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## THE IMPORTANCE OF RENEWABLE ENERGY SOURCES FOR SUSTAINABLE DEVELOPMENT

### Abstract

*The accelerated development of the global economy is leading to increasing consumption of natural resources. The exploitation of resources is moving at an accelerated pace, while their availability is decreasing. The biggest problem is the depletion of non-renewable and limited resources that are the carriers of the raw material base of energy and manufacturing industry, which calls into question the preservation of energy stability and efficiency at the global level. Uncontrolled industrial growth, accompanied by increasingly intensive depletion of non-renewable natural resources, especially fossil fuels, has caused enormous pollution of the environment and the entire planet. In the conditions of depletion of natural resources, negative climate changes accompanied by global warming and a serious threat to the survival of life, it is necessary to adopt and implement the concept of sustainable development. The concept of sustainable development explicitly aims to achieve optimal economic results, while preserving and improving the environment and the social component of development. Natural resources play an extremely important role in achieving economic growth and development. The aim of this paper is to point out the importance of renewable energy sources for achieving sustainable development. It is necessary to investigate the importance of renewable and non-renewable natural resources, as well as the factors that affect their exploitation, with the aim of successfully implementing the concept of sustainable development.*

**Key words:** *sustainable development, renewable and non-renewable natural resources, optimal use of natural resources, environmental protection*

**JEL classification:** *Q20, Q40, Q50*

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## ЗНАЧАЈ ОБНОВЉИВИХ ИЗВОРА ЕНЕРГИЈЕ ЗА ОДРЖИВИ РАЗВОЈ

### Апстракт

*Убрзани развој глобалне економије доводи до све веће потрошње природних ресурса. Експлоатација ресурса креће се убрзаним темпом, док се њихова расположивост све више смањује. Највећи проблем представља исцрпљивање необновљивих и ограничених ресурса који су носиоци сировинске базе енергетике и прерађивачке индустрије, чиме се доводи у питање и очување енергетске стабилности и ефикасности на глобалном нивоу. Неконтролисани индустријски раст праћен све интензивнијим исцрпљивањем необновљивих природних ресурса, посебно фосилних енергената, проузроковао је енормно загађење животне средине и читаве планете. У условима исцрпљивања природних ресурса, негативних климатских промена праћених глобалним загревањем планете и озбиљним угрожавањем опстанка живота, неопходно је усвајање и имплементирање концепта одрживог развоја. Концепт одрживог развоја експлицитно поставља за циљ постизање оптималних економских резултата, уз истовремено очување и унапређење животне средине и социјалне компоненте развоја. Природни ресурси имају изузетно важну улогу у остваривању економског раста и развоја. Циљ овог рада је укаже на значај обновљивих извора енергије за остваривање одрживог развоја. Неопходно је истражити значај обновљивих и необновљивих природних ресурса, као и фактора који утичу на њихову експлоатацију, а са циљем успешне имплементације концепта одрживог развоја.*

**Кључне речи:** *одрживи развој, обновљиви и необновљиви природни ресурси, оптимално коришћење природних ресурса, заштита животне средине*

### Introduction

Classical economic theory analyses economic growth based on the observation of several key factors of economic policy, including savings, investments, technical-technological research and development, education, population growth, free trade, etc. In traditional economic thought, an important indicator of economic growth and development is precisely the size and movement of gross domestic product.

Faced with the real problem of depletion of non-renewable and limited resources, global warming of the planet and general pollution and endangerment of the environment, there have inevitably been changes in the understanding of economic growth and development. In addition to economic growth, environmental protection is equally important, above all, from the point of view of corporate responsibility. We are witnessing a growing interest in the efficient use of natural resources and environmental protection. In the fields of economic theory and policy, efforts are being made to harmonize economic and environmental interests and to find more adequate instruments for encouraging sustainable social development.

