse gas emissions and fulfil international commitments under the Paris Agreement (Opoku *et al.*, 2024). One of the main reasons for high investment in the OECD is the existence of stable and favourable business conditions, such as a clear legal framework, access to capital and the development of innovative technologies. OECD countries often offer various forms of government support, such as subsidies, tax breaks and green bonds, to

encourage the development of renewable energy. Table 1 shows the consumption of renewable energy in OECD countries.

Table 1. Renewable energy consumption (% of total final energy consumption) in OECD countries in 2000-2024

Year	USA	Germany	Japan	France	Canada
2000	5.4	3.7	3.7	9.3	20.3
2001	4.7	3.9	3.5	9.4	19.8
2002	4.8	4.4	3.7	8.7	20.1
2003	5.3	5.4	4.2	8.8	19.7
2004	5.5	6.3	4.3	8.9	20.4
2005	5.8	7.3	4	8.6	21.6
2006	6.4	8.6	4.4	8.5	21.5
2007	6.3	10.5	4.3	9.4	21.6
2008	6.8	10.2	4.4	10.5	21.6
2009	7.3	10.7	4.5	11.2	22.2
2010	7.4	11.6	4.7	11.9	21.4
2011	8.4	12.5	4.8	10.6	21.5
2012	8.5	13.6	4.7	12.3	21.8
2013	8.9	13.6	5	13.4	22.2
2014	9	14	5.6	13.2	22.2
2015	8.9	14.6	6.2	13.3	22.3
2016	9.3	14.2	6.4	14.2	22.1
2017	9.7	15.2	6.9	14.1	22.8
2018	9.9	16	7.3	15.2	22.3
2019	10.2	17.1	7.8	15.5	22.4
2020	11	18.5	8.5	16.8	23.9
2021	10.9	17.6	8.8	16.2	23.8
2022	10.9	17.4	9.0	16.3	23.6
2023	11.2	18	9.0	16.5	24
2024	11.5	18.5	9.2	16.2	24.2

Source: compiled by the authors based on Eurostat (n.d.), International Renewable Energy Agency (2024), Organization for Economic Co-operation and Development (n.d.)

Table 1 shows a steady increase in the share of renewable energy in total final consumption in the five leading OECD countries, reflecting the gradual transformation of energy systems towards decarbonisation. Germany has the fastest growth, from 3.7% in 2000 to 18.5% in 2024. The United States shows a moderate but steady increase from 5.4% to 11.5%, mainly due to increased investment in solar and wind energy after 2010. Japan, with an initially low share, is gradually increasing its share of renewables, reaching 9.2% in 2024, although the growth rate remains slow. France demonstrates an increase from 9.3% to 16.2% but with noticeable fluctuations due to energy dependence on nuclear power. Canada, which has traditionally performed well due to hydropower, maintains a consistently high share of over 20% throughout the period, reaching 24.2% in 2024. Overall, the data confirm different national trajectories of energy transformation, driven by political decisions, availability of natural resources and technical capabilities.

Germany remains a leader among European countries in terms of investments in renewable energy, demonstrating consistency in the implementation of the energy transition strategy laid down in the Energiewende policy (Germany's energy transition…, n.d.). During 2000-2025, the country conducted a large-scale transformation of the energy sector, gradually reducing the share of coal and nuclear generation. The bulk of investments are directed at the development of wind farms, both onshore and offshore, as well as the massive deployment of solar panels, including systems on the roofs of private homes. Government support mechanisms play an important role, including auctions for the supply of electricity from renewable energy sources, tax breaks for green companies, and preferences for households that generate their energy. In addition, significant funds are being invested in grid modernisation and the construction of new transmission lines capable of integrating decentralised generation (Naegler *et al.*, 2021).

The United States, with its large energy market and great potential in the clean energy sector, demonstrates one of the highest growth rates of investment in renewable energy among OECD countries. The driving force behind this growth was the adoption in 2022 of a large-scale package of legislative initiatives, the Inflation Reduction Act (2022), which provides for more than USD 369 billion of investment in climate policy and energy transformation. The largest investments are being made in the construction of large wind and solar parks, especially in states with naturally favourable conditions, such as Texas, California, and Arizona (Cohen *et al.*, 2019). At the same time, energy storage infrastructure is being expanded to ensure the stability of electricity supply with a high share of variable sources.

