

# RENEWABLE ENERGY INDUSTRY IN THE EU AS A KEY CLIMATE CHANGE DRIVER

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*Abstract: The European Union aims to increase the share of energy from renewable sources (RES), mainly to combat climate change, but also to maintain its leading position in high-performance technologies. As a member of the European Union, Romania attaches great importance to the development of this type of energy, as can be easily observed from the ambitious targets set and the massive investments made in this field.*

*This article aims to analyse recent developments in the renewable energy sector in the European Union and in Romania in particular. In the first part of the paper, we conducted a quantitative analysis that included four indicators on renewable energy, and in the second part, we focused on the future development prospects of this sector in Romania. Our main findings show that even though Romania is well positioned in terms of the indicators analysed, the potential of RES is not yet fully exploited. To this extent, measures such as improving support schemes for RES, building and putting into operation new RES electricity generation capacities, in particular wind and solar, modernising existing cogeneration plants, or expanding nuclear generation capacities should be considered.*

*Keywords: renewable energy, Romania, climate change, European Union*

*JEL classification: Q42, Q48, Q49, Q54*

## 1. Introduction

The transition to a low-carbon economy aims to create a sustainable energy sector that stimulates growth, innovation, and job creation, while improving quality of life, broadening the range of products and services available and, as a result, reducing electricity bills (Kurbatova et al., 2023; Haas et al., 2023; Saraji et al., 2023). A streamlined and coordinated approach at the EU level ensures a truly continental impact in the fight against climate change (Wang et al., 2024). Measures to promote renewable energy and improve energy efficiency are essential to reduce Europe's greenhouse gas emissions and meet the commitments made under the Paris Agreement (Karakosta et al., 2025; Gajdzik et al., 2024).

At the international level, the EU plays an important role, working with other countries, regions, and international organisations to find solutions to energy issues and ensure a reliable and competitive energy market in Europe (Kalantzakos et al., 2023). In line with the Paris Agreement, the Council of the European Union supports that the EU and its Member States will strengthen global action on climate change, demonstrating that a path to climate neutrality is not only essential but also feasible and desirable (Schwarte, 2021).

As mentioned above, renewable energy involves increasing the share of energy production from non-fossil fuels, such as solar, wind and hydro energy. Compared to their fossil fuel equivalents, such as coal, oil, and natural gas, renewable energy sources have a substantially lower impact on the environment (Chen et al., 2023). As a result, this proactive transition to renewable energy is emerging as a crucial and compelling strategy for ensuring the long-term sustainability of the planet, supporting the EU's objectives of reducing greenhouse gas emissions and stimulating sustainable economic growth (Gajdzik et al., 2024).

Romania, as a member state of the European Union, attaches great importance to the development of energy from renewable sources, as can be easily seen from the targets it has set and the legislation it has adopted (Ciot et al., 2025; Memo et al., 2023). The objective of this research is to analyse the latest developments in the renewable energy sector in the European Union and in Romania in particular. Therefore, a quantitative analysis of the energy sector in the European Union will be carried out, with a focus on Romania, from the perspective of

the most important indicators in the field, followed by an analysis of the development prospects for the renewable energy sector in Romania.

## 2. Literature review

The literature (Delbeke, 2024; Joița et al., 2023; Rimšaitė, L., 2024) shows that to become the first climate-neutral continent by 2050, European authorities must implement measures that enable European citizens to benefit from the green transition. The utilisation of energy from renewable sources has been demonstrated to engender a multitude of potential benefits (Algarni et al., 2023; Batra, 2023). These include the reduction of greenhouse gas emissions, the diversification of energy supplies, and the reduction of dependence on fossil fuel markets (especially oil and natural gas). Furthermore, the utilisation of renewable energy has been identified as a pivotal factor in fostering employment opportunities within the domain of green technologies (Ma et al., 2025; Chou et al., 2023). This aspect is poised to assume a significant role in the “Clean Industrial Deal”.

On 11 December 2019, in view of the European Green Deal, the Union committed to finding solutions to the challenges related to energy, climate and the environment and to achieving climate neutrality by 2050, in line with the Paris Agreement. The literature (Nagaj et al., 2024; Battisti, 2023; Khaleel et al., 2024) also shows that the transformation of the Union's energy system plays a key role in this regard, as energy production and use account for more than 75% of greenhouse gas emissions.