Radukić & Petrović-Ranđelović (2019) point out that "natural resources are the basis for the development of human society for at least three reasons. First, the availability

of natural resources is the basis for the development of many human activities. Second, the environment is a complex asset that provides numerous services, but also a type of special asset that provides human existence. Third, the environment performs some other indispensable functions that are vital to ensuring quality of life, such as stabilizing the global climate or filtering harmful ultraviolet radiation from the stratospheric ozone layer" (pp. 34-35). Furthermore, these authors indicate that the one of the most important preconditions for achieving sustainable development is economically efficient management of natural resources.

Thus, in order to apply the principles of sustainable development, it is necessary to monitor environmental changes caused by economic activity, i.e. economic activity must be sustainable. On the one hand, there is no possibility of increasing the amount of non-renewable natural resources, i.e. renewal, so the problem of the optimal use of these resources is reflected in finding the optimal rate of depletion, i.e. optimal rates of resource exploitation. On the other hand, the economic analysis of renewable resources indicates that the economically efficient use of resources should be compatible with environmental sustainability.

However, free access to these resources leads to their overexploitation. In the case of renewable resources, it is important that exploitation takes place at a level that will not jeopardize the renewal of resources and that a sustainable rate of return is achieved. A combination of regulatory and market mechanisms is needed to simultaneously achieve sustainable yields and renew depleted resources. Achieving the concept of sustainable development is possible through the rational use of non-renewable and the increased use of renewable natural resources. Therefore, the analysis of the role of resources in the process of sustainable development is very important.

The subject of research of this paper is to consider the importance of the use of renewable natural resources, primarily renewable energy sources and their place and role in achieving the concept of sustainable development. The group of renewable resources includes natural or biological funds (forests, fisheries fund, etc.), which belong to the group of depletable resources, and energy flows (solar energy, hydropower, wind energy, etc.), which are considered inexhaustible resources. Having in mind the problem of limited non-renewable natural resources, as a potential limitation of the future growth and development of modern economies, the alternative would be renewable energy. Biological funds have the possibility of natural growth or quantitative regeneration, so that their use can be analysed from static and dynamic aspects in order to achieve the optimal rate of exploitation and to prevent the uncontrolled use of resources. There is a practically unlimited possibility of using energy sources, so the goal is to increase the use of these sources as much as possible in the future.

Energy is a fundamental production input in modern economy. At the same time, the accelerated development of world economy is accompanied by increasing energy consumption. It is inevitable to increase energy production in order to meet the growing needs of humanity.

Classical energy sources are based on the use of non-renewable natural resources. Certainly, fossil fuels (coal, oil, natural gas) are of the greatest importance, and they took millions of years to create. Given that these are non-renewable natural resources, their quantity is quantitatively limited and humanity is faced with a real problem of potential depletion of the reserves of these and other non-renewable natural resources. Also, a big

problem is the fact that the use of non-renewable natural resources as energy sources greatly pollutes the already disturbed environment.

Renewable energy sources represent the so-called "clean energy sources". Their use contributes to the preservation of the environment and the satisfaction of energy needs, which is the basic goal of the concept of sustainable development.

The positive characteristics of renewable natural resources are the following: renewability – the sources are quantitatively unlimited, they represent the so-called clean energy sources, environmental protection, reduction of carbon dioxide (CO<sub>2</sub>) emissions into the atmosphere, gradually becoming competitors in non-renewable energy sources. The main advantage of renewable energy sources over non-renewable ones is their renewables.

The structure of this paper is as follows. After introductory considerations, the second part gives a brief review of renewable energy sources as a factor of sustainable development. Possibilities of using alternative energy sources in the Republic of Serbia are considered in the third part of the paper, followed by concluding remarks.

## **1. Renewable energy sources as a factor of sustainable development**

Energy stability and efficiency are crucial for successful functioning of modern economies. Renewable energy sources (solar energy, wind energy, water flow energy, biomass, etc.) are gaining in importance with a clear tendency to increase their share in total energy production and consumption.

Solar energy is one of the most important renewable energy sources. Starting from the total annual needs for electricity at the level of the entire planet, the solar energy that reaches the Earth in one year is about 10,000 times higher than the total planetary energy needs. This fact clearly indicates the potential of solar energy and possibilities of satisfying the energy needs of humanity.