Japan, which faces the challenges of limited space and a shortage of local energy resources, has focused its efforts on the development of solar energy, especially after the Fukushima NPP accident in 2011, which significantly changed the country's energy policy. According to the 2050 decarbonisation plan (Together for action…, 2024), the government has introduced favourable tariffs for the purchase of energy from renewable sources and actively supports the creation of micro energy systems, for households and municipalities. Particular attention is paid to the development of smart grids and energy storage technologies, which improve the efficiency of RES integration into the national energy system (Zhu *et al.*, 2020).

France, despite its traditional strong focus on nuclear power, is gradually expanding its share of renewables in its energy mix. The national main efforts are focused on the development of offshore wind energy, geothermal projects, and the modernisation of power grids. The French government is implementing green finance instruments, through state-owned banks and guarantee mechanisms that attract private capital to strategic energy projects (Malecki, 2021). For instance, Green OATs (n.d.), a French green bond instrument, can raise funds to finance environmentally oriented projects such as the development of clean energy, eco-transport, and energy-efficient technologies.

Canada, which has significant hydroelectric resources, traditionally has one of the highest shares of renewable energy among OECD countries. The government increased investments in other areas, including wind and bioenergy, as well as energy storage infrastructure. Provinces such as Quebec, Ontario, and Alberta are acting as local centres of energy innovation, implementing projects at the intersection of renewables and digital technologies (Adebayo, 2022). The Smart Renewables and Electrification Pathways Program (n..d), a Canadian government programme, supports projects to develop smart renewable energy and electrification, with an emphasis on integrating innovative technologies, reducing greenhouse gas emissions and increasing the resilience of energy systems.

Table 2 shows the volume of investments in renewable energy by previous countries.

Table 2. Investments in renewable energy in OECD countries in 2000-2024, billion USD

Year	USA	Germany	Japan	France	Canada
2000	4.2	2.8	1.6	1.4	1.8
2001	3.9	2.7	1.5	1.3	1.9
2002	4.4	3.1	1.9	1.5	2.2
2003	5.0	3.3	2.1	1.7	2
2004	4.6	3	2	1.9	2.4
2005	6.1	4.2	2.5	2.2	2.6
2006	6.8	5.0	2.7	2.5	2.9
2007	8.4	6.6	3.2	2.8	3.3
2008	7.2	5.9	2.9	2.6	3.1
2009	9.6	7.5	3.4	2.9	3.5
2010	12.1	9.2	4.1	3.4	3.8
2011	11.3	8.7	5.8	3.2	4.1
2012	13.5	10.1	6.4	3.6	4.4
2013	14	11.7	6.7	4.1	4.8
2014	15.6	13	6.2	4.9	5.1
2015	19.1	14.5	7.1	5.3	5
2016	17.4	13.2	6.8	5.1	5.4
2017	21.3	15.8	7.5	5.7	6
2018	26.7	18.9	7.2	6.8	6.7

2019	24.8	17.4	8.5	7.3	6.2
2020	31.2	20.5	9.4	8.1	7.4
2021	38.9	22.3	10.6	9.2	8.1
2022	90.4	27.6	16.7	11.7	9.6
2023	270.8	32.2	24.3	13.2	11.4
2024	257.1	30.5	22.1	12.7	13.8

Source: compiled by the authors based on Eurostat (n.d.), International Renewable Energy Agency (2024), Organization for Economic Co-operation and Development (n.d.)

The highest investment activity is demonstrated by the United States, where, following the adoption of the Inflation Reduction Act (2022), there has been a sharp increase in financing from USD 38.9 billion in 2021 to more than USD 270 billion in 2023, making the country a global leader in clean energy. Germany also maintains a consistently high level of investment, with an emphasis on wind and solar energy as part of its Energiewende strategy. Japan, France and Canada are showing moderate but steady growth rates, with local peaks associated with domestic reforms and participation in international climate initiatives. Overall, Table 2 shows a consistent shift by OECD countries towards sustainable energy sources in the context of the global energy and climate transition. Figure 1 illustrates the investment growth rate.

