

DOI: 10.5281/zenodo.5040190

## GREEN ENERGY PRODUCTION IN ROMANIA

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**Abstract:** *Green energy is the popular name for renewable and non-polluting energy sources. Electricity generated from renewable sources is becoming more and more available. By choosing such renewable energy sources, consumers can support the development of clean energy that will reduce the impact on the environment associated with conventional energy generation and increase energy independence (Tuttle, 1901). Moreover, when these technologies can help the consumer by reducing the bills for different utilities (water, heating) and by a short payback time in the case of domestic water heating systems, the installation of solar panels becomes an extremely profitable investment. in the case of household consumers, hotels, hospitals, etc. The choice of such sources reduces the impact that traditional energy has on the environment. This type of energy comes from resources such as sunlight, wind, rain, tides, waves and heat (Popescu, 1995). Photovoltaic and wind energy is an example of green energy, being a solution to replace traditional energy. Solar energy is consistent and continuous, it acts all year round and is distinguished by its ability to be used quickly by a large part of the rural or even urban population.*

**Keywords:** *green energy, sustainable development*

**JEL Classification:** *Q01, Q42, Q56*

### 1. Introduction

Renewable sources (wind energy, solar energy, hydropower, ocean energy, geothermal energy, biomass and biofuels) are alternatives to fossil fuels, which help reduce greenhouse gas emissions, diversify energy supply and reduce energy dependence. volatile and unreliable markets for fossil fuels, especially oil and gas (Negrei, 1995).

Wind energy is a source of renewable energy generated from wind power. The main advantage of wind energy is the zero emission of pollutants and greenhouse gases, due to the fact that no fuels burn. No waste is produced. Solar energy is available in huge quantities, is inexhaustible (at least for several billion years) and is environmentally friendly (Samuelson & Nordhaus, 2000). The means of capturing solar energy are not polluting and have no harmful effects on the atmosphere. In the case of the production of electricity through photovoltaic panels, the percentage of solar energy in the total energy produced in the world has increased more and more over time and as technology develops, solar energy will be used more and more. Solar energy is definitely an alternative, as is wind or marine energy.

## **2. Green energy production in Romania**

It is increasingly clear that Romania has a huge potential for alternative energy and that the projects are feasible. However, the problems appear in the exploitation of this potential and in how the Romanian state understood to support green energy (Parvu & Stefan, 2002).

According to the latest available data, since April 2015, 3% of installed net power comes from solar energy, 15% wind energy, 31% hydropower, 18% from hydrocarbons, 26% from coal, and 7% from nuclear energy.

Romania has renewable energy production units with an installed capacity of over 4,500 MW, which is equivalent to almost a quarter of all units. Most of the renewable energy production capacities are represented by wind units. The government is currently supporting the production of energy from renewable sources through the green certificate system. Each producer receives from the state company Transelectrica, the operator of the national electricity transmission system, a certain number of green certificates for the energy it produces and delivers on the grid, and suppliers are obliged to purchase them to meet the mandatory quotas set for achieving the targets set at European level. Furthermore, suppliers (companies such as Enel, CEZ, GDF Suez) recover their costs from final consumers, both the population and the industry.

According to the initial support scheme, for each MWh of energy produced, two green certificates were granted in the wind field, three in micro-hydropower and six in the photovoltaic segment. The support scheme was amended by Emergency Ordinance 57/2013 (Constantinescu, 1976). Thus, by 2017, support for renewable energy will be limited: fewer green certificates will be issued for each technology (one green certificate for producers in the wind and microhydro sectors and two for those in the photovoltaic sector).

As reality has shown, the support scheme adopted by Romania is far from perfect. We mention here the investment bubble born from the race for green certificates, in which European energy giants implemented projects of tens and hundreds of megawatts, all in Dobrogea, connecting to the support scheme in question. From only 13MW of wind power capacity installed in 2009, the level reached 2800MW in 2014 (Popescu, 1995).

However, the sustainable development of the renewable energy sector means encouraging small-scale production, distributed throughout the country, as close as possible to the place of consumption. The way decisions have been made so far on the support scheme is a negative example of governance. The process of outlining it was opaque, with a minimum of consultation of those concerned and with decisions taken abruptly and unilaterally, to the exasperation of investors.

