

EXPERIENCE OF FOREIGN COUNTRIES IN INVESTING IN RENEWABLE ENERGY SOURCES

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Abstract: *In recent decades, the world and the region have experienced an energy crisis, expressed in rising prices for energy resources and the complexity of their delivery from traditional places of production. Therefore, in many countries there has been a need to invest in Renewable Energy Sources. To increase investment, many countries use methods to stimulate economic agents.*

In this article, we will compare the incentive methods of a few countries, compare the established tariffs for the purchase of electricity, and compare the difficulties that these countries face in stimulating increased growth of investment in renewable energy sources.

Key words: *electricity, renewable energy, investments, energy prices, industry.*

JEL: *Q42, Q43, Q47.*

1. Introduction

In recent decades, renewable energy sources (RES) have become an increasingly pressing topic in global energy policy. Climate change and limited fossil fuels are forcing countries around the world to look for alternative and environmentally friendly sources of energy. Investments in renewable energy sources are becoming a key tool for achieving sustainable development and reducing greenhouse gas emissions.

As a result, the world economy found itself in a transformation of the entire global energy sector. These processes are accelerated by the direct rise in prices for traditional energy resources in recent years and decades. Also, in view of the ongoing global political, military, and social processes, the costs of delivering energy resources from traditional places of their extraction and receipt to places of greatest consumption have increased, and the risk of their direct supply has also increased, which leads to higher prices for insurance, guarantees and security.

As a result, not only countries that do not have fossil energy resources, but also countries that have significant reserves and production of them have come to understand investing in renewable energy sources. Also, many countries, in addition to investing in renewable energy sources, are actively studying ways to increase their efficiency, reduce their cost and scale.

Also, the development of energy technologies largely determines the degree of development and rate of economic growth of the state's economy. This article examines the experience of various countries in the field of investing in renewable energy sources, analyzes their successes and difficulties, and draws conclusions about the most effective approaches.

2. Research results

Table 1. Commissioned renewable energy capacity for a number of countries in Megawatts

CAP (MW)	2 014	2015	2 016	2017	2 018	2019	2 020	2021	2 022	2023
World	1 698 295	1 852 496	2 015 003	2 185 712	2 360 957	2 548 686	2 819 247	3 083 431	3 391 349	3 864 522
Europe	439 951	465 128	488 677	513 004	537 514	574 844	609 134	651 443	715 649	785 821
China	414 651	479 103	541 016	620 856	695 463	758 870	896 412	1 017 852	1 156 126	1 453 701
Bulgaria	4 123	4 136	4 145	4 289	4 316	4 319	4 364	4 532	5 015	6 215
Moldova Rep	69	69	71	81	106	110	116	153	255	308
North Macedonia	682	716	720	731	736	742	820	828	973	1 354
Romania	11 152	11 212	11 162	11 145	11 169	11 169	11 121	11 120	11 580	11 763
USA	180 970	196 009	216 174	230 714	245 595	263 821	293 527	326 733	354 314	385 205
Brazil	106 445	112 646	121 378	128 425	136 613	144 658	150 685	161 483	176 709	194 085
India	71 892	78 582	90 414	105 258	118 227	128 475	134 774	147 390	163 213	175 934
Germany	90 325	97 851	104 436	112 514	118 905	125 068	131 686	139 077	149 143	166 939
South Africa	2 711	3 430	4 652	6 552	7 911	8 014	9 523	9 827	10 505	10 623

Source: compiled by the author based on data from (IRENA). (2024, July)

For comparison, we took 10 countries from different regions of the world, among them very developed countries in terms of the implementation of renewable energy sources. The table shows that several countries occupy a significant share in global production from renewable energy sources, and many countries have grown significantly over 9 years. China in 2014 occupied a share of 24.4% of the world's renewable energy capacity, and in 2023 - 37.6%, which indicates an accelerated growth in implementation compared to the world level. Moldova increased significantly over the period by 4.5 times and South Africa by 3.9 times.

