

# OBNOVLJIVI IZVORI ENERGIJE, POTENCIJALI I PRIMENA U SVETSKIM OKVIRIMA I U SRBIJI

## RENEWABLE ENERGY SOURCES, POTENTIALS AND APPLICATIONS WORLDWIDE AND IN SERBIA

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*Oko 80% globalne potrošnje energije (struje i toplote) proizvede se sagorevanjem fosilnih goriva. Ovakav vid goriva je ograničen u svojoj količini, a nakon obavljenih alarmantnih podaka o posledicama emisije gasova sa efektom staklene bašte, koji nastaju upravo sagorevanjem fosilnih goriva, sve više država se opredeljuje za obnovljive izvore energije. Obnovljivi izvori energije se nalaze u prirodi i obnavljaju u celini ili delimično. Upotreba obnovljivih izvora energije se nameće kao vrlo prihvatljiva mogućnost u osiguranju energije za budućnost i za zaustavljanje dalje degradacije životne sredine.*

**Ključne reči:** obnovljivi izvori energije; energija; životna sredina.

*Approximately 80% of global energy use (electricity and heat) is produced by burning fossil fuels. The need for the use of renewable energy sources has surfaced over the past several decades since alarming data has been released on the effects of greenhouse gases emitted by combustion of fossil fuels, which are limited in nature. Renewable energy sources are in nature and are renewed in whole or in part. The use of renewable energy sources is imposed as a very acceptable option in providing energy for the future and for stopping further environmental degradation.*

**Key words:** renewable energy sources; energy; environmental.

### 1 Introduction

The most acute problem in terms of energy resources is the pace and how they are exploited and used. It is estimated by experts that the maintenance of current trends will lead to an increase by 2050 in terms of resource extraction up to five times higher than at present [1].

Based on the concept of sustainable development of human society, the current consumptions must be analyzed and predictions must be made on the trends in use of traditional energetic resources [1].

In addition to finite deposits of fossil and mineral fuels such as oil, gas, coal and uranium, the earth also offers various natural, auto-regenerative - or renewable - sources of energy that derive from sun insolation, geothermal activity and gravitational forces.

Theoretically, the global supply of energy from such renewable sources by far exceeds the earth's present total energy demand. The supply of energy is subject in part to pronounced technical and economic utility limitations, e.g., the disparity between the temporal/spatial demand for energy and the actually available supply of renewable energies, and the latter's modest power density compared to conventional energy vehicles.

The main renewable energy (RE) sources are:

1. Insolation, i.e., the direct radiant energy of the sun (made useful by collectors, solar cells, etc.)
2. Energy obtained from biomass; biochemical energy of photosynthetic products; made useful by:
  - burning (of wood, straw, etc.)
  - gasification (of wood, etc.)
  - anaerobic digestion (= biogas)

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- alcoholic fermentation
- 3. The kinetic energy of wind
- 4. The kinetic energy of moving water:
  - low-pressure systems
  - high-pressure systems
  - micro-hydropower plants
  - tides, waves, ocean currents
- 5. Miscellaneous
  - geothermal energy
  - thermal energy deriving from differences in seawater temperature
  - osmotic energy deriving from concentration gradients between salt water and freshwater.

Energy is closely linked to economic development and the quality of the environment. It is central to the world economy, providing the strength needed for industrial production, transportation and (increasingly) agriculture. Energy makes a major contribution to health, well-being and productivity, enabling the existence of services that include heating, lighting and cooling. The energy chain that provides these services begins by collecting or extracting a primary energy source - for example, coal - that can be transformed into another form of energy, such as electricity, transported or transferred to the point of use and eventually used to power some equipment as which is a heater, lamp or motor. Figure 1 shows an energy chain, which uses coal, as an energy source, as an example.