Approximately 1kW/m<sup>2</sup> of insolation can be obtained on the Earth's surface under optimal conditions. The values of insolation (the length of solar radiation during the day) depend on a number of factors: location, season, climate, etc. The duration of insolation and the inflow of solar energy are not proportional, because part of solar energy is lost through the passage of the sun's rays through the atmosphere and the absorption of oxygen, carbon dioxide and ozone. Also, radiation energy itself is dissipated by passing through the atmosphere. The use of solar energy, as an energy source, implies the use of solar energy when it reaches the Earth.

This energy represents a huge energy potential. Namely, if we compare the energy of the Sun when it reaches the Earth with the total coal reserves in the world, it is about 170 times higher. Due to the great potential of solar energy, it is necessary to consider the techniques of its use. The use of solar energy implies the following direct principles of using solar energy (Energetski portal, 2020): passive techniques, solar collectors (conversion of solar energy into heat), photovoltaic cells (direct conversion of solar energy into electricity) and focusing solar energy (for use in large power plants).

Passive techniques are the simplest way to use solar energy. A common example is the use of solar energy to heat a greenhouse space. The passive technique of using solar

energy means that the process of using solar energy is based on spontaneous natural processes. There is no electricity investment and this technology is 100% environmentally friendly. With such a passive technique, combined with active solar technology, heating systems ideal for residential areas can be constructed. Solar collectors absorb solar energy and convert solar energy into heat. These systems contribute to the preservation of the environment and achieve significant energy savings. The degree of conversion of solar energy into heat is extremely high (and ranges up to 70%). Extremely large economic savings can be achieved by combining water and air heating through solar collectors. The smallest collectors are about 2m<sup>2</sup> in size. They are enough to heat water for the average household. It is common for solar energy absorbed in this way to be combined with some other energy source to ensure the availability of hot water throughout the year.

It could be noticed that one of the most economical ways of using solar energy for water heating is achieved through solar collectors, primarily in households. Photovoltaic (solar) cells enable the direct conversion of sunlight (energy) into electricity. These cells function on the principle of the photoelectric effect. Photovoltaic cells are very thin plates of silicon crystals with an admixture of arsenic. Exposed to sunlight, they act as a semiconductor junction. The solar cell industry is one of the fastest growing industries in the modern world. However, the disadvantage is the small degree of the use of solar energy, only about 15%. This industry was developed in Japan and then in other parts of the world. In order to achieve a significant percentage of the use of solar energy in the production of electricity, at least two more decades of technical and technological progress and the improvement of photovoltaic cells are necessary. Solar energy is focused with the help of a mirror or lens. Otherwise, it is used to drive large generators. This way of using solar energy requires a large space for the power plant. For that reason, they are most often built in deserts, where the sun's radiation is the largest and most pronounced.

The data from the Ministry of Mining and Energy (2020) show that the Republic of Serbia has a significant solar potential that is greater than in most European countries. However, this energy potential is completely untapped, because solar electricity is very expensive and thus uncompetitive. So far, solar energy in the Republic of Serbia has been mostly used for heating water in households. The utilization of this energy for the production of electricity is very small, so this renewable energy source in our country is practically unused.

As a source of energy, solar radiation is more favourable than wind energy in the sense that it is more predictable, but it is less favourable in the sense that there is no solar radiation during the night. Also, during the winter, the sun's radiation is less intense, and energy consumption is the highest in that period. Since there is no solar radiation during the night, plants that use solar energy can only work during the day, so additional plants would have to be built to ensure the accumulation of energy and the supply of the same during the night.