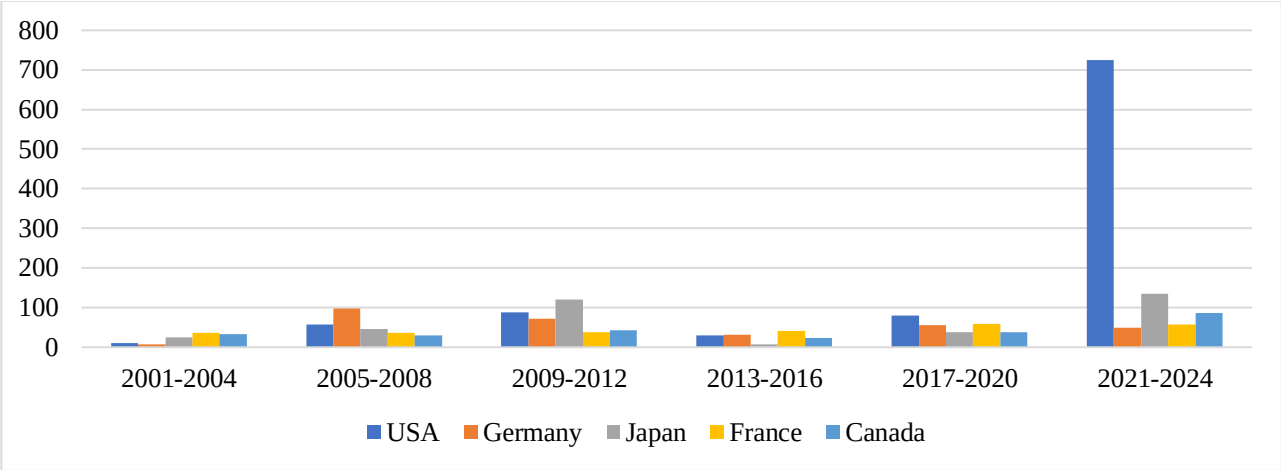

Figure 1. Overall growth rate of renewable energy investments in countries of the Organisation for Economic Co-operation and Development (%) over four-year periods

Source: compiled by the authors

An analysis of investment growth rates in renewable energy over four-year periods reveals a gradual acceleration of investment dynamics, with a particularly sharp increase observed during the 2021-2024 period. During this timeframe, countries recorded their highest growth rates, most notably the United States of America, which exceeded 724%, indicating the effectiveness of newly implemented government policies. While growth in earlier periods remained moderate, the intensification of investments in recent years reflects the broader context of the global energy transition. Countries that adopted comprehensive financial and institutional incentives demonstrated consistent and robust growth rates, whereas jurisdictions with less ambitious frameworks showed comparatively restrained progress. These findings underscore the critical role of strategic governmental support and international initiatives in expediting the shift towards a sustainable energy future.

Compared to the OECD countries, the Western Balkans have significantly lower absolute levels of investment in renewable energy, but relative growth in the region is high. Investment activity in countries such as Serbia, Bosnia and Herzegovina, and North Macedonia has increased since 2010, thanks to EU support, access to international financial institutions, and green energy incentive policies (Đurašković *et al.*, 2021). Table 3 shows renewable energy consumption in the Western Balkans.

Table 3. Renewable energy consumption (% of total final energy consumption) in Western Balkan countries, 2000-2024

Year	Albania	North Macedonia	Serbia	Montenegro	Bosnia and Herzegovina
2000	41.4	19.4	22.1	-	19.4
2001	39	15.2	19.6	-	20.3
2002	35.8	14.6	18	-	21.2
2003	33.7	17.3	15.7	-	20.1
2004	35.8	18.2	14.6	-	20.1
2005	36.8	19	16.1	47.6	19.7
2006	31.6	19.8	15.3	44.8	18.1
2007	32	15.7	14	42.3	14.8
2008	35.8	15.6	15.5	38.8	14.3
2009	37.1	18.4	20.7	49.2	17.4
2010	37	22.3	20.5	49.1	19.6
2011	35.8	18.6	17.4	42.8	14.2
2012	39.9	18.3	19.5	45.9	15.3
2013	41.1	21.2	20	49.3	19.5
2014	38.6	21.2	23.2	46	23.6
2015	38.5	23.9	21.2	43	25.2
2016	39.4	21.4	20.9	43.9	23
2017	36.9	19	20	37.8	18.5
2018	37.8	20.9	21	40.6	35.4
2019	40.1	17	21.4	38.7	36.8
2020	44.4	20	26	39.6	37.7
2021	41.9	19.5	27.2	39.6	36.6
2022	43.7	20.1	28.4	41	35.8
2023	41.2	21.3	27.5	42.2	37.1
2024	42.5	22.7	29.1	43.6	38

Source: compiled by the authors based on Eurostat (n.d.), International Renewable Energy Agency (2024), Organization for Economic Co-operation and Development (n.d.)

