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RENEWABLE ENERGY SOURCES IN THE ENERGY DEVELOPMENT STRATEGY OF THE REPUBLIC OF SERBIA UNTIL 2040 WITH PROJECTIONS UNTIL 2050

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Abstract:

The energy transition is a process that requires a comprehensive transformation, first of all, of the economy and society, which necessarily aims at achieving a very significant reduction of the negative anthropogenic impact, primarily of the energy sector, on nature, the living and working environment. Special attention is paid to the reduction of greenhouse gas emissions. The process of energy transition requires first of all the use of new technologies, procedures and materials, which rely on innovation, digitization, digital integration and smart management of energy processes using artificial intelligence. Investments of significant material resources, resources of another kind and a change of consciousness of all subjects in the energy sector, but also in society as a whole, are needed. New geopolitical circumstances in the first half of the 21st century indicate that, in addition to goals such as: energy transition and improvement of the state and system of environmental protection, improvement of energy security, achieving energy independence and economic sustainability, the most important goals of the energy policy of the Republic of Serbia remain.

Keywords: Energy transition, innovation, digitization, digital integration

Introduction

The use of energy from renewable sources is in the public interest of the Republic of Serbia and is of particular importance for the Republic of Serbia. The law on the use of renewable energy sources regulates the use of energy from renewable sources, the objectives of the use of energy from renewable sources, the method and methodology of determining the share of renewable energy sources of the Republic of Serbia in the gross final energy consumption. In this way, the process of integrating energy from renewable sources into the market is enabled, the incentive systems for the production of electricity from renewable sources are regulated, and the method and procedure for realizing the

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guarantee of the origin of electricity. It is especially important that the production of electricity from renewable sources for self-consumption be clearly and precisely defined due to the implementation of incentive measures. The use of renewable energy sources in the field of thermal energy and the field of traffic represent very significant areas where enormous amounts of energy are consumed in the modern information society. Special procedures related to the construction and connection of energy facilities that use renewable energy sources must be clearly and precisely defined for easier implementation in the energy system of the Republic of Serbia. The provisions of the law regulating the field of energy in the Republic of Serbia are applied to all questions from the field of energy related to renewable energy sources that are not regulated by the Law on the Use of Renewable Energy Sources.

1. Biomass in the Energy Development Strategy of the Republic of Serbia until 2040 with projections until 2050

Serbia's energy industry is facing fundamental structural changes that are conditioned by both global and national circumstances, i.e. economic, technological and environmental changes and internationally and nationally accepted development goals. During the second half of the 20th century and in the first decades of the 21st century, the energy system of the Republic of Serbia represented a safe support for economic and social development, and in order to remain so in the future, it must fundamentally change and adapt to economic and social development, especially in terms of sustainability.

Regulation of the use of energy from renewable sources in the Republic of Serbia includes measures and activities undertaken to achieve long-term goals, namely:

- 1) Reducing the use of fossil fuels and increasing the use of renewable energy sources in order to protect the environment;
- 2) Long-term reduction of dependence on energy imports;
- 3) Creation of new jobs and development of entrepreneurship in the field of renewable energy sources;
- 4) Encouraging research, innovation and competitiveness in the field of using renewable energy sources;
- 5) Digitization, simplicity, economy and efficiency of procedures in the field of renewable energy sources;
- 6) Integration of electricity from renewable sources into the electricity market, which includes the exposure of electricity producers to

changes in market prices of electricity in order to maximize their market income;

- 7) Ensuring the stability of the electricity market while taking into account the costs of integrating renewable energy sources into the system and the stability of the network;
- 8) Regional development of the use of renewable energy sources;
- 9) The stability of the incentive system and the application of operational state aid in the form of a market premium, except for small plants and demonstration projects;
- 10) Allocation of incentives through auctions in a public, transparent, competitive and economic manner, without discrimination, which ensures a high degree of project realization, except in the case of small plants and demonstration projects when incentives do not have to be awarded through auctions;
- 11) Sustainable and independent development through the maximum use of national scientific-research, technological-development and human capacities in the planning process of increasing the use of renewable energy sources. [3]