Wind energy is used to produce electricity with the help of windmills that are set up and distributed so as to form the so-called "wind parks". When using wind energy as an alternative energy source, it is necessary to perform detailed spatial microlocating before deciding to build a wind farm. In order to assess the wind energy potential in an area, it is necessary to perform a detailed analysis of the type of wind and wind speed. There must be adequate speed of wind in order to design a wind farm at the rotor

axis height. With aeolian power plants, there is a high reliability of the plant, also the production is completely ecological and there is no environmental pollution. However, the disadvantages are high construction costs and variability of wind speed. For this reason, the continuity of energy supply cannot be guaranteed.

Thus, production is of a variable nature and cannot be fully predicted. Also, the price of electricity obtained in this way is quite high, up to 10 times higher than that produced in thermal power plants. The United States and the European Union have compiled atlases of their wind resources based on detailed wind studies. These atlases were made for a wind speed of 45m above the ground. During the last decade, the popularity of using wind energy to generate electricity has grown rapidly. Great popularity of this renewable energy source makes this production an equal member of the electricity system of certain European countries. Denmark and Germany represent a typical example. The estimates of the Hydrometeorological Institute of Serbia (2020) are that the Republic of Serbia has a significant potential for aeolian energy, especially in some parts of Vojvodina and Eastern and Southern Serbia.

Energy of water currents (hydropower), as an alternative energy source, includes all possibilities of obtaining electricity from: inland watercourses (rivers, streams, and canals), sea waves, tides, internal energy of the sea and the ocean, and geothermal energy. Hydropower has been the most important renewable energy source in terms of commercial use so far. The electricity produced using hydropower represents about 96% of the energy produced by all renewable sources in the Republic of Serbia (Nacionalna strategija održivog korišćenja prirodnih resursa i dobara, 2012). Electricity is produced in hydroelectric power plants using hydropower. Modern hydroelectric power plants have an extremely high degree of water energy utilization and even about 90% of water energy can be converted into electricity. Small hydropower plants with the capacity of 5–10 MW do not have a significant impact on the environment. However, in large hydropower plants, where entire areas around hydropower plants may be submerged, there is a significant impact on the environment. Due to the flooding of large areas, submerged plants may go rotten and methane may be released, and there is also local climate change, etc.

For the Republic of Serbia, the most important renewable energy resource is the hydro potential. It is estimated at 17,000 GWh per year. In Serbia, there are about 1,000 locations attractive for the construction of small hydropower plants (ESCO Beograd, 2020).

Also, the movement of water under the action of the Moon and the Sun creates the energy of tides and it can be used as a renewable energy source. It is not possible to produce electricity only by using tides. It is necessary to combine it with another way of obtaining electricity. Namely, the energy obtained by using tides is not constant and thus cannot be an autonomous system of obtaining electricity. Power plants that use tidal energy to generate electricity must be connected to the power system, where there are power plants that have the total power several times larger than a power plant that uses tidal energy. Economic analyses show that only 2% of the total tidal energy is usable, and in real production only about 20% of theoretically estimated production possibilities can be used in the most favourable circumstances (Nacionalna strategija održivog korišćenja prirodnih resursa i dobara, 2012).

Geothermal energy can be used for heating and electricity generation. Geothermal energy comes from the heat of the Earth, which is located in porous rocks. The advantages

of this energy source are both economic and environmental. From an economic point of view, the costs of energy exploitation are the lowest. Also, exploitation does not ecologically damage the environment and this energy is ecologically clean. Geothermal energy is one of the most expected forms of renewable energy. In America, large funds are being invested in the research of geothermal sources and the development of new technologies for the exploitation of geothermal energy. The estimated potential of this energy for Serbia shows that it could replace about 3 million tons of oil a year (Gulan, 2020). Regarding the natural phenomena in Serbia, 160 natural sources with over 15 degrees Celsius have been registered (Matić, 2018).

There are several hundred geothermal water wells on the territory of the Republic of Serbia. For now, they are used primarily for spa tourism and bottling. However, the use for heating and electricity production is insignificant.

Biomass represents a renewable energy source. Biofuels are obtained from certain vegetable crops (oilseed rape, soybean, and sunflower vegetable oils) and they are an ecological alternative to fossil fuels because they give less greenhouse effect, release less carbon dioxide and other harmful gases. However, the areas used for planting these crops reduce the area of agricultural land and thus directly affect the possibility of food production.

