



Wind energy in Romania: A review from 2009 to 2016



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ABSTRACT

The main purpose of this study is to highlight the continuing need of policies for subsidizing through Green Certificates, the production of electricity from renewable sources in Romania and especially wind energy. Amending legislation in 2013 by diminishing the support for the RES producers led to a significant reduction in investment in this area and eventually will cause an end. Romania met the planned capacity for 2014 with 2967 MW installed above 2880 MW planned. However, reducing the number of GC can affect the deployment of future projects in order to meet the 4000 MW expected by 2020.

The European Union has set a unique path in terms of developing renewable energies by 2020, but each country has different potentials depending on geographical location, landscape, climatic influences and local policies. Romania's wind potential is considered to be the highest in Southeast Europe with Dobrogea region being the second highest wind potential area on the continent.

RES Romanian producers benefited Green Certificates (GC) scheme upon accreditation by the National Regulatory Authority for Energy (ANRE). Green Certificates can be redeemed only in Romania within the national agreed quota. Owing to the 2010 legislative measures, installed capacity of wind power increased from 7 MW in 2009 to 976 MW peak in 2012, by 2015 reaching a total installed power of 2990 MW.

Promotion of electricity from renewable sources over 2010–2013, through the national subsidy policy has led to a significant drop in greenhouse-gas emissions from the production of electricity from 438 g/kWh in 2011 to 326 g/kWh in 2015.

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Abbreviations: EU, European Union; RES, Renewable Energy Sources; GC, Green Certificates; ANRE, National Regulatory Authority for Energy; GHG, Greenhouse-gas emissions

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1. Introduction

The European Union plays an important role on the international energy market, being the greatest importer and the second largest consumer. Romania's accession to the European Union on 1 January 2007 has determined significant changes in the energy sector. The changes involved reviewing energy policy, alignment with the EU energy legislation and promotion of renewable and sustainable energy.

There is a widespread interest in reducing energy consumption. Nevertheless, we are undoubtedly witnessing demographic growth (more people have access to energy) and economic development, leading to an increase in energy demand. In 2008, about 81% of the electricity generated on Earth was produced from burning fuels as follows: fossil oil (33.5%), coal (26.8%) and gas (20.9%) [1]. Burning these fuels contributes significantly to emissions of greenhouse gas, the main contributor to the current global warming. Besides the negative environmental effect of excessive use, energy from fossil fuels can put at risk the future global energy security due to the significant drop in remaining resources on Terra. Burning fossil fuels for energy requirements contributes to the increase in greenhouse-gas concentrations in the atmosphere [2–17], thus enhancing the security of power supply chain and diminishing the greenhouse-gas emissions, which require heedful care and serious consideration now more than ever [18,19]. This is the main reason why both local and global measures need to be taken.

Increasingly countries have taken steps to favor the use of renewable energies aimed at alleviating environmental problems and reduce dependence on fossil fuels. Following these measures, wind power has had a rapid growth after 2000 [20–24]. Romania's energy potential derived from renewable-energy sources consists of: solar energy, wind energy, biomass, hydro and geothermal energy. The largest contributor in this case is represented by hydro energy, followed by wind energy. Hydroelectric power can be stored, and electricity can be produced at a constant rate. These two are the greatest advantages of hydro energy, but they present many disadvantages too. Among hydroelectric power drawbacks we could mention:

- Dams and all hydroelectric power plants are very expensive to build;
- Payback period is significantly long;
- Natural environment may be destroyed [25–29] ;
- Effects on agriculture;
- Dependence on annual rainfall levels;

Hydropower is a sustainable and long-lasting source of energy but building a hydroelectric power plant raises many environmental concerns.

Among the ways in which electricity can be generated from renewable-energy sources (RES), the one based on wind turbines is believed to be the least harmful to the environment [30–32]. It has also been the most cost effective of the RES, until now [33]. Due to the combination of these two factors, wind energy is the most extensively utilized of all renewable-energy sources for electricity generation if large hydropower is excluded from consideration (as it usually is) [34,35]. Wind energy is sustainable and long-lasting too, pollution free and eco-friendly [35–61]. Wind energy is a clean renewable-energy source [36,37], [62–65] and is

strategically important to national and socioeconomic development [66,67].

The paper's main objective is to emphasize wind power energy potential in Romania and to analyze and present this sector at its current state. As a European Union member, the first step of our research was to evaluate this type of energy at European level. Having assessed this, based on energy dependency across EU countries - energy from renewable sources across EU countries, we subsequently put emphasis on the wind energy sector. For each criterion we identified and highlighted our country's position inside the European Community.

We chose to present Romania's wind energy sector in detail, because it is the second largest segment of renewable energy, in Romania, after hydropower energy. The greatest hydropower plants in Romania were built long before the country's accession to the European Union. In the last 27 years only maintenance of existing facilities and resumption of older projects have been made in this sector. In contrast, in short periods of time substantial amounts of money have been invested, in wind power plants. This strategy seems to result from climatic changes (global warming) and longer periods of recorded drought, which hinders investments in large hydropower plants but supports other types of renewable-energy sources.

2. Methods and procedures

This study traces the evolution of wind power energy in Romania from 2009 to its actual state by presenting the regional climatic conditions, Romanian legislation on renewables and the role of wind farms in the local power industry. We first analyzed wind energy in the European Union, before 2016, by evaluating energy dependency, energy from renewable sources and wind energy across EU countries. Once we have identified our country's position in the European Union, we analyzed wind energy in Romania, to emphasize its advantages as a sustainable and renewable-energy resource. Romania is significantly decreasing its dependence on traditional fossil fuels. It is to be mentioned that wind power plants became in Romania, in six years the second main source of energy among renewable-energy sources, after hydro.

3. Wind energy in the European Union before 2016

3.1. Energy dependency across EU countries

The European Union had to import 53.4% of the energy consumed in 2014, according to Eurostat, the statistical office of the EU. Energy dependency varies widely across EU countries. In 2014, the least dependent EU countries were Estonia, Denmark and Romania, followed by Poland, the Czech Republic, Sweden, the Netherlands and Bulgaria, as in Fig. 1.

At the opposite end of the scale, the highest energy dependence rates were registered in Malta (97.7%), Luxembourg (96.6%), Cyprus (93.4%), Ireland (85.3%), Belgium (80.1%) and Lithuania (77.9%).

Among the five EU countries consuming the largest amounts of energy, the least dependent on energy imports were the United

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