Establishing a system for the equitable promotion of renewable energy requires the initiation of a dialogue between the government, regulators, producer associations, municipalities and all other relevant actors. There have been voices - even numerous in recent years - who have claimed that renewables have gone wrong, in Romania, for various reasons - mainly economic and environmental. In our turn, we argue that in order to make things right, political will and action are needed, a message that we will address to decision-makers whenever it is needed to initiate change.

With currently available technologies, the consolidation of a generation system based only on renewable energy is becoming viable, not only to cover electricity demand but also total energy demand (example: heating and cooling) (Istrate & Bran, 1996). The serious environmental problems that obtaining energy generate require action on all possible fronts: as consumers we could bring about faster change by choosing clean energy.

Every year there are reports warning of the health and economic costs generated by air pollution caused by the energy sector. These costs can be avoided by adopting a common vision based on efficient and clean energy production alternatives (Popescu, 1995).

The new requirements in the field of sustainable development have determined the states of the world to question the methods of energy production and to increase the share of energy produced on the basis of renewable energies. The Kyoto Protocol commits the signatory states to reduce greenhouse gas emissions. This agreement led to the adoption of national policies for the development of wind turbines and other sources that do not emit carbon dioxide (Table 1).

**Table 1.** Main renewable technologies and their applications in the electricity, heating / cooling and transport sectors

<b>Renewable technology</b>	<b>Energy conversion</b>	<b>Application</b>
Hydroelectric power	From water flow and waterfalls in electricity	Electricity
Wind turbines	From wind energy to electricity	
Solar energy (photovoltaic and thermal - this includes concentrated solar energy)	From sunlight to electricity	
Biomass / biogas / bio liquids	From biomass / biogas / bio liquids to electricity	
Waste incineration	From waste to electricity	
Wave energy, tidal energy and other ocean energy	From the energy of waves and tides to electricity	
Geothermal energy	From temperature differences in electricity	
Solar thermal energy	From sunlight to heating and cooling	Heating and cooling
Biofuels / biogas	From biomass to liquid fuels or gases	
Waste incineration	From waste to heating and cooling	
Geothermal energy	From temperature differences in heating and cooling	
Biofuels / biogas	From biomass to liquid fuels or gases	transport

Source: <https://op.europa.eu/webpub/eca/special-reports/wind-solar-power-generation-8-2019/ro/index.html>

For the 2007-2013 and 2014-2020 programming periods, around € 8.8 billion has been allocated to renewable energy projects through cohesion policy funding from the European Regional Development Fund (ERDF) and the Cohesion Fund. As shown in Table 2, since 2007, investments in wind energy have been allocated approximately 972 million euros, and an amount of 2,868 million euros has been allocated for projects in the field of solar energy.

**Table 2.** ERDF and Cohesion Fund allocations for investments in renewable energy sources in the EU, 2007-2020, in EUR million

	<b>2007-2013</b>	<b>2014-2020</b>	<b>Total</b>	<b>%</b>
<b>Wind power</b>	<b>541</b>	<b>431</b>	<b>972</b>	<b>11 %</b>
<b>Solar energy</b>	<b>1 064</b>	<b>1 804</b>	<b>2 868</b>	<b>33 %</b>
<b>biomass</b>	<b>1 267</b>	<b>1 576</b>	<b>2 843</b>	<b>33 %</b>
<b>Other renewable energy sources</b>	<b>851</b>	<b>1 195</b>	<b>2 046</b>	<b>23 %</b>
<b>Total renewable energy sources</b>	<b>3 723</b>	<b>5 006</b>	<b>8 729</b>	<b>100 %</b>

Source: <https://op.europa.eu/webpub/eca/special-reports/wind-solar-power-generation-8-2019/ro/index.html>

In 2017, the share of renewable energy in the EU's gross final energy consumption reached 17.5%, the overall target for 2020 being 20%. This percentage was almost twice as high as in 2005 (9.1%). 11 of the 28 Member States have already reached their 2020 target (Gradinaru, 2001). These are: Bulgaria, the Czech Republic, Denmark, Estonia, Croatia, Italy, Lithuania, Hungary, Romania, Finland and Sweden. For the other 17 Member States:

- Greece, Latvia and Austria are most likely to reach their 2020 target if they continue to implement measures aimed at renewable energy sources at the current pace. These three states still need an increase of less than 2 percentage points (p. P.) In the share of energy from renewable sources by 2020;
- the share of renewable energy sources in eight other Member States (Belgium, Germany, Spain, Cyprus, Malta, Portugal, Slovenia and Slovakia) should increase by 2.4 p.p. for these countries to reach the 2020 target (in other words, the pace needs to be faster than before);
- the remaining six Member States are unlikely to meet their 2020 target, as they need the following increases in the share of renewable energy sources: the Netherlands - 7.4 pp, France - 6.7 pp, Ireland - 5.3 pp, United Kingdom - 4.8 pp, Luxembourg - 4.6 pp and Poland - 4.1 p.p.

### 3. The evolution of green energy production in Romania

The economic development of a country is largely dependent on creating and optimizing access to energy sources. Energy consumption is directly proportional

to the number of inhabitants, and with the population explosion, a greater number of resources is needed to cover the minimum necessary for consumers.

Energy security is, in short, the ability of a country to provide energy resources necessary for the well-being of the population, at stable prices. Currently, conventional methods of heating and lighting homes are not only endangered due to overload, but also harmful to the environment. And this phenomenon is beginning to make its presence felt in Romania as well. Globally, the energy sector has a massive effect on the environment, practically forcing the competent authorities to take measures to ensure a stable level of greenhouse gas emissions that are released into the atmosphere, but also the beginning of steps to reduce them in the near future (Istrate & Bran, 1996).

Given the current situation, which is far from ideal in most parts of the world, renewable energy is the number 1 substitute for this problem, being a viable solution to reduce the carbon footprint left in the atmosphere (Popescu, 1995).

In theory, the potential of renewable energy exceeds other types of energy, because it is unlimited and has no negative effects. Moreover, because 85.77% of the world's total energy consumption is represented by greenhouse gases, a radical change to renewable energy is not only welcome, but also mandatory for a greener future (Gradinaru, 2001).

Currently, in Romania, renewable energy constitutes 30% of the total percentage of energy used, although we have a high potential of renewable energy sources such as biomass, hydro or wind energy. From a statistical point of view, we are very good in this regard, already managing to reach the target of 25% renewable energy by 2020, much of this success being due to the consumption of hydropower.

We must also mention that the production of renewable energy in Romania is significant, ranking the country in second place in South-Eastern Europe, after Poland, and at a considerable distance from other European countries.

With an increase of only 3.1% between 2000 and 2016, the average established in Europe was not exceeded, but an increase of 7.8% can be observed between 2015 and 2016, which suggests an active involvement in the use of green energy in Romania in recent years.

At present, the production of renewable energy in Romania is 6550 ktoe, and a potential of 8000 ktoe remains untapped, but it can still be accessed in the future (Table 3).

**Table 3.** Evolution of energy production in Romania by categories  
(thousand kilowatts)

	1992	2000	2010	2015	2018	2019
Total, of which:	22177	21905	19911	23829	23553	20908
Termoelectrica	16442	15078	11637	11332	11115	8467
Hidroelectrica	5735	6120	6474	6638	6609	6595
Wind	0	0	389	3130	3032	3037
SOLAR	0	0	0	1318	1386	1398
Nuclear power	0	707	1411	1411	1411	1411

Source: Institutul Național de Statistică, Baza TEMPO on-line

### ***Wind power***

Due to its favorable geographical positioning, Romania has among the highest wind energy potentials in South-Eastern Europe, especially in areas such as Dobrogea, where wind turbines reach speeds of 7m / s at an altitude of 100 m. The above-mentioned potential can bring benefits for the future of wind energy in the country, estimating an additional generation of 23,000 GWh per year due to it. Romania is located in a temperate continental climate with high energy potential (~ 23 TWh estimated), especially in coastal and alpine areas.

In 2014, Dobrogea captured the largest amount of wind energy in Central and Eastern Europe, and in 2016, 23% of the total energy generated by Romania came from it. At the end of 2018, 16 more plants with a total capacity of 9.5 MW were installed, producing an average of 11.02 GWh per year.

### ***Hydropower***

Hydropower remains one of the most important sources of renewable energy, generating approximately 36 TWh per year and contributing 30% of the total energy stored in the network. Growing from year to year, there was an expansion of 10% between 2000 and 2016, and currently Romania has an installed capacity of 6.71 GW and an annual production of 1.25 Mote.