In modern conditions, humanity is facing increasing needs for both food and fuel. The use of biomass (wood biomass - briquettes, sawdust, twigs, logs and agricultural biomass - straw, manure, liquid manure, and residues of agricultural and field crops) as a renewable energy source has a number of benefits, but it is extremely important that it allows obtaining energy that can be redistributed to other areas. Briquettes are produced from wood residues. The use of briquetting provides great opportunities, primarily in agriculture, forestry and wood industry. The production of biogas from liquid manure is practiced in the United States and Austria. Liquid manure is collected on large farms, and it is possible to get electricity or heat. This type of biogas production has not been practiced in the Republic of Serbia. Otherwise, biomass represents the most significant energy potential in our country. The Republic of Serbia has 5.06 million hectares of agricultural land, out of which 71% is used intensively (in the form of arable land, orchards and vineyards), as well as 2.25 million hectares of forests, which makes 29.1% of the total area (Strategija poljoprivrede i ruralnog razvoja Republike Srbije za period 2014-2024. godine, 2014).

## **2. Possibilities of using alternative energy sources in the Republic of Serbia**

The use of renewable energy sources contributes to increasing energy stability, i.e. the stability in energy supply, which is extremely important especially in situations of energy crises. Also, the use of renewable energy choices contributes to the security of national economies, increases energy efficiency, but also improves their competitive performance.

Alternative energy sources are used more and more, but their share in total energy production is still small. It is for this reason that the EU has set a target that 20% of electricity must come from renewable energy sources (Milenković, 2017). By signing the

Agreement on the Establishment of the Energy Community of Southeast Europe and the EU in 2006, the Republic of Serbia accepted the obligation to implement the prescribed directives related to the use of renewable energy sources. Also, in 2007, the Republic of Serbia ratified the Kyoto Protocol. The Energy Development Strategy of the Republic of Serbia envisaged that by the end of 2015, the share of renewable energy sources in total final consumption would increase to some 1.5% -2%. Otherwise, the potential of energy from renewable energy sources in the Republic of Serbia is such that it could meet about 25% of the annual needs of the population and the economy. The Republic of Serbia has a lot of quality renewable energy sources (solar energy, hydropower, wind energy, geothermal energy). To achieve the increased use of renewable energy sources, as a strategic goal of the Republic of Serbia, it is necessary to rely on those energy sources that have the greatest potential, namely the following energy sources: biomass, small watercourses, wind energy, geothermal energy and solar energy. Serbia has a total of about 4 million toe (tons of oil equivalent) of renewable energy potential. The potential of solar energy is about 640,000 toe, geothermal energy about 185,000 toe, wind energy about 160,000 toe, small hydropower plants about 440,000 toe (or 1747 GWh), biomass 2.68 million toe (out of which agriculture 1.6 million toe, and forests 1 million toe) (Djajić, n.n.).

Economically developed countries have already achieved significant results in the use of renewable energy sources. According to the data of the Euractiv portal (2020), in the EU member states, in the first half of 2020, the amount of electricity produced from renewable sources exceeded the amount of electricity produced from non-renewable sources. About 34% of electricity was obtained from fossil fuels and about 40% of electricity from solar, aeolian and hydropower. In Denmark, about 64% of electricity is produced from aeolian and solar energy. In the EU member states, the use of fossil fuels for electricity generation has significantly decreased. For example, in Spain, the use of coal for electricity production has been reduced by about 60% and in Portugal by impressive 95%. In the field of using aeolian energy, China has the installed wind power capacity of 221 GW, which in relation to the Republic of Serbia represents 31 times more than the installed power capacity of the entire electric power system of Serbia.

The importance of renewable energy sources was also recognized by the company Apple (2020), which created a business policy company so that it does not use carbon energy in the work of its centres until 2030. The company announced the construction of 200m high wind turbines that should produce 62 Gw/h of energy per year and which, according to the official announcement of this company, would be enough to meet the needs of about 20,000 households, which will be the second largest wind farm in the world.