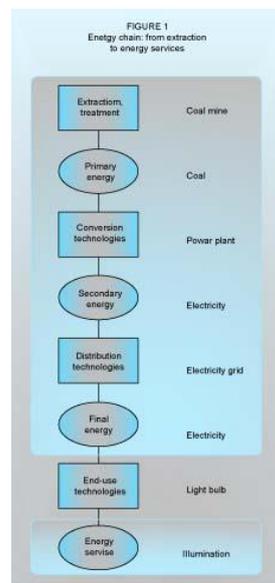


Figure 1. Energy chain: from exploitation to energy services

## 2 Energy production and distribution in world frames

Primary energy sources include fossil fuels (coal, oil, natural gas) and renewable sources such as biomass (wood, other plant sources, fertilizer), hydropower, solar energy, wind energy, tidal energy and geothermal energy. A small but significant part of the world's electricity is also provided by nuclear energy. The ways in which these primary sources are extracted, transformed, delivered and used have a huge impact on the environment locally and globally. They also have both positive and negative effects on human health. Figure 2 shows global primary energy sources and totals. Between 1973 and 1997, the total amount of primary energy used in energy production increased by almost 60%. Nuclear power plants, which were almost non-existent in 1973, provided more than 6% of the world's energy by 1997. Much of the primary energy is used to produce electricity, especially in the developed world.

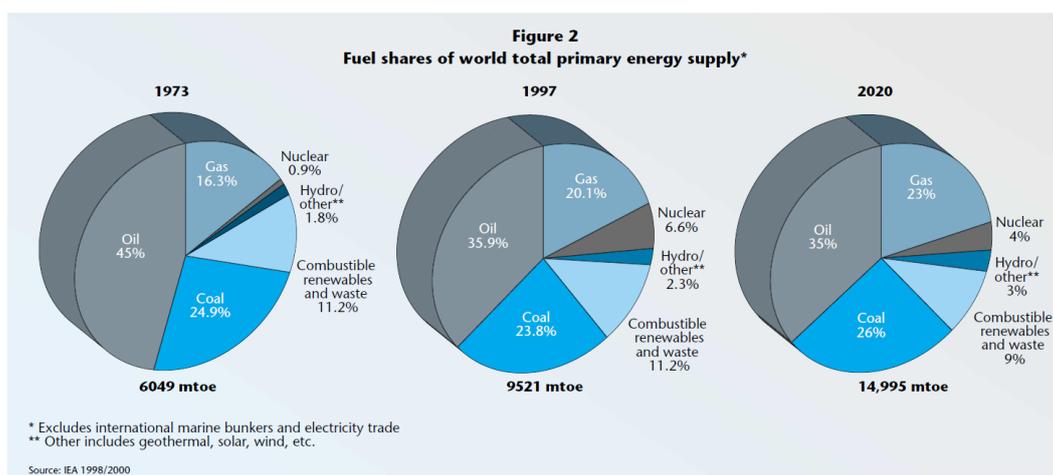


Figure 2. Share of fuel in total world primary energy consumption (source: IEA 1998/2000)

\* Other energy sources are: geothermal, solar, wind, etc.

The share of fossil fuels, renewables and nuclear energy in electricity generation is shown in Table 1. Estimates of future energy use are based on “as usual” scenarios, in which current trends continue [2]. There are huge differences in the primary energy resources of different countries and regions (Figure 3), as well as the way these resources are used (Figure 4) - for example, whether they are converted into secondary energy or consumed directly in the household [3]. Although less primary energy is used as a whole for transport than for energy production, transport is the most important oil-consuming sector [4].

Tabla 1. World electricity generation (source: IEA 1998/2000)

					Share of total, %*	
	1971	1995	2010	2020	1995	2020
Electricity generation (TWh)	5248	13204	20852	27326		
Solid fuels	2131	5077	7690	10490	38	38
Oil	1100	1315	1663	1941	10	7
Gas	691	1932	5063	8243	14	30
Nuclear	111	2332	2568	2317	18	8
Hydroenergy	1209	2498	3445	4096	19	15
Other renewables	5	49	154	239	0,4	0,9

In Africa traditional biomass energy sources provide roughly 37% of total energy used, with commercial sources providing the remainder [5]. However, there are huge variations among the different parts of Africa: biomass sources account for some 84% of all energy use in East Africa and the islands of the Indian Ocean, but only about 3% of that in North Africa [5].