Domestic production of primary energy includes exploitation/use of domestic resources of coal, crude oil, natural gas and RES (hydropotential, geothermal energy, wind energy, solar energy, biomass). Production of primary energy in Serbia in 2021 amounted to 10,186 Mton. The import of primary energy (including electricity) in 2021 amounted to 7,251 Mton. The necessary additional quantities of crude oil and oil derivatives, natural gas and coal are provided by import. The largest share in imports, at 56%, was crude oil and oil derivatives, followed by natural gas 26%, coal 9%, electricity 8% and biomass less than 1%. The total available energy in 2021 was 16,251 Mton.

2. Situation in the biomass sector in the Republic of Serbia

Biomass is a renewable source of energy that can be used as a substitute for fossil fuels in the production of heat and electricity. Unlike fossil fuels, burning biomass does not increase the amount of CO_2 in the atmosphere, and therefore has a positive impact on the environment. The current state of the renewable energy sector in Serbia is very bad, although Serbia has good potential for development in this field. For example, the total energy potential of biomass in Serbia is approximately 2.7 million tons, which is more than the total consumption of oil in Serbian agricultural production. Of that, about 1.7 million tons lie in the remains

of agricultural production and about 1 million tons in wood biomass. The analysis of the biomass structure from the remains of agricultural production shows that more than half of the resources lie in corn biomass, more than a quarter in the straw of small grains, primarily wheat, and the rest of about 15 percent in the harvest residues of sunflower, soy, rapeseed or pruning residues of orchards and vineyards. On the other hand, the potential of forest biomass as another important biomass resource in Serbia lies in the processing of around 1.5 million cubic meters of forest growth per year in the form of cuttings, steaks, bark, sawdust, etc. The third important biomass resource in Serbia is biogas, created from remains of animal origin. With almost one million head of cattle, one and a half million sheep, two million pigs and almost ten million poultry, Serbia has the potential to produce so much biogas that it can replace about 20% of imported natural gas. It remains to be determined what potential lies in the more rational use of the existing approximately 3 million hectares for partial sowing of energy plants, as well as the use of the remaining half a million hectares, which for various reasons are currently not being used in Serbia. Although there is no single strategy for the use of biomass in Serbia, and the opinions of experts differ, there seems to be a consensus around the fact that it is not advisable to use all biomass for energy needs, but that it would be useful to consider the possibility of using a part of it. Thus, the fact that using only one quarter of the estimated potential for energy production would save the equivalent amount of diesel fuel used in the entire agricultural production in Serbia speaks convincingly in favor of the need for further development of procedures and methods for more rational use of biomass. It seems that the awareness among decision-makers has matured that the lack of legal and technical regulation in the field of renewable energy sources and especially biomass, and the lack of incentives, are the main problems of development. This is evidenced by the recently adopted Regulation on incentives for privileged producers of green energy, which also includes biomass. More significant use of renewable energy also stands as an international obligation of Serbia, so it is clear that this sector will have to be given more attention in the future. In their paper [4], Brkić and Janjić estimated the amount of agricultural biomass in AP Vojvodina at around 6 million tons per year (Table 1), noting that it has decreased by 30 to 40% compared to earlier periods, primarily due to changes in the sowing structure.

Energy entities that use biomass as a renewable energy source in the Republic of Serbia, especially the sector that uses biogas in the Republic