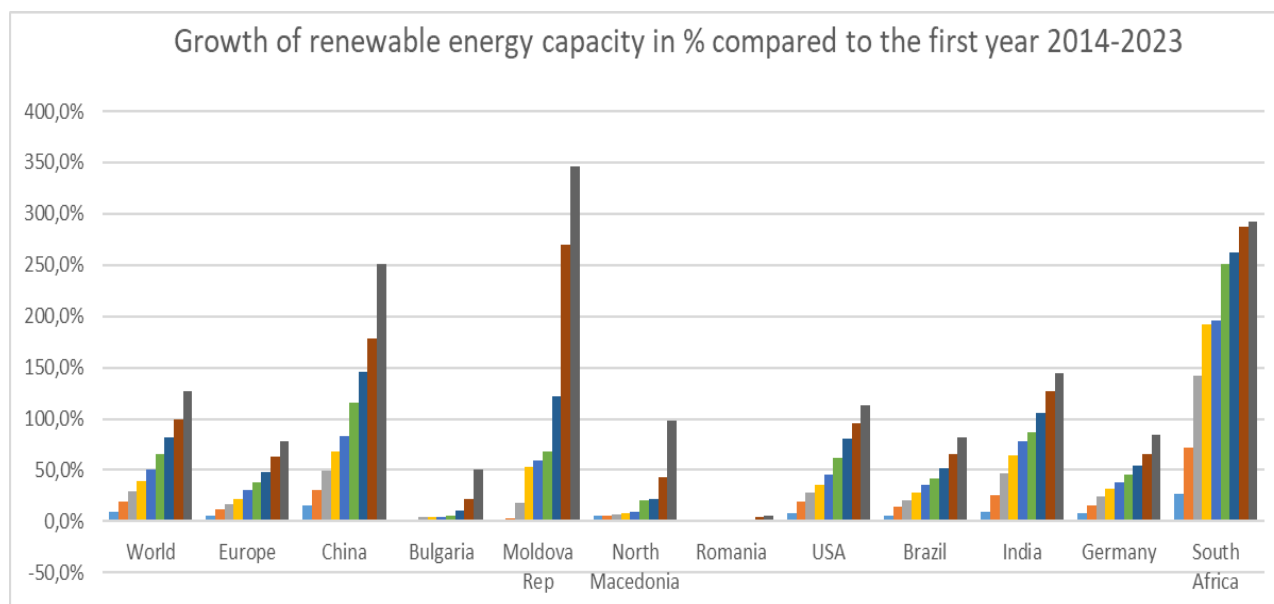


Figure1. Growth of RES capacity in % relative to the first year from 2014 to 2023

Source: compiled by the author based on data from (IRENA). (2024, July)

According to the figure, we see that the greatest growth in % compared to the first year of 2014 was demonstrated by Moldova 346.4%, as well as South Africa 291.8%, the growth in China was also significant 250.6%, these values significantly exceed the global and pan-European growth of 127.6% and 78.6%, respectively.

In the case of China, the result is very significant, despite the fact that even the starting positions in China were significant. In the case of Moldova, the impact is not significant RES capacity in 2014 and significant injections in subsequent years.

These countries have had some experience in introducing investments in renewable energy sources

German experience

Energy turnaround (Energiewende): Since 2010, Germany has been implementing the Energy Transition program, which aims to transition to 100% renewable energy sources by 2050. According to the German Federal Ministry of Economics and Energy, in 2023 the share of renewable energy sources in the country's energy balance exceeded 45%. (German Federal Ministry for Economic Affairs and Climate Action, 2024)

Increase in renewable energy capacity: In 2022, Germany installed an additional 5.5 GW of wind power capacity and 4.5 GW of solar panels, a new record for the country (WindEurope, 2022)

According to the Institute for Economic Research in Cologne (IW), Germany has invested more than 30 billion euros in the development of renewable energy sources in 2022. A significant portion of this investment comes from the private sector, stimulated by various subsidies and tax benefits.

US experience

The United States is actively investing in renewable energy, but policies and approaches to renewable energy development can vary greatly from state to state.