The initial directive pertaining to renewable energy sources, which came into force on 23 April 2009, acknowledged that 20% of total final energy consumption across the European Union, and 10% of energy consumption within each EU Member State, should derive from renewable sources by the year 2020. The Directive further stipulates binding national targets in alignment with the EU's overarching objective. In accordance with the EU's policy directives, member states were obliged to devise indicative pathways to assist them in the achievement of their stated targets. They were further obliged to submit national action plans for the development of renewable energy, and to publish bi-annual national reports that would document the progress made in this field. As stated in the directive, a number of mechanisms are available to EU Member States for the purpose of stimulating investment in renewable energy sources. These comprise support programs, feed-in tariffs, joint projects, and cooperation with non-EU countries. Furthermore, environmental standards for biofuels are to be established.

The first revision of the Renewable Energy Directive was brought into force in 2018 as part of the “Clean Energy for All Europeans” package. The Directive, which was to be incorporated into national legislation by EU countries by June 2021, established a new mandatory EU target for 2030. This target stipulates that a minimum of 32% of gross final energy consumption must be derived from renewable energy sources. Additionally, it has set an augmented target of 14% for the share of renewable fuels in transport by 2030.

In accordance with Regulation (EU) 2018/1999, EU Member States were required to propose national energy targets and establish ten-year National Energy and Climate Plans (NECPs) for the 2021-2030 period by March 2023. The NECPs are subject to biennial monitoring through progress reports, and are subject to assessment by the Commission. The Commission is entitled to implement measures at EU level to ensure the NECPs comply with the EU's overall targets.

The second amendments to the Renewable Energy Directive were the result of three major changes in 2023. The “Fit for 55” package, implemented in July 2021, included the first amendment, the purpose of which was to align the EU's renewable energy targets with the new and ambitious climate goal.

In March and May 2022, as part of the REPowerEU package following Russia's aggression against Ukraine, the second bill aimed to accelerate the transition to clean energy, reflecting the decision to end dependence on Russian coal. This was to be achieved through the installation of heat pumps, increasing the capacity of solar photovoltaics and importing hydrogen from renewable sources and biomethane.

The third amendment of November 2022 aimed to accelerate the deployment of renewable energy, based on the principle that certain renewable energy installations are of high public interest. According to studies (Danilova, 2024; Gurreck, 2025), this allows for faster authorisation of renewable energy projects and specific derogations from EU environmental legislation.

The renewable energy guidelines that came into force in November 2023 increase the 2030 target for renewable energy sources to 42.5%, while European Union member states are aiming to reach 45%. In addition, the measures speed up the approval of new renewable energy installations, such as solar panels or wind turbines, and set a maximum approval period for new installations at 12 months in areas considered priority for renewable energy production and 24 months in other areas.

Regulation (EU) 2020/1294 establishes a mechanism for EU financing to help countries achieve their individual and collective renewable energy targets. This mechanism establishes links between countries that invest in projects (financing countries) and countries that agree to host new projects on their territory (hosting countries). The Commission sets out the operational framework and financing modalities, specifying that EU countries, funds or contributions from the private sector can finance activities under this mechanism. Energy produced through this mechanism counts towards the renewable energy targets of all participating countries.

The REPowerEU strategy was initiated with the objective of increasing solar photovoltaic capacity to 320 gigawatts by 2025, with a further ambition of reaching 600 gigawatts by 2030. The strategy encompassed a phased legal commitment to the installation of solar panels on new public, commercial and residential buildings, in addition to a strategy to double the pace of installing heat pumps in central and local heating systems. EU member states are obligated to pinpoint and implement strategies for the establishment of areas conducive to the development of renewable energy projects, accompanied by the acceleration and streamlining of permit processes. The revised Renewable Energy Directive establishes expedited procedures for the approval of permits for the installation of solar energy equipment.