In Europe and Central Asia there has been a transformation of the energy industries since the 1960s, when coal was the primary source of energy for electricity generation, industry and domestic heating in most parts of these regions [5]. In Western Europe oil, natural gas and nuclear power are now the primary sources for energy production, while Central and Eastern Europe and Central Asian countries have reduced their coal use and moved increasingly towards oil, natural gas, and hydro and nuclear power for electricity generation [5].

Two of Asia’s giant economies, China and India, rely heavily on coal and will continue to do so in the next few decades due to its abundance and easy availability [5]. West Asia (Iran, Iraq, Syria and the Arabian Peninsula) relies on its abundant oil and gas reserves for virtually all of its energy needs [5].

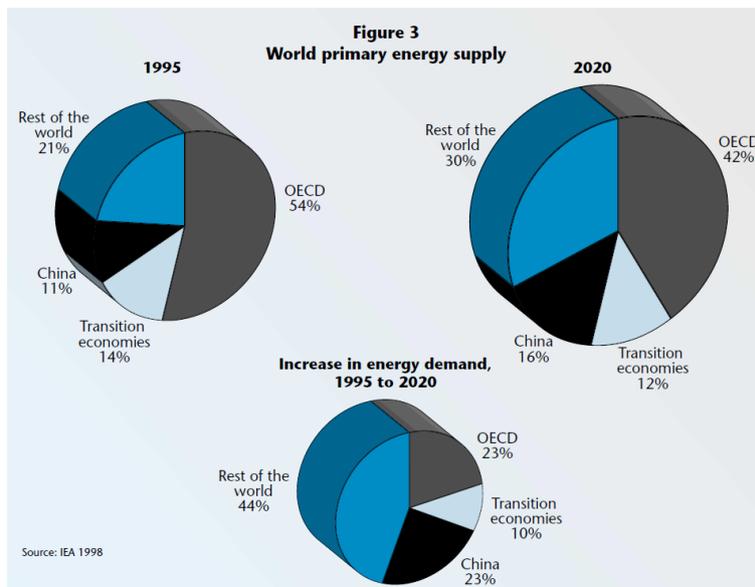


Figure 3. World primary energy supply

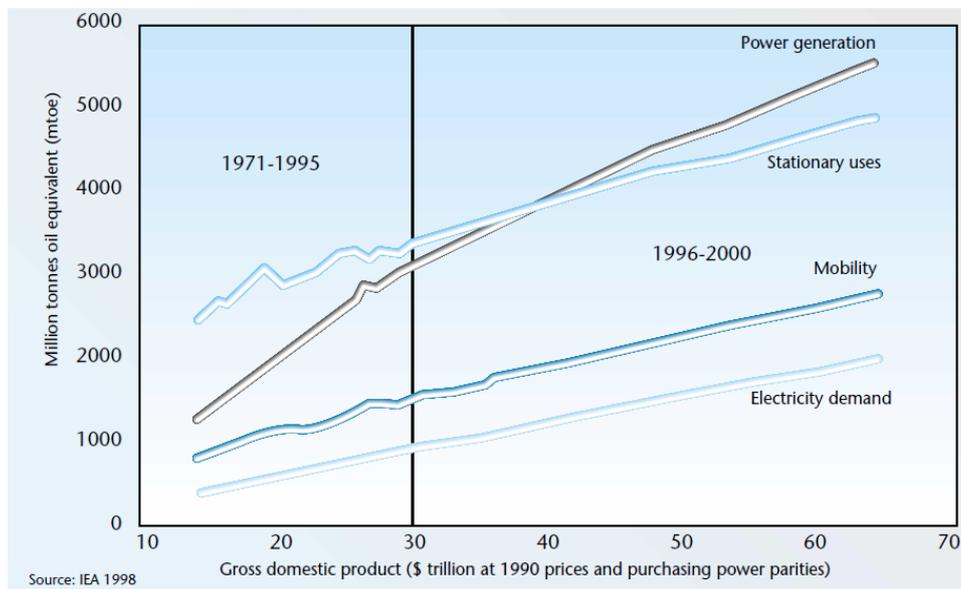


Figure 4. World energy-related services, 1971-2020.