Leaders in solar energy: California is a leader in solar energy development, with more than 32 GW of installed solar capacity, representing about 30% of the nation's total installed solar capacity. (Solar Energy Industries Association [SEIA], 2024)

Wind energy development: Texas ranks first in the U.S. for wind power, with more than 30 GW of installed capacity. This allows the state to generate about 20% of its electricity from wind. According to the US Department of Energy, \$3.5 billion was announced in 2023 for the development of renewable energy infrastructure, including modernization projects electrical networks and the development of energy storage systems. (U.S. Department of Energy, 2024)

Chinese experience

China is a world leader in the production and consumption of renewable energy. The country is actively developing all types of renewable energy sources, including solar, wind, hydro and bioenergy.

Main achievements

Large-scale projects: China's solar sector is set to break records in the coming years. When installed capacity crosses the 500 gigawatts (GW) mark by the end of 2023, it will have taken 13 years to reach that milestone. (Rystad Energy, 2024)

Leadership in equipment production: China is the largest manufacturer of solar and wind energy equipment, exporting to dozens of countries around the world. The Chinese government allocates

huge funds for the development of renewable energy sources. In 2022, investments in this sector exceeded \$100 billion, allowing the country to maintain a high rate of growth in this industry (Bown, 2023)

Indian experience

India is actively developing solar energy, using large areas to install solar panels.

National Solar Mission: In December 2021, the Ministry of Natural Resources requested expressions of interest for a Phase II evaluation study of the grid-connected rooftop solar program. The program was part of the National Solar Mission, which aimed to connect 40 GW of rooftop solar systems to the grid. by 2022. (Mordor Intelligence, 2024)

Experience from Brazil

Brazil is one of the world's leading countries in the use of hydropower but is also active in the bioenergy and wind energy sectors.

Development of bioenergy: Brazil is a world leader in the use of biofuels and bioenergy, allowing it to significantly reduce its dependence on Fossil Fuels

Wind parks: In 2022, wind power capacity in Brazil reached 20 GW, representing about 10% of the country's total electricity capacity. (Flanders Investment & Trade, 2022)

Experience from North Macedonia

North Macedonia, as a small country in the Balkans, is actively seeking to diversify its energy sources and reduce its dependence on fossil fuels.

Hydropower development: North Macedonia has traditionally relied on hydropower, which accounts for a significant portion of the country's electricity production. In recent years, the government has increased investment in upgrading existing hydroelectric power plants.

Solar energy projects: A solar energy initiative was launched in 2021, with plans to build large solar parks such as the 50 MW Bitola solar power plant (Energy Community, n.d.)

North Macedonia has developed a national strategy for sustainable energy development, which places particular emphasis on the development of renewable energy sources and the reduction of greenhouse gas emissions. As part of this strategy, the country seeks to increase the share of renewable energy sources to 23% by 2030 (Energy Community, n.d.)

Romanian experience

Romania is one of the leading countries in Eastern Europe in the use and development of renewable energy sources. Thanks to its natural resources and support from the European Union, the country has made significant progress in this area.

Wind energy: Wind energy is the main direction of development of renewable energy sources in Romania. The country has powerful wind resources, especially in the Dobruja region, where more than 3 GW of capacity has been installed (WindEurope, 2023)

Bioenergy: Romania is actively developing bioenergy, using waste from agriculture and forestry to produce energy. In 2022 power bioenergy exceeded 500 MW (European Energy, 2024)

Romania receives significant financial support from the European Union for the development of renewable energy sources.

Bulgarian experience

Bulgaria, as a member of the European Union, is actively developing renewable energy sources as part of the overall EU goals of reducing carbon emissions and transitioning to sustainable energy.

Solar energy: Bulgaria has significantly increased investment in solar energy in recent years. By 2024, about 1.5 GW of capacity will be installed in the country solar power plants (IENE, 2024)

Geothermal energy: Bulgaria has significant geothermal resources, which are gradually being brought into operation to produce electricity and heat. Bulgaria actively uses European Union funds to support renewable energy projects. In 2023, the European Commission allocated 300 million euros to Bulgaria to modernize its energy infrastructure and develop new solar and wind energy projects (European Parliament, 2023)

Experience of the Republic of South Africa (RSA)

South Africa, one of Africa's largest economies, is aggressively developing renewable energy to reduce its dependence on coal, which has long been the country's main source of energy.