Directive (EU) 2018/2001 on renewable energy sources includes targets for advanced biofuels, biogas and RFNBO (such as hydrogen) in the transport sector of 1% by 2025 and 5.5% by 2030. In July 2020, the Energy System Integration and Hydrogen Strategies set a target of at minimum 6 GW of renewable hydrogen electrolyzers and the production of up to 1 million tonnes of renewable hydrogen in the EU by 2024. These strategies also set an ambitious target of 40 GW and 10 million tonnes by 2030, demonstrating a commitment to substantial growth. The REPowerEU plan, launched in 2022, established an ambitious target of producing and importing 10 million tonnes of hydrogen from renewable sources by 2030. In 2023, the Renewable Energy Directive set an indicative target of 42% renewable hydrogen in total hydrogen consumption by 2030 and 60% by 2035 for industry.

### **3. Methodology**

The methodological design used in this article is a mixed one, based on an analysis of indicators on the progress of renewable energy in all Member States, with a focus on Romania (using the latest Eurostat data available), and a qualitative assessment of the future development prospects of the renewable energy sector in Romania, including the identification of possible measures for its sustainable development.

The quantitative analysis is based on Eurostat data and aims to highlight Romania's progress in the field of renewable energy compared to other EU Member States. To this end, we analysed the four most important indicators for renewable energy sources, namely: share of energy from renewable sources, share of energy from renewable sources in gross electricity consumption, share of energy from renewable sources for heating and cooling, and share of energy from renewable sources in transport.

The data used and background information were carefully selected from the relevant literature. The analysis focuses on the challenges and opportunities for developing renewable energy sources, while also looking at the current state of this sector in Romania and its prospects. The most important limitation of this research is related to the absence of data for the year 2024, and, bearing this in mind, the extension of the research as soon as this data becomes available is seriously taken into consideration.

## **4. Recent developments in the renewable energy sector in the European Union and Romania**

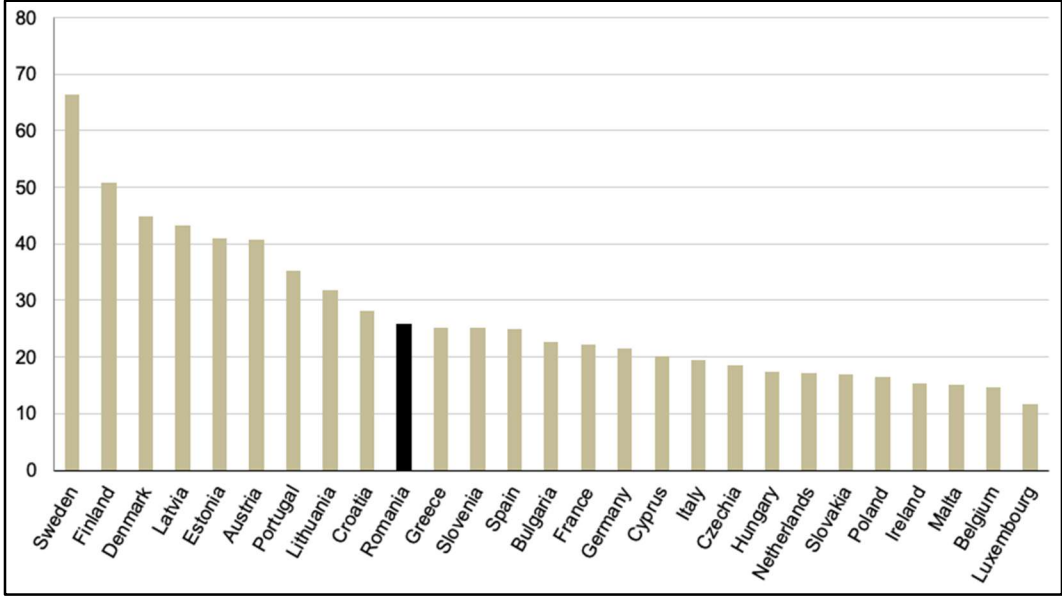
This section of the document presents statistical data on the share of energy from renewable sources in the total volume and in each of the three most important sectors for consumption (electricity, heating and cooling, and transport) in the European Union (based on the latest data from Eurostat), with a focus on Romania. Renewable energy sources include wind, solar (thermal and photovoltaic), hydropower, wave energy, geothermal energy, heat extracted by heat pumps, biofuels and the renewable fraction of waste.