Primary energy sources in Latin America and the Caribbean countries vary widely. Mexico and Venezuela, which have important oil and gas resources, use them for much of their energy; in Central America over 50% and, in Brazil, some 70% of electricity is generated by hydro power [5]. Drought in recent years has made hydro power supplies uncertain in some areas. And there is a trend in Argentina, Brazil and Colombia, for example, to move from renewable energy to fossil fuels in both the electric power and transportation sectors following deregulation of the energy sector [5].

North America has enormous coal, oil, natural gas and hydro resources. Coal is used to produce some 40% of its electricity. It's well developed transportation sector, and the high rate of vehicle ownership, make North America a major oil consumer as well. The United States is the world's largest oil importer, but also the second largest oil producer after Saudi Arabia [5].

### 3 Renewable energy sources in Serbia and its potentials

Serbia is a middle-income country with a great potential for fast economic development, as the country is endowed with natural and mineral resources and fertile and arable agricultural land. Serbia's GDP fell dramatically in the 1990s. However, since 2000 the GDP has increased steadily and in 2006 it was nearly 30% higher than in 2000. Strong economic progress has been achieved since 2001, particularly in expanding private sector participation in the economy. Macroeconomic stability,

achieved swiftly in the first years of transition, has been broadly maintained although economy is currently hit by global downturn. Serbia has a total dependence of 40%, and compared to the energy dependence of other EU27+ countries [6] the country's energy dependence is considered average.

Serbia has extensive unused potential for greater energy efficiency and RES production. Serbia's renewable energy potential can cover almost half of its primary energy needs. Moreover, projections suggest that with minor adjustments in the regulatory system, RES could easily rise to one-third of Serbia's overall primary energy consumption, which now relies on fossil fuels for 93% of its supply [7].

The wind energy potential is about 1,9 Mtoe a year (2,3 TW h/year). This potential is based on the long-term data of the existent hydro-meteorological stations that carry out measuring on 10 m altitude and on the new data where measuring was carried out on 100 m altitude [8,9].

According to the available data, use of photovoltaic solar energy is currently almost negligible. Solar energy is used for water and space heating in the domestic and tourist sectors, but there are no figures on the extent of this use. The country's solar energy exploitation potential is approximately 0.64 Mtoe a year. In Serbia the solar energy potential is vast, as the number of solar irradiation hours is much higher than in some other European countries reaching approximately 2000 h/year [10].

The unused hydropower potential (0.9 Mtoe) in Serbia is situated mainly in the catchments of Drina and Morava rivers and it can be utilized for large as well as for small HPPs. According to the electricity utility company Elektroprivreda Srbije, this potential may be used in 52 large HPPs that would have average capacity of around 25 MW [11]. Around 0,4 Mtoe a year are found in small streams, where the smaller hydro-electric power stations could be built. This estimation is based on the land register of small hydro-electric power stations where there are 856 locations suitable for building small power stations of 90 kW to 8,5 MW, of the total power of 450 MW and 1590 GW by which around 90% of locations have the technical potential under 1 MW [12].