The Western Balkan countries have shown generally positive dynamics in the share of renewable energy in energy consumption, albeit with some fluctuations. Albania maintains one of the highest rates in Europe due to its large share of hydropower, although dependence on weather conditions leads to annual fluctuations. Serbia has been gradually increasing its use of biomass and wind, which has contributed to steady growth, although progress has been uneven. In North Macedonia, growth is linked to government programmes to encourage renewables, especially in the private sector. Montenegro and Bosnia and Herzegovina have shown relatively stable growth due to the modernisation of hydropower plants and the development of new solar and bioenergy projects. Overall, the region is gradually moving towards energy transformation, although the pace varies significantly between countries.

Albania has a unique energy profile in the region, with over 95% of its electricity generated by hydroelectric power plants. This heavy dependence on hydropower makes the country vulnerable to climate change, especially during periods of drought, which has repeatedly led to energy crises. The government is therefore actively seeking ways to diversify production (Hoxha *et al.*, 2023). The 2020s have seen a significant revival of investment in solar energy, particularly through government auctions. The construction of the 140 MW Karavasta solar power plant, the largest in the country, has provided a significant boost. Most of the capital is provided by international financial institutions, including the European Bank for Reconstruction and Development (EBRD) and the International Finance Corporation (IFC).

North Macedonia is actively reforming its energy policy to reduce its dependence on fossil fuels (especially coal) and increase the share of renewables. In 2024, the country adopted a new Energy Law, which created a legal framework for attracting private capital to the sector. The main areas of investment were solar parks, including a major project in the Ovče Pole region, as well as small

hydropower plants (HPPs). In 2024, investments reached EUR 218 million, which was made possible by EU support and the launch of new government support programmes.

Serbia is a leader in the region in terms of investment in renewable energy. The development of wind energy has become a landmark area: Cibuk 1 (158 MW), Kovacica (104 MW), and other projects have been commissioned, significantly increasing the share of renewables in the energy balance. In addition, the government has introduced a contract for difference (CfD) mechanism, which is a signal for long-term investment. Solar energy is still developing more slowly, but the government has plans to install several hundred megawatts of new solar capacity.

Montenegro is a small country with ambitious climate goals. In 2019, the 72 MW Krnovo wind farm was commissioned, which was a breakthrough for the national energy market. The country also encourages the construction of solar installations in the private sector. Through its participation in the Energy Community and support from the EU, Montenegro has access to technical and financial assistance.

Bosnia and Herzegovina's energy sector is characterised by a high share of hydropower, but the significant fragmentation of the regulatory system (due to the country's division into entities) complicates the development of renewable energy. Nevertheless, since 2015, there has been an increase in investment in bioenergy, solar parks (e.g., in Trebinje), and wind projects, including the Mesihovinje wind farm (50 MW). The EBRD, KfW, and other international donors are substantial in compensating for the fragmentation of domestic policy.

Table 4 shows the estimated volume of investment in renewable energy in the above countries.

Table 4. Investments in renewable energy in the Western Balkans in 2000-2024, million EUR

Year	Albania	North Macedonia	Serbia	Montenegro	Bosnia and Herzegovina
2000	20	30	10	-	12
2001	18	32	12	-	11
2002	25	38	13	-	16
2003	33	40	17	-	18
2004	28	43	19	-	20
2005	44	51	22	74	24
2006	61	66	21	89	30
2007	55	60	26	95	27
2008	72	79	30	103	36
2009	69	82	33	110	39
2010	83	95	36	123	44
2011	98	101	41	115	51
2012	90	107	45	134	55
2013	94	112	42	148	59
2014	106	117	49	140	63
2015	119	132	55	158	69
2016	113	124	59	165	66
2017	126	143	63	174	75
2018	145	153	61	182	78
2019	139	158	69	170	74
2020	160	172	73	196	83
2021	183	191	80	213	91
2022	210	212	86	240	97
2023	202	205	77	229	102
2024	218	218	90	252	108

Source: compiled by the authors based on Eurostat (n.d.), International Renewable Energy Agency (2024), Organization for Economic Co-operation and Development (n.d.)