### **4.1. Energy from renewable sources in gross final energy consumption**

In 2023, the European Union's share of renewable energy was 24.5% of total energy use. This figure represents an increase of 1.5% compared to 2022, and is almost three times higher than in 2004 (9.6%). Directive 2023/2413 stipulates that the EU should endeavour to increase its reliance on renewable energy sources. In

accordance with this directive, the target for energy from renewable sources has been increased from 32% to 42.5%, with the aim of rising to 45%. This necessitates a collaborative effort among EU countries to ensure the attainment of the 2030 targets. In consideration of the newly established target, it is imperative to augment the proportion of energy derived from renewable sources within the EU's gross final energy consumption by approximately 20%. As demonstrated in Figure 1, the most recent data available concerning the proportion of renewable energy in final energy consumption is illustrated.

**Figure 1: Share of energy from renewable sources in final energy consumption in 2023 (%)**



Source: Author based on Eurostat data, 2024

In 2023, Sweden was ranked first in the world in terms of the proportion of its total energy consumption that came from renewable sources, with two-thirds of this total coming from such sources. Sweden has utilised solid biofuels, hydropower and wind energy. Finland attained second place with 50.8%, while Denmark secured third with 44.9%, employing biofuels and wind energy as primary sources of energy. The lowest shares of energy from renewable sources were recorded in Luxembourg (11.6%), Belgium (14.7%) and Malta (15.1%).

It is evident that certain nations have utilised statistical transfers to attain levels that surpass their 2020 targets, which in turn represent their commitment for the subsequent period extending from 2021 to 2030. Statistical transfers are defined as agreements between EU countries to transfer a quantity of energy from renewable sources from one country to another.

In Romania, the share of renewable energy in final energy consumption was 25.8% in 2023, the last year for which data are available, compared to 24.14% in 2022. Romania's strong performance in terms of this indicator is due to hydropower and investments in wind energy.

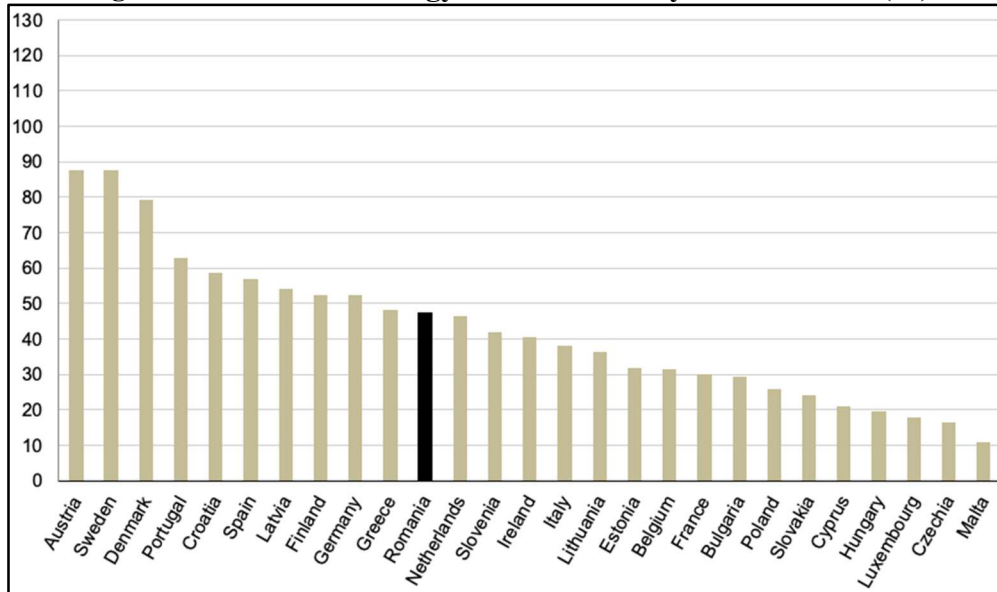
### 4.2. Renewable energy in the electricity sector

The criteria set out in Directive 2018/2001 stipulate that electricity produced from water and wind sources must be regulated to consider annual climate variations (hydropower has been regulated for the past 15 years, while wind energy has been regulated for the past five years, with separate regulation for onshore and offshore wind energy.)