Renewable Energy Program (REIPPPP): The South African Renewable Energy for Private Producers Program (REIPPPP) is one of the continent's most successful examples. This program has attracted more than \$20 billion in investment and led to the commissioning of approximately 6 GW of capacity in the renewable energy sector, including solar, wind and bioenergy (Bloomberg, 2022)

Solar and wind projects: Large solar and wind parks, such as the De Aar solar farm and the Jeffrey's Bay wind farm, are examples of successful implementation of renewable energy in the country. Collectively, these projects provide thousands of megawatts of clean energy, helping reduce the country's carbon footprint

South Africa is actively receiving international support for the development of renewable energy sources. In 2021, the country was supported by international donors, including the World Bank, which allocated more than \$8 billion for projects in the field of renewable energy sources and modernization of the energy system (African Development Bank, 2021) The government also continues to encourage private investment in the sector, which is helping to develop new projects.

Experience from Moldova

Moldova, being one of the least developed countries in Europe, faces a number of economic and political challenges, but at the same time is taking steps towards the development of renewable energy sources.

Solar energy:

In recent years, Moldova has begun to actively develop solar energy, and in 2023, a project to build a solar power plant in the Cahul region with a capacity of 2 MW was completed. Although these figures are modest compared to other countries, this is an important step towards energy independence for Moldova.

Bioenergy: Moldova also uses biomass as an energy source, which is especially important for rural areas where there is access to agricultural waste.

Moldova receives significant support from international organizations such as the European Bank for Reconstruction and Development and the United Nations Development Program (UNDP), which finance projects in the field of renewable energy sources. In 2023, the EBRD allocated a grant of 10 million euros to Moldova for the development of solar energy and modernization of the energy system (EU4Moldova, 2023) At the same time, many countries face problems and challenges when introducing investments in renewable energy sources

Table 2. Problems and challenges in the implementation of renewable energy sources

China	Bulgaria	South Africa	North Macedonia	Romania	USA	Brazil	India	Germany	Moldova Rep
The growth of renewable energy production leads to overload of power grids, which requires significant investments in the modernization and expansion of networks.	Like other countries in the region, Bulgaria produces a significant portion of its electricity from coal-fired power plants, which complicates the transition to renewable energy sources	Despite progress in the development of renewable energy sources, coal continues to be the main source of energy in South Africa, which creates environmental and economic problems. Coal-fired power plants provide 70% of South Africa's electricity	The Macedonian economy is experiencing difficulties in attracting foreign investment in renewable energy sources due to political instability and insufficiently developed infrastructure	Processes for obtaining permits for the construction of new renewable energy projects may be delayed, which hinders the development of the sector	Despite the growth of renewable energy sources, traditional energy sources such as oil and gas are still highly developed in the United States, which creates competition for investment and resources	The development of large hydropower projects leads to significant environmental consequences, such as flooding of large areas and changes in ecosystems	Limited access to financing for small and medium-sized renewable energy projects slows down their development	The growing share of renewable energy sources creates problems with balancing electrical networks, which requires additional investments in energy storage systems and network modernization	Limited investment opportunities and financial instability are slowing down the development of renewable energy sources in the country. Most of the projects are financed by international donors and organizations
Despite the active development of renewable energy sources, China continues to face serious environmental problems due to the large volume of CO2 emissions.	Problems with corruption and poor governance may reduce the effectiveness of renewable energy projects	Frequent changes in government policy and economic instability create uncertainty for investors and slow down the development of new renewable energy projects	Despite the growth of renewable energy sources, coal power plants continue to provide a significant part of the energy mix, which complicates the transition to cleaner energy sources	The energy infrastructure inherited from Soviet times requires significant investments in modernization for the effective use of renewable energy sources.	Policy changes and insufficient federal support may create uncertainty for investors	-	Existing energy infrastructure cannot always cope with the integration of new energy sources	High costs of maintaining renewable energy infrastructure and integrating them into the overall energy system lead to an increase in the cost of electricity for end consumers	Moldova depends on the import of electricity from neighboring countries, which poses a threat to energy security. The development of renewable energy sources is considered as one of the ways to reduce dependence

Source: compiled by the author based on data from Daily Maverick. (2023, November 1)., European Commission. (2023, December 21), EY Romania. (2021, April)., World Economic Forum. (2022, July)., World Bank. (2023, May 4)., Energy Community. (2024, August 2)., Deloitte. (n.d.)., Clean Energy Wire. (n.d.)., U.S. Department of State. (2024)., ScienceDirect. (2024).