*Table 2. Total technically available potential of renewable energy sources*

<i>RES</i>	<i>Available technical potential used (Mtoe/year)</i>	<i>Unused available technical potential (Mtoe/year)</i>	<i>Total available technical potential (Mtoe/year)</i>
BIOMASS	1,054	2,394	3,448
Agriculture biomass	0,033	1,637	1,67
Agriculture remains	0,033	0,99	1,023
Residues in fruit growing, viticulture and pre-fruit production		0,605	0,605
Liquid manure		0,042	0,042
Wood (forest) biomass	1,021	0,509	1,53
Energy crops			NA
Biodegradable waste	0	0,248	0,248
Biodegradable municipal waste	0	0,205	0,205
Biodegradable waste (except municipal)	0	0,043	0,043
HYDROENERGY	0,909	0,77	1,679
For installed capacities up to 10 MW	0,004	0,151	0,155
For installed capacities up to 10 MW up to 30 MW	0,02	0,102	0,122
For installed capacities over 30 MW	0,885	0,517	1,402
WIND ENERGY	≈0	0,103	0,103
SOLAR ENERGY	≈0	0,24	0,24
For the production of electricity	≈0	0,046	0,046
For the production of thermal energy	≈0	0,194	0,194
GEOTHERMAL ENERGY	≈0	0,1	0,18
For the production of electricity	≈0	≈0	≈0
For the production of thermal energy	0,005	0,175	0,18
TOTAL OF ALL RES	1,968	3,682	5,65

With 55% of its territory being arable land, and 25% under forests, Serbia has high biomass potential. This potential lays around 2,7 Mtoe annually, (63% share in the total RES potential), where

1.1 Mtoe represents the wood biomass potential (woodcutting and wood mass refuse produced in its primary and/ or industrial processing) and more than 1,6 Mtoe constitute agricultural biomass (agricultural and farming cultivation residues, including also liquid manure) [10]. Production of pellets is also considered as very promising, having a potential of 250–350 kt/year from sawmill waste [11].

The total technically available potential of renewable energy sources in the Republic of Serbia is estimated at 5,65 million tons per year. Of this potential, 1,054 million tons of biomass (mostly as firewood) and 909 thousand tons of hydropower are already used [13].

### 3.1 Share of renewable energy sources in Serbia

In Serbia, most of the energy comes from coal, which is used the most in addition to oil and natural gas. Coal is the dominant raw material in electricity generation. In Serbia, only hydro potential and biomass have been used to a greater extent from renewable sources. In the production and consumption of energy from renewable sources, large hydropower plants are also calculated according to EU regulations, but those in the field of environmental protection are not considered ecological plants due to the harmful effects of dam construction on the environment. In this context, without large hydropower plants, the share of electricity from renewable sources is very small.

Regarding the current situation in Serbia, it must be emphasized the lack of quantitative indicators in the planned areas of application of renewable energy sources, as well as the need for much more pronounced efforts to promote their use [14]. The share of energy from renewable sources in Serbia is about 6% (including large hydropower plants) and is projected to remain stable in the coming period. The Energy Development Strategy until 2015 envisages that the share of new renewable sources (excluding large hydropower plants) in total primary energy consumption should increase from 1.07 to 1.21% in 2015, (Table 3) [15].

*Table 3. Share of energy from renewable sources in total primary energy consumption, according to the Energy Development Strategy, scenario of dynamic economic development. [15].*

	2006	2009	2012	2015
Total primary consumption energy	615	647	715	753
Share of energy from renewal. Sources (without large hydropower plants)	0,8	1,1	1,05	1,1

The share of energy obtained in Serbia from renewable sources is small. Currently in Serbia, only about 1% of energy is obtained from alternative sources, which is negligibly small, if we take into account the natural potentials and requirements of the Kyoto Protocol.

## 4 Conclusion

Serbia has significant energy potential in renewable energy sources, but it has not been sufficiently used. The use of energy from renewable sources is still in its infancy in the world, except in some developed countries, and the biggest challenge is the transition to cleaner technologies while achieving economic profitability.

In addition to environmental, the use of renewable energy sources has economic significance - it can contribute to reducing the import of fossil fuels, the development of local industry and job creation, but also enable savings for households.

### *Thank-you note*

To the Ministry of Education, Science and Technological Development of the Republic of Serbia and call for a contract: Agreement on the implementation and financing of scientific research work of NIO in 2020, Record number: 451-03-68 / 2020-14 / 200052.

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