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A BRIEF OVERVIEW OF THE RENEWABLE ENERGY POTENTIAL IN ROMANIA

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ABSTRACT

The work proposed herewith presents a review of the renewable energy potential and its extraction in Romania. This includes especially hydro, wind, solar and biomass ~~power~~ energy. Besides the actual stage of energy extraction and consumption, the work also presents several future targets and the roadmap for the year 2020. The main conclusion is that Romania has a relevant potential in terms of renewable energy and its intensive extraction becomes an issue of high priority.

Keywords: renewable energy, Romania, wind, hydro power, solar, biomass

1. INTRODUCTION

The evolution of industrial technique, appearance of machinery and equipment and the large diversity of them, depending on the needs of each area brought also some disadvantages, which mainly are: carbon emissions, waste, especially those that are not biodegradable, and even toxic for us, but, at the same time, for the generations to come. Emissions of carbon that pollute cities and affect the ionosphere, causing the greenhouse effect, should be reduced as much as possible, and this can be achieved by using renewable energies.

Energy defined as renewable energy or eco defined green energy, is the form of energy produced by the energy transfer of energy resulting from natural processes, renewable, which involve capturing sunlight, wind, water, biological processes and geothermal energy, using different processes of energy. Such kind of energy is called renewable because the resources are practically inexhaustible.

The main renewable energy sources are wind, sun, rivers, seas and oceans, springs of thermal water and biomass.

As concerning the wind or eolian energy, the principle is quite simple and well known, even from many centuries ago. Thus, the wind transfers its energy to the propeller blades, which drive a turbine and, thus, turns kinetic energy into mechanical energy, which, in turn, is converted to electricity. The wind is air circulation, generated by the uneven heating of the Earth's surface. Thus, pressure differences occur from one region to another, forcing the movement of the air masses. For a wind speed of 20 km/h, some turbines can produce up to 5 MW electricity. Nevertheless, this aspect results under the assumption that the wind is constant and the turbine blades have a certain openness.

Sunlight sents to earth, brings a light energy that can be converted into electricity using solar installations that are of two types, thermal and photovoltaic. The heat helps to reduce gas consumption by 70% per year, and photovoltaic solar energy is converted directly into electricity.

Water can be also made to work using hydraulic energy, tidal energy or osmotic energy potential. The hydraulic energy is used to produce electricity by the force of water in the hydroelectric plants. They are formed by dams, which accumulate large amounts of water directed through hydroelectric turbines, producing electricity. Tidal energy is used by turbines that produce electricity due to the increase or the decrease in sea level and ocean. Osmotic potential energy or salinity gradient energy is the difference in salt concentration between seawater and river water and it is carried out by electrolysis and reverse osmosis pressure challenge.

Geothermal energy is obtained from the heat inside land. Hot water and steam are used for space heating and electricity production.

Energy incorporated into biomass is released by various methods, but, finally, is the chemical process of combustion (chemical conversion in the presence of molecular oxygen). Biomass is the biodegradable fraction of products, waste and residues from agriculture, including vegetal and animal substances, forestry and related industries, as well as the biodegradable fraction of industrial and municipal waste. Obtaining biofuels can be achieved by direct combustion with generation of heat, burning pyrolysis, the generation of syngas ($CO + H_2$), fermentation, with generation of biogas (CH_4) or bioethanol (CH_3-CH_2-OH), chemical transformation of vegetable oil biomass by treatment with an alcohol and esters and generating enzymatic degradation of biomass to ethanol or biodiesel production [1].

2. THE POTENTIAL FOR RENEWABLE ENERGY IN ROMANIA

National energy policy aims to capitalize on renewable sources of RES energy. With the signing of the Accession Treaty of April 2005 and the acquisition of EU membership as of January 1, 2007, Romania adopted and ratified all energy measures regarding the capitalization of RES. Romania was the first country in Annex 1 to have ratified the Kyoto Protocol through Law No. 3/2001 on the reduction of carbon emissions. From 2001 to 2007, Romania signed and ratified 10 Memoranda of Understanding with the International Bank for Reconstruction and Development and various European countries in order to have a legal framework for implementing agreements on the use of RES.[2] [11][12]

The strategy for capitalizing on renewable energy sources, approved by Law 1535/2003, imposed objectives that: the integration of RES into the national energy system structure, the removal of technical and social obstacles in the use of RES, the promotion of investments, the energy independence of Romania, to capitalize on the local RES resources, Romania's participation in the European Green Certificates Market for RES [3], [12].