of Serbia and especially the owners of biogas power plants, based on the past experience in the Republic of Serbia, which amounts to more than 12 years, coincided with this period and the period of subsidies for the delivered quantities of electricity. The owners of biogas power plants have gained the necessary experience in plant management, they have established logistics chains for the procurement of raw materials and waste disposal, they have reached a solid level of efficient work, and they still have all the necessary infrastructure at their disposal. By the decision of the Executive Board "EPS" A.D. Belgrade, the possibility of extending the incentive period for privileged producers of electricity from biogas was introduced. This means that the existing Agreements on the purchase of electricity from biogas, which were originally valid for 12 years, are extended for an additional 8 years, and biogas plants will have the chance to be in subsidized production mode for a total of 20 years. On the example of Germany, which made the biggest penetration of biogas technologies in Europe, by building around 14,000 biogas plants with a total power of around 5GWe, it was made possible, among other things, by the favorable duration of the incentive period of exactly 20 years. First of all, insufficient utilization of substrate and digestate. The owners of biogas plants, who do not have enough agricultural land in their possession, are forced to spread a part of the digestate free of charge on the surrounding plots of other farmers. Even when they have enough plots, the logistical requirement is huge (required time, manpower, machinery, fuel and its drive). Very often, the surrounding farmers are not even willing to compensate, even partially, the value of the organic fertilizer delivered to them through the digestate. The owners of biogas plants spread the digestate at their own expense, if the surrounding farmers are willing to accept it. The gradual introduction of the EU Nitrate Directive (91/676/EEC) in the Republic of Serbia will limit the permitted amount of nitrogen introduced into the soil. This will further complicate the situation, because the cooperation with the surrounding farmers will have to be intensified or even initiated, in order to distribute the digestate on agricultural land according to the regulations.

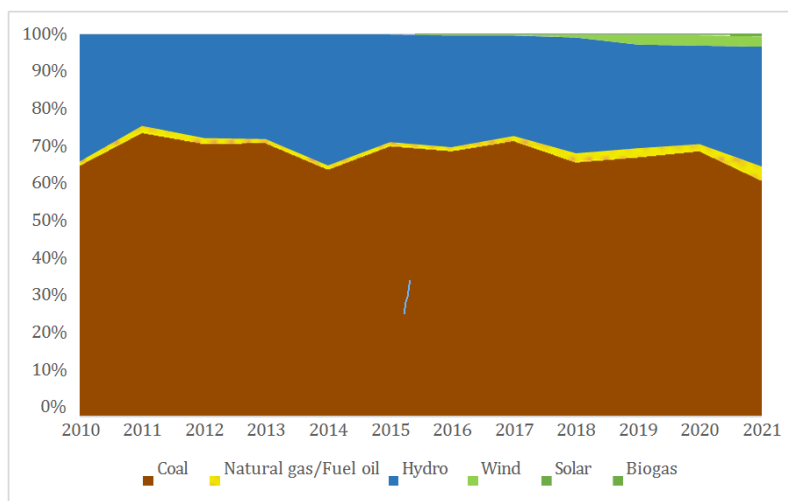
The effect of cogeneration of biogas plants (simultaneous use of electricity and thermal energy) is practically not realized or is a rare exception in the biogas sector in the Republic of Serbia. The reason is the high initial investment, and the seasonal character of use, if the owner of the biogas plant needs to realize the investment himself, which in that case is often not economically justified. Even in addition, it is incomprehensible that there is not a significant number of facilities that have found a solution for

the use of thermal energy in cooperation with commercial and private entities in their surroundings. Although it would fall into the domain of perspective, i.e. achievable only in the future, the carbon dioxide that remains after burning biogas, is another by-product, and also a potential resource. Carbon storage technologies are under development and are considered very important for the future even when they enable the reuse of carbon dioxide originating from renewable sources.

Table 1: Biomass production in agriculture in the AP Vojvodina (2003 - 2007) [1]

Culture	Surface (ha)	Biomass yield (t/ha)	Mass of biomass (t/year)
Wheat	297.403	3,766	1.120.074
Rye	1.474	3,056	4.506
Barley	47.921	3,234	154.964
Oats	5.179	2,344	12.140
Maize (stalk+cob)	636.728	5,165	3.288.447
Sunflower (trunk + head)	171.489	4,565	680.714
Sunflower (husk)	-	0,595	102.107
Soy	127.856	4,852	620.358
Canola oil	4.204	4,180	17.572
Tobacco (tree)	4.321	0,516	2.230
In total	1.296.575	4,630	6.003.112

This fact is important, because it is known that energy from biogas, obtained by anaerobic fermentation, has low carbon footprint values (CO_2 equivalents per energy unit), especially when manure is used as raw material.