A gradual but uneven increase in renewable energy investment was noted in Western Balkan countries, reflecting the growing importance of the sector in the region. Montenegro has consistently been a leader in terms of financing, largely due to hydro and solar projects supported by both state and international financial institutions. Albania and North Macedonia are also showing steady

growth, driven by the development of national energy transition strategies and the attraction of foreign investors. Serbia, despite some fluctuations, is increasing investments in bioenergy and wind power, especially in cooperation with the EU. Bosnia and Herzegovina is gradually increasing its financing in renewable energy, although the growth rate remains restrained due to the difficult political situation and limited institutional capacity. Figure 2 presents the investment growth rate.

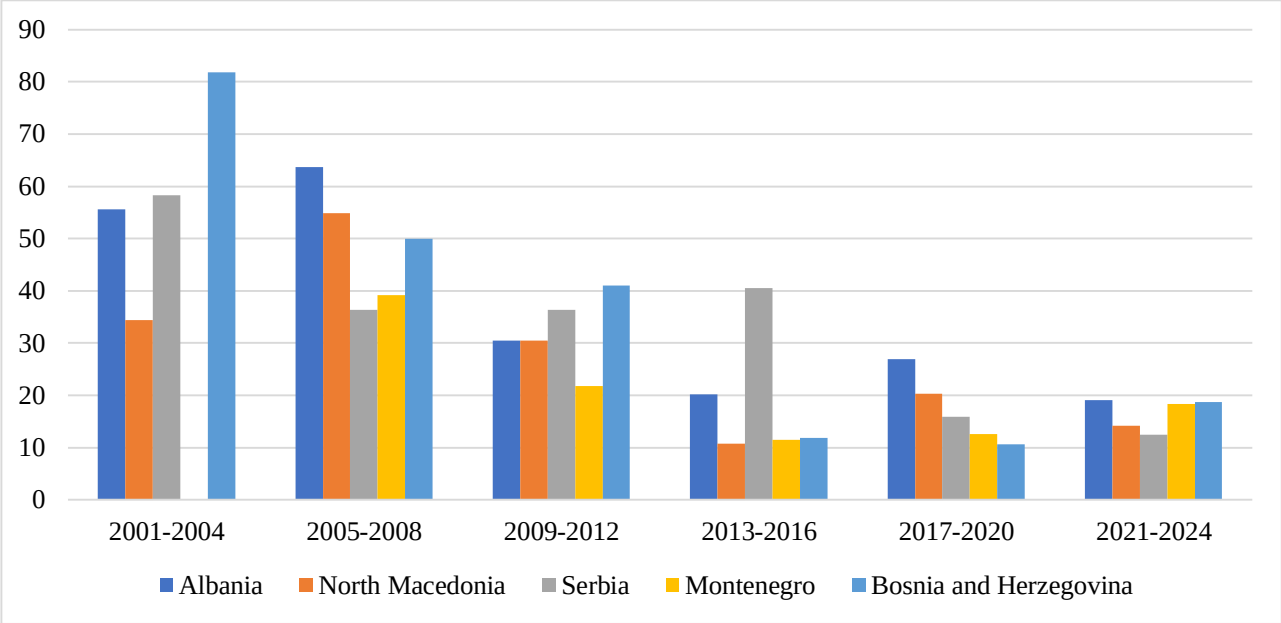

Figure 2. Overall growth rate of renewable energy investments in the Western Balkan countries (%) over four-year periods

Source: compiled by the authors

The figure illustrates a declining trend in the growth rate of renewable energy investments across the Western Balkan countries over the analysed four-year periods. The initial years (2001-2004) showed the highest increases – particularly in Bosnia and Herzegovina and Serbia – reflecting the early stage of investment acceleration. Subsequent periods indicate a gradual deceleration in growth, which becomes especially noticeable from 2013 onward, when most countries began to register growth rates below 20%. This trend highlights the diminishing base effect, institutional inertia, as well as the limitations of domestic markets and an unstable investment environment.