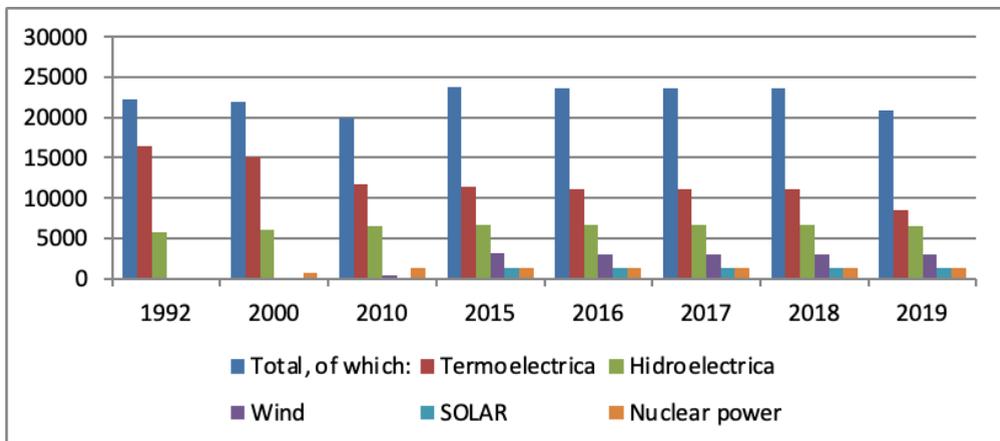
### ***Solar energy***

Romania has a substantial advantage from this point of view due to the favorable geographical position and the large number of sunny days per year, registering a significant progress in the previous years. Dobrogea, in particular, is an area where solar energy has taken a real lead. Of course, there are many other areas in the country where the number of solar panels installed continues to grow.

Of course, this is just the beginning! Storage capacity also saw an exponential increase between 2012 and 2016, increasing from 29 MW to 1300 MW in just 4 years according to the market analysis from Renewable Market Watch.

Analyzing the evolution of energy production by categories in the period 1992-2019, we see a massive decrease in the production of electricity produced in thermal power plants and an increase in other types of energy (Figure 1 and Table 4).

**Figure 1.** Energy production in Romania by categories (thousand kilowatts)



Source: National Institute of Statistics, TEMPO online base

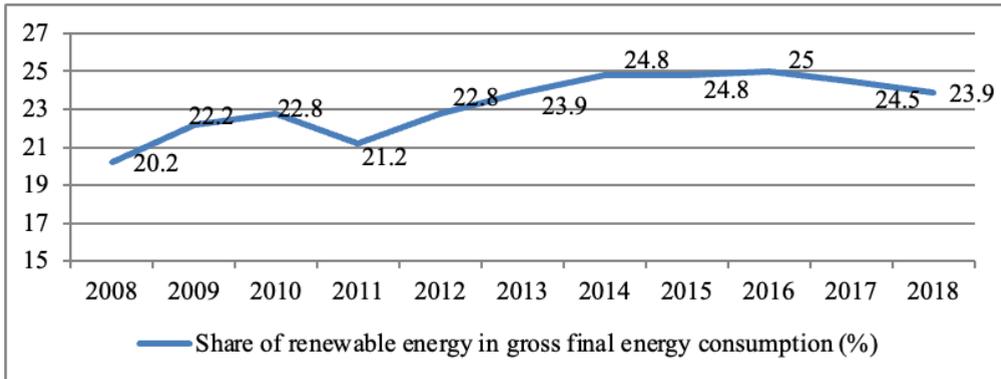
**Table 4.** Evolution of the share of energy production in Romania by categories (%)

	1992	2000	2010	2015	2018	2019
Termoelectrica	74,1	68,8	58,4	47,6	47,2	40,5
Hidroelectrica	25,9	27,9	32,5	27,9	28,1	31,5
Wind	0,0	0,0	2,0	13,1	12,9	14,5
SOLAR	0,0	0,0	0,0	5,5	5,9	6,7
Nuclear power	0,0	3,2	7,1	5,9	6,0	6,7

Source: National Institute of Statistics, TEMPO online base

Regarding the evolution of the share of renewable energy in the gross final energy consumption (Figure 2), we find that it had a sinuous evolution with increases and decreases in the period 2008-2018, the largest decrease being registered in 2011.