The medium and long term concrete targets were for the commissioning of capacities with an installed capacity of 441.5 MW of electricity for the period 2003-2010 and an installed capacity of 789 MW of electricity for the period 2011-2015. For thermal energy an installed power of 3274.64 thousand toe, for the period 2003-2010, respectively 3527.7 thousand toe, for the period 2011-2015. From this perspective, Figure 1 presents the Romanian energy efficiency potential, while Figure 2 the Romanian thermal energy efficiency potential.

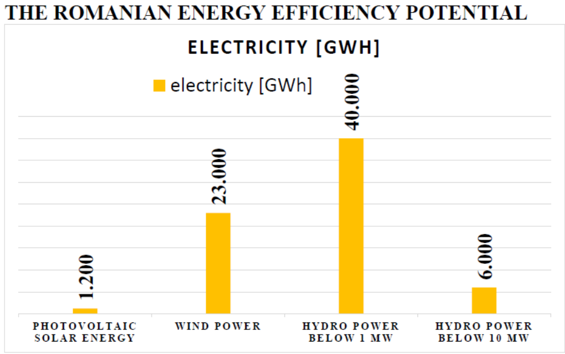


Fig. 1. The Romanian energy efficiency potential [2][11]

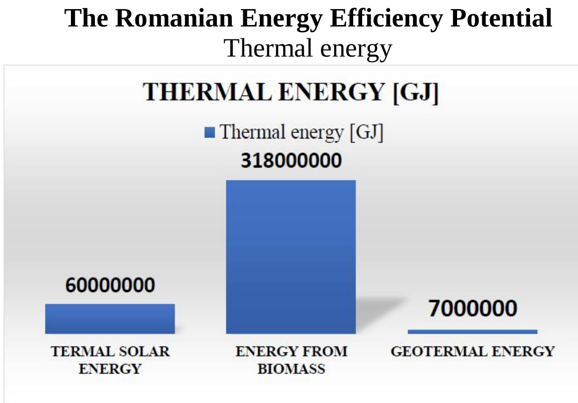


Fig. 2. The Romanian thermal energy efficiency potential[2][11]

Toe is a unit of measure of energy that represents the chemical energy released by burning a ton of oil. The International Energy Agency has recommended that the calorific value for oil of 10000 kcal/kg and the value of a calorie in the International System is 41868 J, so one tonne of oil equivalent is 41868 MJ.

Quantities in 2010 were to produce 19.65 TWh of electricity and 2015 to 23.37 TWh of electricity.

The share of RES use in total electricity production was 33% for 2010, 35% for 2015 and 38% projected for 2020 [3].

If we equate the potential of renewable energy sources in Romania, we notice that biomass sources have the greatest potential, with 7597 thousand toe, followed by hydro power less than 1 MW, with 3440 thousand toe and then wind energy by 1978 thousand toe [3].

Electricity consumption increases with the growth of population and the plurality of industrial and domestic appliances, with the growth of living quarters and the areas where people live. In Figure 3 we can see the evolution of electricity production in RES from total electricity production, with a forecast by 2020 [2].

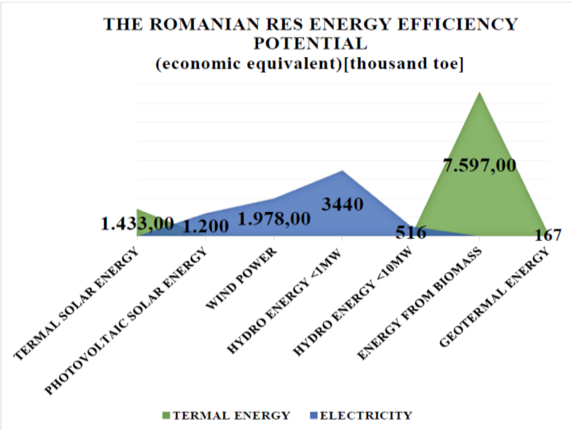


Fig. 3. The Romanian RES efficiency potential[3][13]

In the following charts, the expected consumption in the heating, cooling, electricity and transport sectors for the years 2005, 2011, 2016, 2020. Thus, Figure 4 presents the forecast of electricity production and on the other hand of the RES energy production, Figure 5 the expected consumption in the heating, cooling, electricity and transport sectors and finally Figure 6 Total RES expected consumption.