In general, investments in renewable energy in the Western Balkans show a clear upward trend, although the overall volumes are significantly lower than in OECD countries. The main challenges include insufficient infrastructure, political instability, slow regulatory reforms, and dependence on international assistance. At the same time, given the growing support from the EU, integration into the European energy market, and increased interest from private investors, the region has significant potential for sustained growth in clean energy investments.

The prospects for renewable energy development in the Western Balkans largely depend on the region's ability to adopt the best practices of developed countries, including members of the Organisation for Economic Co-operation and Development. Although the Western Balkan countries have substantial natural resources of hydro, solar and wind energy, their potential remains underutilised due to several challenges: unstable regulatory environment, lack of financing, outdated infrastructure, weak regional integration and low institutional capacity. However, with a targeted policy focused on adapting the OECD experience, the region is well positioned to become part of Europe's wider energy transition.

Firstly, it is necessary to improve the investment climate in the RES sector. In OECD countries, RES development has been supported by comprehensive policy instruments: stable regulatory frameworks, financial incentives, feed-in tariff systems, renewable generation tenders, and green certificate mechanisms. For the Western Balkan countries, it is critical to implement at least some of these instruments. It is necessary to create a predictable legal environment: to adopt a stable energy

strategy with clearly defined renewable energy targets for 2030 and 2050, and to avoid sudden changes in tariff policy that could reduce investor confidence. In addition, it is important to introduce transparent mechanisms for issuing permits for the construction of renewable energy facilities. In many countries in the region, these processes are still opaque, lengthy and often complicated by administrative barriers.

Another critical area is the development of access to finance. In OECD countries, public investment and international capital are central to scaling renewable energy. For the Western Balkans, it is necessary to strengthen cooperation with international financial institutions, in particular the European Bank for Reconstruction and Development, the European Investment Bank (EIB), and the World Bank, as well as to use EU financial instruments, such as the Instrument for Pre-Accession Assistance (IPA III). It would also be advisable to establish a regional RES support fund as a joint financial mechanism that could provide concessional loans or guarantees to investors in RES projects in the region.

Regional cooperation is another important component. The development of a common energy market in the Western Balkans will improve energy integration, optimise resource use, ensure more efficient balancing of power systems and reduce infrastructure costs. A good example would be the synchronisation of the region's energy systems with the European network European Network of Transmission System Operators for Electricity (ENTSO-E), which would enable the export of surplus green energy to EU markets. In addition, the countries of the region can implement interstate projects, such as the construction of cross-border power lines, the joint use of hydro resources, and the development of regional energy storage centres. Such projects will have a significant multiplier effect both economically and environmentally.

International partnerships have the potential to drive the transformation of the region's energy sector. The Western Balkans should seek closer cooperation with OECD countries in research, technology transfer and training. Joint institutes or platforms could be created to share knowledge on modern technologies in solar and wind generation, energy storage systems, and smart grids. It is also necessary to develop academic cooperation: mobility programmes for students and researchers specialising in renewable energy will contribute to the formation of high-quality human capital in the renewable energy sector.

In addition to economic and technological aspects, attention should be paid to institutional capacity. Energy regulators in the Western Balkans should be independent, professional and able to implement European standards. National and regional strategies that are aligned with the EU's Green Deal and climate goals should also be developed EU Green Deal and climate goals. Public involvement, transparent decision-making, and environmental assessment of projects are critical to ensuring the sustainable development of RES. For example, in the OECD, the implementation of large energy facilities is necessarily accompanied by an environmental impact assessment, public hearings, and biodiversity impact audits, and such practices should become the norm in the Western Balkans region.

In sum, the successful integration of OECD experience into the Western Balkans region requires a phased and comprehensive approach: simultaneous development of the institutional framework, improvement of investment attractiveness, infrastructure development and human capital formation. Through the effective use of external support, regional cooperation and strategic vision, the Western Balkan countries can gradually move from a fragmented, carbon-dependent energy system to a dynamic and sustainable renewable energy sector integrated into the European energy space.