The increase in electricity from renewable sources between 2013 and 2023 is due to the significant increase in electrical energy from wind and solar energy in the European Union. In 2023, renewable energy sources accounted for 45.3% of total electricity consumption in the European Union, an increase of 4% compared to the previous year (41.2% in 2022).

Electricity generated from wind and water sources accounts for more than two-thirds of total electricity generated from renewable sources (38.5% and 28.2%). The remaining electricity was produced from solar energy (20.5%), solid biofuels (6.2%) and other renewable sources (6.6%). Electricity produced from solar energy sources recorded the largest increase, from only 1% in 2008. This represents an increase of 7.4 terawatt hours in 2008 to 252.1 terawatt hours. The share of energy from renewable sources in electricity consumption is shown in Figure 2.

**Figure 2: Renewable energy in the electricity sector in 2023 (%)**



Source: Author based on Eurostat data, 2024

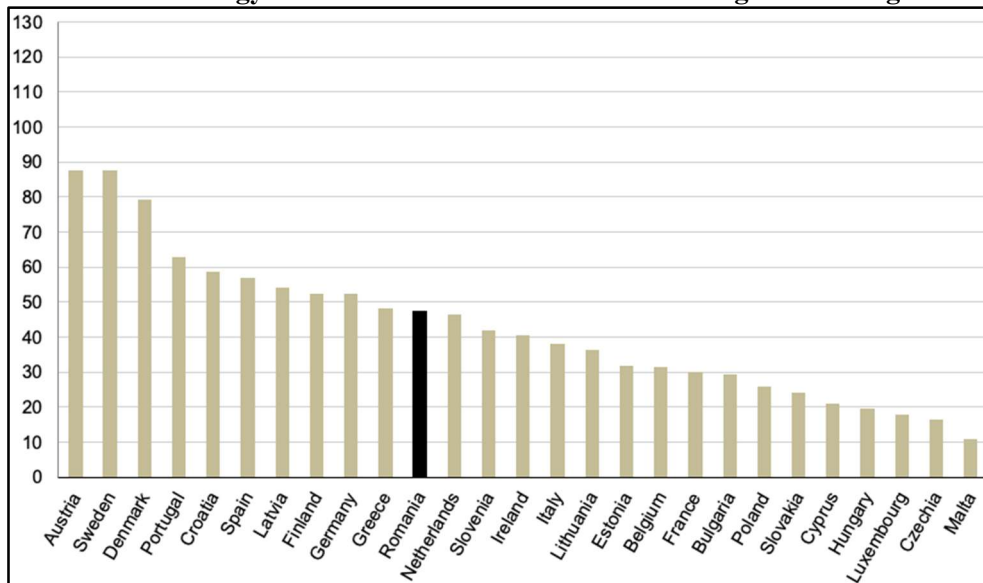
In 2023, more than 75% of the electricity used in the European Union came from renewable sources. The most significant proportions were in Austria, Sweden and Denmark, all of which had a share of around 80%. Portugal, Croatia, Spain, Latvia and Finland also used more than 50% of renewable sources for their electricity production. On the other hand, Malta, the Czech Republic, Luxembourg and Hungary had less than 20% of renewable sources in their electricity production.

In Romania, the share of renewable energy in electricity consumption in 2023 was almost 50%, more precisely 47.4%, compared to 43.7% in 2022. The reasons for Romania's very good performance in this regard were related to market liberalisation, European Union requirements, investments in infrastructure and favourable natural conditions.

### 4.3. Renewable energy in heating and cooling

In 2023, energy from renewable sources accounted for 26.2% of the total energy used for heating and cooling in the European Union. This is up from 11.7% in 2004. This increase was due to developments in industry, services and households. It includes energy from heat pumps for heating and cooling. Figure 3 shows the energy used for heating and cooling in the EU.