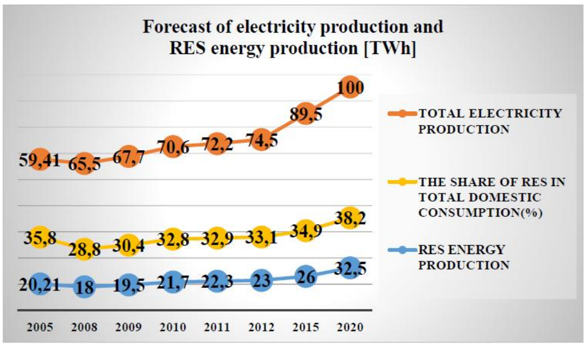
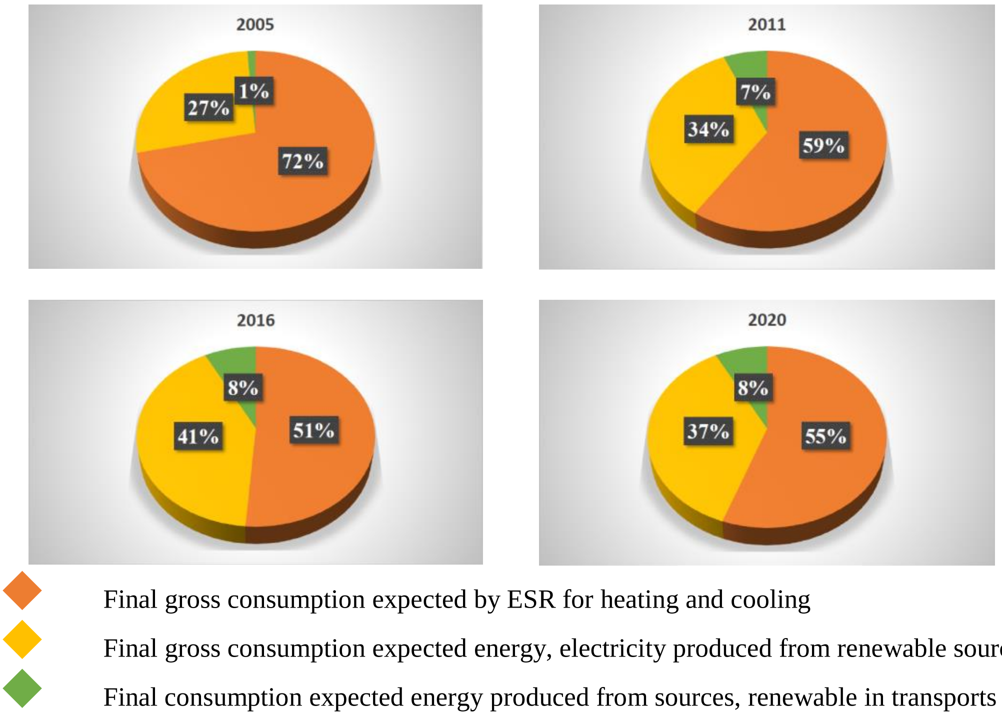


Fig. 4. Forecast of electricity production and RES energy production[3]

In sectors such as heating and cooling, electricity and transport Directive 2009/28/EC has set lines for Member States to set targets for the percentage of RES consumption by 2020. If, in 2010, the percentage of electricity consumption in RES was 4529 kPa, in 2017, the percentage of RES electricity consumption is 6214 kPa, a consumption of 7268 kPa is expected for 2020, with almost double the consumption of electricity from RES in 10 years.