Discussion

The results of the study show significant differences in the dynamics and structure of investment in renewable energy between developed countries and countries that are just forming the relevant sectors. In the former case, investments are characterised by predictability, long-term nature and a high degree of government support. This reflects the institutional environment, where legislative initiatives are not only adopted but also implemented in conjunction with financial incentives,

targeted programmes and investment protection mechanisms. In countries with lower economic potential, investment activity in the renewable energy sector is more fragmented, limited to individual projects, and has uneven dynamics due to institutional instability and lack of domestic resources. J. Young & A. Macura (2023) emphasised the critical importance of creating a regional energy market for the Western Balkans. The authors believed that only through full integration of energy systems and synchronisation of regulatory policies could a breakthrough in the development of renewable energy be achieved. In the current study, regional cooperation is also seen as an important factor, but it is not the central element. Instead, more attention has been paid to national institutional constraints, while the author tends to view the solution exclusively in an external coordination mechanism.

Notably, in more developed jurisdictions, the transition to clean energy is becoming an element of a broader socio-economic strategy that includes employment, scientific and technological development, export potential, and industrial decarbonisation. In less developed economies, this approach has so far remained at the level of general declarations. There, investments in renewable energy are often centred around available natural resources, such as wind or hydropower opportunities, but are not accompanied by the development of the full value chain, from engineering and equipment manufacturing to training and localisation of production. D. Kong *et al.* (2020) analysed the impact of external investors on energy projects, concluding that foreign capital often does not leave significant added value in the region. This partially coincides with the current findings on the unsustainable nature of investment, but the current analysis presents this problem in a broader context, including the lack of localisation of production, insufficient technology transfer, and weak impact on domestic business development.

Another important topic is the correlation between investment activity and energy consumption patterns. Regions with historically high levels of hydropower use may show positive indicators for the share of renewable sources in final consumption, even without large-scale modern investments. However, such a structural "bonus" does not guarantee stability in the face of climate change, technical wear and tear of infrastructure, or growing demand. In turn, the expansion of new capacities, particularly in wind and solar energy, requires not only technical solutions but also the adaptation of networks, the construction of storage systems and the formation of flexible market mechanisms. A. Caragliu & M. Graziano (2022) addressed the technological dimension of the transition to renewable energy, arguing that without the development of local scientific potential, countries risk remaining merely "sales markets" for foreign technologies. In the current study, technology transfer was indeed mentioned as a necessary component of a successful transition, but more emphasis was placed on legal and financial instruments, while the author emphasised innovative self-sufficiency as the final goal.

In many developing countries, a key constraint to sustainable investment growth is a fragmented legal framework. The existence of one or more progressive pieces of legislation does not compensate for the lack of coherent bylaws, regional harmonisation of rules, transparency in permitting and predictability of regulatory policy. In addition, administrative barriers, a lack of experienced personnel in government agencies, and potential investors' distrust of the judicial system or the fulfilment of obligations may also be obstacles. M. Bozoudi (2021) addressed the gap between legislative initiatives and the actual implementation of energy reforms in the Balkans region. The author concluded that formal adoption of laws often does not lead to systemic changes. This approach is fully consistent with current findings but includes not only legal imperfections but also problems of institutional capacity, political will and bureaucratic pressure.

An analysis of existing renewable energy initiatives shows that even single large-scale projects can have a significant impact on the local economy and energy security. Successful implementation of such projects often involves international partners, foreign capital, or cooperation with financial institutions. However, the limitation of such approaches is the lack of replication of success: there are no tools for scaling results, no knowledge transfer system, and the local business ecosystem is left out. Such an approach does not create added value at the national level and does not provide a transformational effect. A. Omri & S.B. Jabeur (2024) studied the role of international financial

institutions in supporting renewable energy projects in transition economies. The conclusions highlighted that financial assistance from institutions such as the World Bank, or the European Bank for Reconstruction and Development is not always used effectively due to a lack of domestic capacity to implement complex projects. This conclusion resonates with current findings on institutional constraints in the Balkans, but the internal factors of inefficiency are discussed in more detail, whereas the author focused mainly on external financing.

In this context, the issue of regional cooperation is of particular importance. The development of renewable energy in small countries with limited markets and energy demand has a much higher potential if efforts are combined. This includes harmonisation of technical standards and tariff approaches, as well as the creation of common infrastructure projects, such as cross-border transmission lines, shared energy reserves and balancing markets. Cooperation can also reduce research and development costs, facilitate joint access to international donor platforms, and accelerate institutional convergence. Q. Hassan *et al.* (2024) focused on regional cooperation in the field of renewable energy, emphasising its critical importance for synchronising energy policies, sharing resources and improving energy security. The study argued that fragmented approaches in different countries of the region hinder the attraction of large-scale investments, while a coherent energy strategy could make countries much more attractive to external investors. The current study agrees with this conclusion, also emphasising practical mechanisms for implementing cooperation, through the creation of regional grid operators, joint technology parks and coordination structures for investment planning.