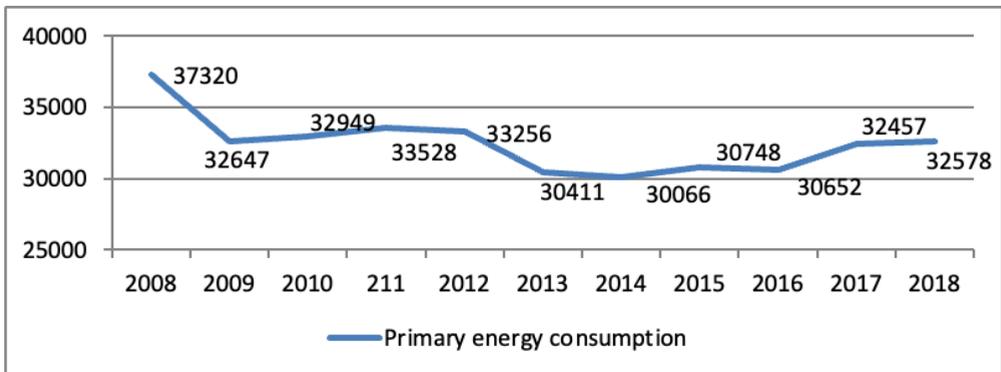
**Figure 2.** Evolution of the share of renewable energy in gross final energy consumption (%)



Source: National Institute of Statistics, TEMPO online base

The evolution of primary energy consumption in Romania (Figure 3) recorded decreases in the period 2008-2018, but these decreases were not spectacular, and from the evolution of the figures we conclude that our country is still dependent on primary energy sources.

**Figure 3.** Evolution of primary energy consumption in Romania (thousand tons)



Source: National Institute of Statistics, TEMPO online base

#### 4. Conclusions

Renewable energies (also known as “green energies”) are considered in practice, energies that come from sources that either regenerate themselves in a short time or are practically inexhaustible sources. The term renewable energy refers

to forms of energy produced by the energy transfer of energy resulting from naturally renewable processes. Thus, the energy of sunlight, winds, running water, biological processes and geothermal heat can be captured by humans using various processes (Popescu, 1995).

Non-renewable energy sources include nuclear energy as well as energy generated by burning fossil fuels, such as oil, coal and natural gas. These resources are obviously limited to the existence of those deposits and are generally considered (see the theory of Romanian academician Ludovic Mrazec of inorganic formation of crude oil and natural gas) non-renewable.

In December 2008, the EU adopted an ambitious and long-awaited package on „climate change and energy” which, among other things, obliges EU-27 countries to increase the share of renewable energy to 20% of Europe’s total energy production by 2020. Being a clean and renewable source of electricity, wind energy is meant to make a significant contribution to achieving the 20% target (Gabor & Colombo, 1983).

In the last decade, wind energy has grown rapidly in Europe. In 2008, it accounted for about 4.8% of total EU electricity consumption. This percentage is expected to increase at least threefold by 2020. Therefore, it is clearly likely that the number of wind farms in the EU will increase considerably in the short and medium term. It is important to ensure that such rapid expansion is sustainable in all respects and that it is carried out in accordance with EU environmental law, including the Habitats and Birds Directives. Recent evidence indicates that, although wind energy is not generally a serious threat to wildlife, poorly located or designed wind farms can be a potential threat to vulnerable species and habitats, including those protected under the Habitats and Birds Directives (Samuelson & Nordhaus, 2000).

Romania has a huge potential in the green energy sector, which is largely latent. In recent years, 6 billion Euros have been invested for the development of the green energy sector in Romania and more than 45,000 MW have been built.

Given that the European Parliament has approved projects that require at least 35% of Europe’s energy consumption to be from renewable energy sources by 2030, the situation in the energy sector will improve considerably (Bran, 1995). And Restart Energy wants to help as many consumers as possible realize the importance of switching to a green energy producer, from all points of view.

CEZ wind farm is the largest onshore wind farm in Europe, producing 1,323 GWh last year, 14% more than in 2016, benefiting from an average wind force of 7.25 m /s.

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