As we see from the table, the problems of many countries are most often similar, the most developed ones have problems with overloading of power grids and the need to invest in their expansion, developing ones have issues with financing and instability of government policies, and many countries are heavily dependent on traditional energy sources, which delays the transition to RES.

Table 3. Average purchasing tariffs for electricity by country

Fixed tariffs (FIT):	Unit of measure	China	Bulgaria	Moldova Rep	North Macedonia	Romania	USA	Brazil	India	Germany	South Africa
solar power plants	EUR/MW	45.87-64.22	81.91-180.99	93.2-102.07	120-160	120-180	96.33-133.03	21.83-24.5	27.52	62.2-85.6	24.75-36.67
wind power plants	EUR/MW	45.87-64.22	62.64-89.92	82.38-95.34	89	20-30	96.33-133.03	21.47-24.58	36.7	-	24.75-36.67

Source: compiled by the author based on data from (DSIRE). (n.d.)., Clean Energy for EU Islands. (n.d.)., United Nations Development Programme. (n.d.)., pv magazine. (2021, July 22)., ANRE. (n.d.)., energypedia. (n.d.)., Cliffe Dekker Hofmeyr. (2023, February 23), World Bank. (n.d.)., National Development and Reform Commission of China. (2019, April 30), pv-tech. (2023, July 24)., Schoenherr Attorneys at Law. (2023, June 15)., Balkan Green Energy News. (2023, July 1),

As we can see from the table, the lowest purchase prices for solar and wind energy are observed in Brazil, India and South Africa.

The price largely depends on various factors regarding the investments made and other conditions, but the general trend is characteristic. At the same time, the growth in capacity commissioning in these countries over the past 9 years has been significant, which indicates other important factors for investing in renewable energy sources. In Brazil, the increase in the share of hydroelectric power plants also had an impact, in India and South Africa to a lesser extent.

The highest purchase prices are found in Moldova, North Macedonia and the USA. At the same time, capacity growth over 9 years has increased significantly in Moldova, but this was also influenced by the low initial base. The US and Macedonia are also growing significantly in capacity, although not as significantly.

China, with average prices in this table, shows significant growth in renewable energy capacity. Other incentives influenced this, as well as the fact that China produces power plants, and their prices are quite lower than those of other market participants.

In addition to purchasing tariffs, there are other incentives for introducing investment in renewable energy sources.