Picture 1. The structure of electricity generation in the Republic of Serbia [3]

Table 2: Overview of total available technical potential of RES in the Republic of Serbia*

Renewable energy source		Unit	Total available technical potential
BIOMASS		Million toe/year	3.196
<i>Agricultural biomass</i>		Million toe/year	1.037
<i>Parts in fruit growing, vine growing and fruit processing</i>		Million toe/year	0.134
<i>Processing industry</i>		Million toe/year	0.030
<i>Liquid manure</i>		Million toe/year	0.074
<i>Wood (forest) biomass</i>		Million toe/year	1.668
<i>Biodegradable municipal waste</i>		Million toe/year	0.026
<i>Biodegradable waste (except municipal waste)</i>		Million toe/year	0.043
<i>Biofuels</i>		Million toe/year	0.043
HYDROPOWER		Million toe/year (GWh/year)	1.547 (18,000)
WIND POWER		Million toe/year (GWh/year)	2.593 (30,152)
SOLAR POWER - PV		Million toe/year (GWh/year)	2.622 (30,499)
GEOTHERMAL ENERGY	<i>For electricity generation</i>	toe/year (GWh/year)	309 (3.6)
	<i>For heat generation</i>	Million toe/year	0.33
TOTAL		Million toe/year	10.288

*The presented RES potentials represent a dynamic category, and the presented data are not limiting their use, except for the sustainable use of biomass, taking into account its annual increase. During the realization of the projects, the economic, environmental, spatial, and other aspects of RES use must be additionally considered. [3]

If technologies that can contribute the most to the decarbonization process are considered, biogas will have even greater chances. However, this aspect can be counted on if the appropriate conditions are prepared, primarily legal regulations, and then the participants themselves in the biomass or biogas sector. Despite some progress in the construction of new renewable energy capacities, the Republic of Serbia remains heavily reliant on fossil fuels. Coal is the most important domestic resource, particularly in electricity generation. The trend of changing energy source structures used in electricity generation from 2010 to 2021 is shown in Figure 1.

3. CONCLUSION

Achieving the goals of the energy policy in the coming period also implies important changes in all segments of the energy chain and in all energy sectors. The most significant expected changes are: intensive application of energy efficiency measures and reduction of specific energy consumption in all sectors of final consumption (households, industry, transport, agriculture, etc.); intensive application of energy efficiency measures and reduction of losses in production, transport/transmission and distribution of all forms of energy; construction of facilities for the production of electricity using natural gas; significant increase in electricity production using solar and wind energy; planned construction of capacity for storage of electrical and thermal energy obtained from RES (reversible hydroelectric power plants, batteries, etc.); increasing the share of electricity obtained from RES in energy consumption (industry, transport, households, public and commercial sector); the use of other technologies that contribute to the energy transition, in accordance with the degree of their commercialization, such as the production of green hydrogen, the collection, storage and use of carbon dioxide, etc. Digitization of energy processes and digital integration of all elements of the energy chain while respecting digital security norms, including the application of smart systems for energy management, blockchain technology with significant participation of research activities and innovations, in order to achieve the necessary technological development and apply the best available technologies.

REFERENCES

- [1] Brkić, M., Janić, T.: Nova procena vrsta i količina biomase Vojvodine za proizvodnju energije, *Savremena poljoprivredna tehnika*, Vol. 36, No. 2, str. 178-188, 2010.
- [2] Gvozdenac, D., Nakomčić-Smaragdakis, B., Gvozdenac-Urošević B.: *Obnovljivi izvori energije*. Edicija tehničke nauke – udžbenici.: FTN, Novi Sad, 2010.
- [3] *Strategy of the development of the energy sector of the Republic of Serbia until 2040 with projections until 2050*, "Official Gazette of the Republic of Serbia", No. 94 of November 28, 2024.