Overview of the main topics in wind energy systems planning

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Abstract. The renewable energy production suffered very much in Romania, being practically stopped since a couple of years, because of legislative changes made “during the game”. Beside the main steps of wind power plant planning, identifying locations with good wind potential, the design of the wind park layout, choosing the best wind turbine type for the given locations, proximity to the transmission/distribution network and other technical features, the legislation in the electricity production from RES will have to ensure economical feasible support scheme, in a predictive legislative framework. The present paper presents possible scenarios for the development of the Romanian RES market at the horizon of 2030, strongly related to the direction that the policy transposes in the legislation.

1. Introduction

Through the ambitious targets settled for 2030, the European Union has positioned itself as a world leader in decarbonization initiatives. [1], [2]

To achieve those targets, in the main areas of the society, certain trends and awareness must be accomplished. The population will have to support such a target, for this, among them, a better understanding of energy use and consumption must be achieved, hand in hand with cultivation of the ecological consciousness. Outgoing from those previously mentioned, also, the social behavior will have to encourage to share mobility, in the context of a growing urbanization. [3]

In favor of reaching these targets, the technologies have a rapidly developing, and in this sense, the production and exploitation costs for energy production from renewable sources are declining. [4-7]

At the same time, the digitalization of the transmission and distribution network to the so-called smart electric grid as well as the lowering cost of the electric vehicles will put pressure on the need of clean and save electricity production units. [9]

From economic reasons also, the volatility of goods prices (i.e. petrol) or the increase of the cost of greenhouse gas emissions justify the accent on independent and safe energy resources (i.e. wind, sun, water). [10]

The politic will has for sure a main role in achieving this target, by creating a legislative framework, characterized by stability and predictability, as well as subsidies and incentives (i.e. electric cars), because any investment in the energy market is high and the return of investment, lasting. [11]
2. Scenarios and forecasts for Romania

2.1. Natural Potential

The natural potential to exploit the renewable energy sources (RES) in Romania, is so high, that, the entire energy consumption could be covered from those. The Romanian natural renewable energy potential, splitted on the main sources, is presented in Figure 1. The diagram excludes the geothermal potential being under 1GB as well as the biomass potential, the references to this potential in Romania being, at least for the moment, unclear. [12]

From the existing potential, approximately 32% would be enough to cover the maximum on energy from renewable sources in Romania. [12]

![Figure 1. Romania renewable energy potential](image)

The hypotheses considered, are based on the official data of the Romanian authorities as well as from feedback obtained from the different professional associations acting in the renewable energy sector. [12-15]

Outgoing from the market forecast, a decreasing of the technology costs (especially for photovoltaic solar panels and wind turbines), and the development of storing renewable energy capacities, make the gain of energy from renewable sources the towards competitiveness to the energy gain from conventional sources. For the period until 2030, the medium investment cost in the wind energy sector is estimated to be around 1.200 EUR/kW, while, for example, the coal-based power plants require substantial investments to comply with the pollution requirements specified through the environmental regulations. As well, the electric energy consumption will increase, considering at least two main factors, electrifying transport, to estimated 500.000 electric cars in 2030, and an increase in the residential sector, because of a higher number of households with electric cooling and heating system, increasing the number of households connected to the electric grid, in general, an improvement of the life quality. [10], [12-14]

Based on macroeconomic indicators, the evolution of the energy consumption in Romania, provides in 2020 the achievement of 45% from the EU average at the level from 2015, in 2030 this consumption will reach 54% of the EU average at 2015 level so that in 2050 the electric consumption / inhabitant will exceed the EU average from 2015. [15]

To fulfill this evolution in the macroeconomics indicator as well as in the marked forecast, the infrastructure will have to develop: transition to the smart grids through a higher level of automatization and network digitalisation; improving the balancing capacity; interconnection inside
the national electricity transmission network as well as increasing interconnectivity with neighbouring countries.

2.2 Analysed scenarios
A first scenario, with the highest probability, under the current conditions, assume: expanding the life of existing nuclear facilities; two additional nuclear reactors (unity three and for) that will be commissioned in 2030 respectively 2031; gradual and natural elimination of all coal groups by around 2035. Under this scenario, the net installed capacities, broken down by sources, is: nuclear (2.000 MW), hydro (6.800), wind (4.400 MW), solar (1.800 MW), biomass (140 MW), coal (3.200 MW), natural gas (3.500 MW), masout (100 MW), Figure 2.

For this scenario, the net installed capacity from renewable energy sources will increase in 2030, comparative to 2020, with 15%: additional installed capacity, in wind power plants, from 3.000 MW to 4.400 MW, Figure 3, and PV systems, from 1.500 MW to 1.800 MW, Figure 4. Outgoing from the given scenario and based on the previous experience in the Romania market, the estimated percentage distribution of the energy by sources in 2030, is shown in Figure 5.

A second scenario captures a 40% increase in net installed capacity in RES compared to 2020. Under those assumptions, the nuclear energy production will increase, expanding the life of the existing nuclear facilities, reactor units one and two (U1 & U2) and gathering additional installed capacity, the units three and four (U3 and U4). In the same time, the coal capacities with theirs associated entities, will be gradual and natural, eliminated by around 2035. The wind power plants will double their installed capacity, increasing from 3.000 MW to 6.000 MW, Figure 6, as well as the installed capacity in PV systems that will also double, from 1.500 MW to 3.000 MW, Figure 7. Based on this second scenario, the estimated net energy production, assigned according to the used sources in 2030, is shown in Figure 8. It can be observed that reported to the increase installed capacity in RES, a decrease in the energy production in natural gas power plants will be assumed.

![Figure 2. Net installed capacity forecast 2030](image)
Figure 3. Additional installed capacity in wind power plants

Figure 4. Additional installed capacity in PV power plants

Figure 5. Estimated distribution of the energy production, by sources, in 2030

The two analyzed scenarios, both considering the initialization and completion of the related investments for the units three & four of the romanian nuclear power plant units, aim to align the RES quota. Romania will have to follow the European Union targets to ensure a fair participation in targeting common objectives of the member states.

For the first scenario, the evolution of the SRE quota is starting from the actual value of the quota, 25% in 2016, as well as the pace of deployment of existing capabilities, ≈ 1 GW annually, reaching a 30% quota by the 2030 horizon, is inertial, Figure 9. The second scenario is based on the increasing of the RES installed capacity and the decrease of the using level of the natural gas power plants, Figure 9. The final energy consumption and the electricity consumption are constant in both addressed scenarios.
Figure 6. Additional installed wind power plant capacity in 2030 compared to 2020

Figure 7. Additional installed PV power plant capacity in 2030 compared to 2020

Figure 8. Estimated distribution of the energy production, by sources, in 2030

Figure 9. Evolution of the RES quota in the analysed scenarios until 2030
3. Conclusions
To be able to implement those scenarios, both, at national and European level, support schemes for RES have proven to be an effective way to favor the use of renewable energy, even if the increase of the technical performance of the equipment will reduce subsidies but will not lead to complete elimination.

General energy policies converge towards achieving the environmental targets set through the Paris Treaty, maintaining also the energy security at national level. Encouraging the development energy electricity production from renewable energy sources (RES) need to have at their disposal instruments facilitated by the authorities, preventing in the same time retroactive changes to the support scheme.

The development of the infrastructure is essential to an economically and technically increased absorption of the renewable energy, such as infrastructure, with the transmission and distribution network, smart grids and interconnections.

Romania is one of the European countries with a great potential of renewable sources, wind, water, and solar (WWS), that, with the right energy policy, will be able to transform this country in a standard of electricity produced from RES.

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