Final gross consumption expected by ESR for heating and cooling

Final gross consumption expected energy, electricity produced from renewable sources

Final consumption expected energy produced from sources, renewable in transports

Fig. 5. Expected consumption in the heating, cooling, electricity and transport sectors [3], [12]

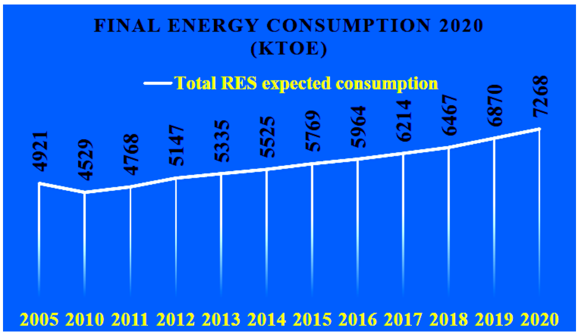


Fig. 6. Total RES expected consumption.[3][12]

3. MAP OF SOLAR AND WIND POTENTIAL IN ROMANIA

The solar potential map presented in Figure 7 shows, depending on the areas of relief and the latitude that they are located, what capacity they have to produce electricity with solar panels or solar plants. Thus, in the south of the country and on the sea shore it is possible to produce between 1450 kWh/mp/year and 1600 kWh/mp/year, in the plains and the Transylvania Plateau can produce between 1350 kWh/mp/year and 1450 kWh/mp/year and, in the high mountainous area, it could be produced between 1250 and 1350 kWh/mp/year, and in some extreme Nordic mountain, the possibility of producing electricity decreases between 1100 and 1250 kWh/mp/year [15].

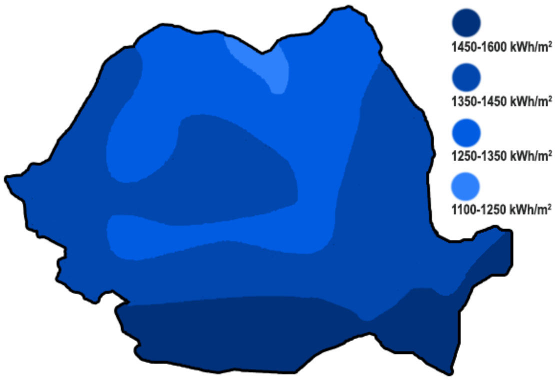


Fig. 7. Map of solar potential in Romania [15]

The wind potential map, presented in Figure 8, has a wider range of variation due to the multitude of the relief forms. Thus, in Figure 8, it is observed that, in zone I, the high mountain area, the wind can have a velocity greater than 11.5 m/s and can produce 1800 W/mp. Furthermore, in the open high area the wind may have a speed greater than 9 m/s and can produce 800 W/mp.

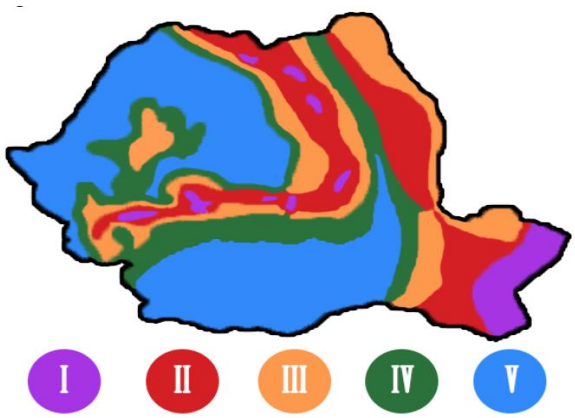


Fig. 8. Map of wind potential in Romania [16]