Table 4. Investment promotion methods for the countries under consideration

Stimulation methods	Moldova Rep	Germany	USA	Romania	India	China
Tenders for large renewable energy projects						
Tender system for new renewable energy projects. Projects that offer the lowest price per kWh of energy produced are awarded contracts, reducing energy costs for consumers and encouraging competition between producers.	It applies	It applies	-	-	It applies	-
Exemption from value added tax and property tax						
Equipment used to produce renewable energy sources can be exempted from VAT, which reduces capital costs for investors.	It applies	-	-	It applies	It applies	It applies
Green Certificates						
a system of green certificates that can be sold to companies to meet their obligations, creating an additional incentive for energy production from renewable energy sources.	-	-	-	It applies	It applies	It applies
Reduces income tax						
In some cases, renewable energy projects can receive tax incentives, making the investment more attractive.	It applies	It applies	-	It applies	-	-
Quotas for the use of renewable energy sources (Renewable Portfolio Standards, RPS)						
mandatory quotas for the share of renewable energy sources in the energy balance, which forces energy companies to invest in the development of renewable energy sources to meet requirements.	-	It applies	It applies	It applies	It applies	It applies
Green Bonds						
State and local authorities and banks issue bonds, the proceeds of which are used to develop renewable energy projects.	-	-	It applies	It applies	It applies	It applies
Grants and subsidies						
provides subsidies and grants for renewable energy projects, especially in rural and remote areas.	It applies	-	It applies	It applies	It applies	It applies
Investments in infrastructure						
Federal and local authorities support the construction of new transmission lines and other infrastructure projects needed to integrate renewable energy sources into the national energy grid.	-	-	It applies	It applies	-	It applies
Cercetare și inovare în surse regenerabile de energie						
Accelerare a permisiunea	-	It applies	It applies	It applies	-	It applies
Accelează permisiunea						
simplificarea procedurilor administrative și accelerarea procesului de obținere a autorizațiilor pentru construcția de instalații de energie regenerabilă.	It applies	-	-	It applies	It applies	It applies
Loans, international financing						
State banks give preferential loans for renewable energy projects, so does the EBRD	It applies	It applies	-	-	It applies	It applies
(Production Tax Credit, PTC)						
It is given for every kilowatt-hour of energy produced at renewable energy installations. The main recipient is wind energy.	-	-	It applies	-	-	-
Tax credit for investments in renewable energy sources (Investment Tax Credit, ITC)						
It allows investors to receive a return of up to 26% on the cost of a renewable energy project	-	-	It applies	-	-	-
Accelerated Depreciation (AD)						
accelerating the depreciation of assets related to renewable energy sources	-	-	-	-	It applies	-
Clean Energy Funds						
to finance local renewable energy initiatives	-	-	It applies	-	-	-
Funding from EU funds						
financing from EU funds including within the Horizon 2020 and ENPARD programs for Moldova	It applies	It applies	-	It applies	-	-
Electricity tax exemption (EEG-Umlage)						
Small producers of energy from renewable energy sources can be exempted from paying electricity taxes	-	It applies	-	-	-	-
Loan guarantees						
In some cases, renewable energy projects receive government loan guarantees	-	It applies	-	-	-	-
Programs for private households and farmers						
Installing small-scale renewable energy sources such as solar panels on house roofs	It applies	It applies	-	-	-	-

Source: compiled by the author based on data from Cherry Tree Group (n.d.), Korolev (2022), Mordor Intelligence (2023), Flanders Investment & Trade (2022), Clean Energy Wire (2023), World Bank (2022).

As we can see from the table, the methods of stimulating investment in renewable energy sources in the countries studied are very similar. These include green certificates and green bonds, and exemption from VAT and income tax, grants and subsidies and quotas for the purchase of electricity and all kinds of funds. From the experience of the countries studied, Moldova can additionally apply incentives for the implementation of renewable energy sources in the form of green certificates and bonds, quotas for the purchase of electricity, investments in infrastructure, scientific research in the field of renewable energy sources

3. Conclusions.

Having analyzed the above information, we observe that the production of electricity from renewable energy sources is actively developing both in the world and in the countries, we studied, and there has been significant growth.

Countries see this as a significant prospect in the development of alternative energy sources and in reducing air carbonization.

The experience of these countries in introducing renewable energy sources is in many ways similar, but at the same time there are specific features of each country.

First, purchase prices differ from RES. In this context, the Republic of Moldova has significant advantages, since the purchase price is much higher than many countries. Also, in other methods of stimulating the introduction of investments in RES, countries generally use similar incentive methods and Moldova also follows their experience.

Yes, there are methods that Moldova should study and perhaps also apply to further stimulate the introduction of investments in RES. Because Moldova has risks for energy security and the risk of interruption of gas supplies for electricity generation at MOLDGRES, there is a need for additional stimulation of the introduction of RES increases even more.

While Moldova has significant renewable energy potential, especially in solar and wind, the required infrastructure and investments do not meet the country's needs. This is due to bureaucratic obstacles, regulatory problems and the difficulty of integrating new energy sources into the existing energy system.

Support measures from the state may include public-private partnerships, provision of government loans and guarantees, compensation for investment costs, provision of grants, reduction of duties, elimination of bureaucratic barriers,

simplification of administrative procedures for investors, weakening of taxation, regulation and obligation to purchase generated capacity at fixed prices

Nevertheless, all these restrictions, increased supply risks, and increased prices indicate that investments in the renewable energy sector are the most appropriate soon.

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