**Figure 3: Share of energy from renewable sources in the heating and cooling in 2023 (%)**



Source: Author based on Eurostat data, 2024

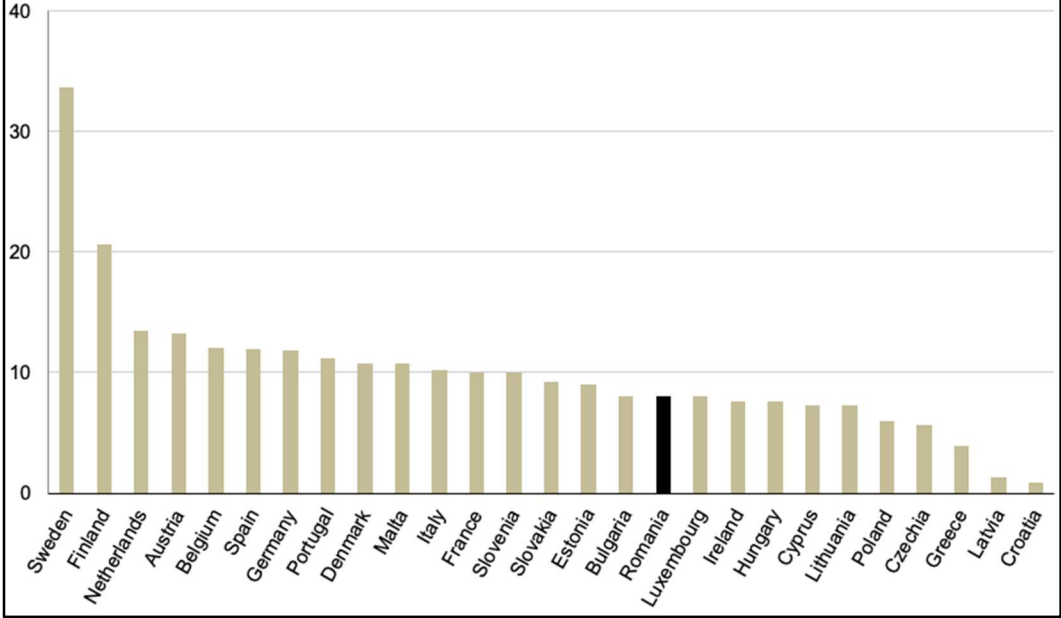
Sweden, Estonia, Latvia, Finland, Denmark and Lithuania were the countries with the highest percentages of renewable energy use in the heating and cooling sector, at over 50%. On the other hand, Ireland and the Netherlands were the only EU countries where less than 10% of the energy used for heating and cooling came from renewable sources.

Regarding Romania, in 2023 the share of energy from renewable sources in the heating and cooling sector was 29.1%, compared to 26.3% in 2022. The main renewable energy sources used by Romania for heating and cooling were biomass, geothermal and solar energy.

#### 4.4. Renewable energy in the transport sector

The European Union has set a common target for 2030 of achieving a 29% share of energy from renewable sources (including biofuels, hydrogen, biogas, “green” electricity and others) in the transport sector. The proportion of energy from renewable sources utilised in the transport sector has increased from 1.6% in 2004 to 10.8% in 2023. Within the European Union, the proportion of renewable energy utilised for transport varied significantly, ranging from 33.6% in Sweden and 20.6% in Finland to less than 5% in Croatia, Latvia and Greece. Figure 4 illustrates the proportion of energy from renewable sources utilised in the transport sector.

**Figure 4: Share of energy from renewable sources used in the transport sector in 2023 (%)**



Source: Author based on Eurostat data, 2024

In Romania, the share of energy from renewable sources used in the transport sector was 8% in 2023, down by 8.2% compared to 2022. This decrease compared to 2022 was also recorded in other Member States, as a result of the decline in the level of electrification of the transport sector in the European Union.

### 5. Prospects for the development of the renewable energy sector in Romania

By 2035, Romania aims to make a significant contribution to achieving the EU's decarbonisation target and will follow best practices in environmental protection. Table 1 shows potential future measures for developing the renewable energy sector in Romania, together with the estimated results of their implementation.