In zone II, in the hills and plateaux, the wind has a velocity between 5 m/s and 6 m/s, and the output can be 150-200 W/mp, in the flat land area, the wind has a velocity between 6.5 m/s and 7.5 m/s, and the production can be 300 W/mp and 500 W/mp, and in the coastal area the wind has a velocity of between 7 m/s and 8.5 m/s, and it can produce between 400 W/mp and 700 W/mp. In zone III, in the hills and plateaux, the wind has a velocity of between 4.5 m/s and 5 m/s and it can produce between 100 and 150 W/mp, in the flat land area the wind has a velocity between 5.5 m/s and 6.5 m/s, and between 200 W/mp and 300 W/mp may be produced. In zone IV, in the area of hills, the wind has a speed of between 3.5 m/s and 4.5 m/s and it can produce between 50 W/mp and 100 W/mp, in the area of flat land the wind has a speed between 4.5 m/s and 5.5 m/s and can produce between 100 and 200 W/mp. In zone V, in the flat land area the wind has a speed of less than 4.5 m/s and it can produce less than 100 W/mp, in the hills and plateaux, the wind has a speed of less than 3.5 m/s and less than 50 W/mp may be produced [16].

4 THE BLACK SEA ENERGY POTENTIAL

Waves of the oceans and seas can produce mechanical energy that can be converted into electricity. The wind that exerts pressure on the water surface helps to form waves. The waves are formed by holes and tides. The distance between two wave raises is called the wavelength. The height of the wave is considered the vertical distance between a gap and a wave ridge. The amount of time a wave needs to wave the wavelength is the wave period. So, wave velocity is the ratio of wavelength to wavelength [6-10].

The mechanical power released by the wave has a value that expresses itself through the relationship

$$P = \frac{1}{2}\rho \cdot g \cdot H^2 \div \lambda \qquad (1)$$

ρ - sea water density, g - gravitational acceleration, H - wave height, λ – wavelength [13].

The Black Sea is a relatively calm sea. The strong winds in the Black Sea have a 38% and those with a low speed of only 0.5%, this shows that the wave energy potential is relatively low.

Based on the analysis of data recorded at the Gloria drilling platform in 2001-2005, Onea [14] has made an estimate of the power provided by some devices using Black Sea wave energy. The results showed that a Wave Dragon could produce around 600 kW in winter and an average of 400 kW over the year. There are over 40 types of devices to harness the energy potential of the world's seas and oceans. Their classification is based on shore-based positioning in offshore, near shore and offshore facilities. Devices can also be divided by system type into oscillating water column systems, water accumulation systems, and flooded floating systems.

5 ADVANTAGES AND DISADVANTAGES OF RENEWABLE ENERGY.

Renewable energy is a clean energy that does not pollute in any way and its influence on the environment is minimal. Renewable energy production plants can be located in areas withdrawn, in places where they have not reached the national electricity grid. Wind turbines, solar panels and mini hydropower plants can be located in the wildest and most inaccessible locations. The location of some poorly-sourced energy sources can lead to the regional development of these areas. Installations offshore and ocean interact relatively little with offshore flora and fauna. Installations located on the shore can remove soil erosion, having a positive impact on tourism.

The disadvantages of renewable energy are minimal. The point of location has a visual impact that disturbs a part of the inhabitants, wind turbine noise and air turbines from shore-based systems can be a little disturbing and offshore systems can create navigational problems, but these issues can be solved by installing beacons.

Personally, the authors do not agree with moving the rivers or adductions made for small private hydropower plants, with hydropower plants that shut down rivers and rivers from one shore to the other, which stops the migration of many fish species, so they think it would be necessary to look for constructive solutions to affect the environment as little as possible, especially the habitat of species of fish that are unique in the world, such as scrubs, trout or losers, which have already been declared as endangered species.

6 CONCLUSIONS

With the advancement of technology and the reduction of green energy costs, it is expected to increase in the very near future the capacity of the wind power plants to 5 MW, 7.5 MW, 8 MW or even 10 MW [12], [13]. For this, it is necessary to implement the reduction of taxes, in all fields, which are largely unjustified, the development of research to obtain the most reliable models, the reduction of the risk of high wind speed destruction, the efficient electricity storage systems and overload protection.

If we think that building a house, instead of roofing the roof, we could place solar panels, which could reduce the energy costs of that dwelling, if the arid or non-agricultural fields could be covered with "planting" of solar panels, which would bring a "harvest" of MW of electricity, which would make these lands profitable, and, due to the fact that this energy is non-polluting, then we understand how important this energy is.

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