Furthermore, effective transfer of experience from developed countries is not a matter of copying individual instruments. It requires deep adaptation to local realities, reform of public administration systems, greater public participation in energy development planning, and a rethinking of the role of the state as an active participant rather than merely a regulator. Only with a comprehensive approach can countries with economies in transition hope for a stable and long-term transition to a low-carbon energy model. M.M.V. Cantarero (2020) analysed the experience of transferring policies from developed countries to less developed regions, focusing on the conditions under which this transfer is successful. In the author's model, adaptation to the local context, institutional capacity and support from international organisations are also important prerequisites. In the current study, although without formal modelling, a similar thesis is confirmed by the example of differences between the approaches of OECD countries and the Western Balkans: direct replication of instruments without adaptation to regional conditions may prove ineffective.

S. Batel (2020) examined cultural barriers and public acceptance of new energy technologies. The author's research showed that in many countries in the region, there is deep opposition to large energy projects, especially wind farms, due to environmental and social concerns. This complements the current findings, as the need for public engagement was mentioned, but not the conflicts around specific projects. Without proper communication and public participation, even economically viable projects can face resistance.

In general, the development of renewable energy is a multifactorial process, where not only financial investments but also the stability of the political environment, institutional maturity, strategic vision and interstate cooperation are central. For the Western Balkan countries, regional cooperation, coordination of strategies and the creation of common institutional platforms are particularly important, forming the basis for a sustainable transition to clean energy.

Conclusions

Statistical analysis demonstrated that in countries with developed economies, investment in renewable energy is growing in the long term, despite occasional downturns caused by economic crises or foreign policy events. In the United States, investment reached USD 257.1 billion in 2024, in Germany EUR 30.5 billion, in France EUR 12.7 billion, in Japan EUR 22.1 billion, and in Canada EUR 13.8 billion. For comparison, in Albania this figure was only EUR 218 million, in North Macedonia EUR 218 million, in Serbia EUR 90 million, in Montenegro EUR 252 million, and in Bosnia and Herzegovina EUR 108 million.

Despite the significant difference in absolute figures, the Western Balkan countries are showing positive investment dynamics. For example, compared to 2000, when the amount of funding averaged EUR 10-30 million, in 2024 these figures increased several times. The largest increase was recorded in Montenegro, where investments have more than tripled since 2005, following the implementation of the Krnovo wind farm. A similar situation is observed in Albania, where the construction of the Karavasta solar power plant has become the largest project of its kind in the Balkans with a total investment of more than EUR 100 million.

In terms of renewable energy consumption, there has been a gradual increase in its share of total final energy consumption. For example, in Albania, this figure rose from 41.4% in 2000 to 42.5% in 2024, in Serbia from 22.1% to 29.1%, and in Bosnia and Herzegovina from 19.4% to 38%. Low growth rates are characteristic of North Macedonia, where the share has increased by less than 3%, indicating structural barriers to the introduction of new technologies and insufficient institutional support.

The study established that the development of RES in the region is heavily dependent on spot projects and external assistance. Legislative initiatives, such as the Energy Law in North Macedonia, have a short-term effect, but without adequate funding, systemic change is impossible. On the other hand, the experience of countries with sustainable decarbonisation policies shows that long-term strategies, such as the Energiewende in Germany or the Inflation Reduction Act in the United States, significantly increase investment efficiency and clean energy penetration.

The results of the study concluded that the effective development of renewable energy in the Western Balkans region requires a systemic state policy aimed at attracting external investors, creating transparent support mechanisms, modernising the institutional framework, and developing regional energy integration. It is also important to formulate national energy transition strategies with benchmarks, considering environmental, social and economic aspects, as well as increasing the role of the public in energy policy decision-making.

A limitation of the study is the lack of data on the exact impact of the domestic political situation and external factors on the investment climate in the Western Balkans. Further research could include a more detailed analysis of the effectiveness of specific government programmes and projects in stimulating renewable energy development in this region, as well as a comparison of their impact with other regions of Europe.

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