**Table 1: Future measures for the renewable energy sector in Romania**

Measure	Estimated result
Improving support schemes for RES (combined with an increase in the performance of RES energy production technologies)	GHG emissions from the energy sector will reach 13.5 million tonnes of CO2 equivalent in 2030, a reduction of 87% compared to 1990
Implementing policies and measures for wind, solar, hydro and biomass energy	Increase of the share of RES in gross final energy consumption to 44% in 2035 and 73% in 2050

<b>Building and commissioning new electricity generation capacity from RES (mainly wind and solar).</b>	Increase of the share of RES in electricity (RES-E) to 73% in 2050.
<b>Expanding clean generation capacity from nuclear and low-carbon gas sources</b>	Diversified and balanced energy mix with low carbon emissions
<b>Modernising existing cogeneration plants and building new units to replace existing polluting capacities</b>	Increase of the energy efficiency of power plant aggregates in operation and promotion of the production of electricity and heat in high-efficiency cogeneration plants
<b>Developing high-capacity battery systems or geographically dispersed medium or low-capacity battery systems</b>	Ensuring balancing for 15-20 GW installed in intermittent power plants at the national energy system level (2050)

Source: Author based on studied literature

The existence of support schemes for RES, coupled with the evolution of GHG emission costs in conjunction with an increase in the performance of RES energy production technologies relative to the decrease in investment and operating costs, will accelerate the energy transition in Romania. Consequently, it is anticipated that greenhouse gas emissions from the energy sector will attain 13.5 million tonnes of CO<sub>2</sub> equivalent in 2030, representing a reduction of 87% in comparison with 1990 levels.

It is estimated that by 2050, renewable energy sources (RES) will account for 73% of the total electricity generation mix, a substantial increase that will be driven by the construction and commissioning of new RES electricity generation capacity, with wind and solar power projected to play a significant role in this transition. Furthermore, there are plans to replace several coal-fired units with natural gas-fired combined cycle units and RES-based units, to refurbish some existing nuclear units, and to build new large nuclear units and the first SMR plants by 2035.

In addition to RES (hydro, wind and solar), there will be an expansion of clean generation capacities from nuclear and low-emission gas sources for a diversified and balanced energy mix with low carbon emissions. The process of modernising existing cogeneration plants and constructing new units to substitute for current polluting capacities will lead to enhanced energy efficiency in operating power plants. Furthermore, it will foster the production of electricity and heat in high-efficiency cogeneration plants.

In 2050, total electricity production will exceed 100% of gross final consumption, as part of it will be used for green hydrogen production. In 2050, a new investment cycle will be necessary to replace the production capacities installed between 2020 and 2030, which will reach the end of their life cycle. This will also require finding solutions for the recycling or safe storage of the components used.

By 2050, it is estimated that 15-20 GW of intermittent power generation capacity will need to be balanced at the national energy system level. Thus, in addition to existing capacities, there is an opportunity to develop large-capacity battery systems or geographically dispersed medium-or small-capacity battery systems as a marginal solution in the balancing market. In this direction, technologies that are currently expensive but could become economically feasible and appropriate, depending on technological progress and the evolution of the energy sector, are fuel cells powered by hydrogen obtained through water electrolysis using energy from RES and other low-carbon energy production technologies.

## 6. Conclusion

Renewable energy is a fundamental part of the effort to combat climate change, and the European Union wants to become a world leader in the transition to a zero-emission economy. With this in mind, the EU has set ambitious targets for energy produced from renewable sources.

As a member state of the European Union, Romania must comply with European targets for renewable energy, while also aiming to contribute significantly to combating climate change by following best practices in environmental protection. The renewable energy landscape in Romania appears very positive, with the country ranking in the top half of European Union Member States for three of the four indicators analysed in this research. The main reason for this is the very good development of hydro energy and recent investments in wind and solar energy.

In terms of the steps that Romania needs to take in this field, it is necessary to improve support schemes for RES, build and commission new RES electricity generation capacity (mainly wind and solar), expand clean generation capacity from nuclear sources, modernise existing cogeneration plants and build new ones. It should



also be taken into account that a good understanding of the medium- and long-term objectives by all stakeholders in this field is imperative.

The limitations of this research are related to the unavailability of data for the year 2024. Taking this into account, an extension of this research will be considered when this data becomes available to the public.

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