The power supply in the Republic of Serbia is predominantly from thermal power plants (about 70%) and the rest of the electricity is obtained from hydropower plants. In order to implement the concept of sustainable development in the Republic of Serbia, intensive work has been done in recent years on the integration of renewable energy sources into the electricity system of Serbia. Kovačica wind farm with the installed capacity of 104.5 MW was opened in 2019. As a result, the installed wind capacity increased to 171.6 MW, and about 370 MW is in the construction and trial production phase. At the beginning of 2020, the Electric Power Industry of Serbia announced the planning and construction of a 97.2 MW solar power plant.

In the field of sustainable use of natural resources, the European Union established the Strategy for Sustainable Use of Natural Resources in 2005. This strategy emphasizes the



place and role of the Member States in achieving the objectives set out in the strategy as well as the actions to be taken at the national level. The Republic of Serbia adopted the National Strategy for Sustainable Development of the Republic of Serbia in 2008, and it represents the broadest policy framework in the field of sustainable use of natural resources. The National Emission Reduction Plan (NERP) was adopted on 31<sup>st</sup> January 2020 with the aim of reducing pollutants originating from old combustion plants. In the Energy Development Strategy of the Republic of Serbia until 2025 with projections until 2030, the Communication "Energy Roadmap 2050" is stated, issued by the European Commission at the end of 2011. It proposed the transformation of the energy sector, which set the goal of reducing greenhouse gas emissions by 2050 from 80% to 95% below the emission levels in 1990.

In the last few years, a whole set of strategic documents in various areas has been adopted, with a large number of them directly related to natural resources. These are strategic documents in the field of agriculture, forestry, energy, introduction of the cleaner production in the Republic of Serbia, etc. However, numerous issues remain open in the field of harmonization of individual solutions from strategic documents with solutions from the National Strategy for Sustainable Development. Serbia must also improve its records on renewable energy sources and take a responsible and cost-effective approach to exploiting the available energy potential provided by renewable energy sources, with the aim of achieving the concept of sustainable development. However, these potentials have not been sufficiently explored and there are no precise studies on the physical and economic estimates of the energy potential of these sources.

## Conclusion

Successful implementation of the concept of sustainable development requires the efficient and optimal use of natural resources. Renewable energy sources are "clean" and practically inexhaustible energy sources. The main goal in achieving optimal economic development is to increase the use of renewable energy sources and increase the economic efficiency of their use. The use of these energy sources contributes to the increase in energy stability, the stability in energy supply, which is extremely important especially in situations of energy crises. It also contributes to the security of national economies and thus increases energy efficiency and economic competitiveness.

The Republic of Serbia has a significant solar potential that is higher than in most European countries. However, this energy potential is completely unused because solar electricity is very expensive and thus uncompetitive, and so far solar energy in our country has mostly been used for heating water in households. Over the last decade, the popularity of using wind energy to generate electricity has grown rapidly. The great popularity of this renewable energy source makes this production an equal member of the power system of certain European countries, such as Denmark and Germany.

The Republic of Serbia has a significant potential for aeolian energy, while hydropower has been the most important renewable energy source in terms of commercial use so far. Electricity produced using hydropower represents about 96% of energy produced from renewable sources in the Republic of Serbia. Also, biomass represents a significant energy potential.

Renewable energy sources represent the future of energy and one of the primary goals of sustainable development. Their use is increasing more and more, but their share in the production

of total energy is still small. The potential of energy from renewable energy sources in the Republic of Serbia could meet about 25% of the annual needs of the population and the economy.

The Republic of Serbia must improve its records on renewable energy sources and approach the use of available energy potential responsibly and economically. The economic development strategy emphasizes the use of renewable energy sources as one of the priorities of energy and energy development of the Republic of Serbia. The main aspiration is to achieve the reduction of import dependence and environmental pollution, as well as the improvement of economic development through the increased use of renewable energy sources.

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