

## RENEWABLE ENERGY SOURCES AND ENVIRONMENT FRIENDLY MATERIALS IN THE FUNCTION OF SUSTAINABLE DEVELOPMENT

Dušan Grdić<sup>1</sup>  
Nenad Ristić<sup>2</sup>  
Gordana Topličić-Ćurčić<sup>3</sup>  
Zoran Grdić<sup>4</sup>

UDK: 502.131.1:620.91

DOI: 10.14415/konferencijaGFS2014.113

**Summary:** *Renewable energy sources are the natural energy sources which can be fully or partially renewed. These sources are: solar energy, wind energy, biomass, geothermal energy and water course energy. Environment friendly materials are those which have the least harmful effect on the environment, which require simple technological processing, low energy consumption, which are available from the local source, are renewable and recyclable. Sustainable building is one of the important parts of sustainable development, and it includes usage of building materials which are not detrimental for the environment as well as application of recycled materials. Concerning the sustainable development, sustainable building must ensure durability and quality which are acceptable in terms of finances, economy and environment.*

**Keywords:** *Renewable energy sources, environment friendly materials, sustainable building*

### 1. INTRODUCTION

**Renewable energy sources** are the natural energy sources which can be fully or partially renewed. The need for usage of such sources arose several decades ago, after alarming data on the effects of greenhouse gases emission, generated by the fossil fuel combustion, were published. This caused global climate change, which reflect, primarily, in the increase of the mean temperature, that is, global warming. The climate change also affected Serbia - the temperature has been increasing since the 80's of the previous century, and due to the climate change, the most extreme changes of weather

<sup>1</sup> Dušan Grdić, dipl.građ.inž., Univerzitet u Nišu, Građevinsko- arhitektonski fakultet u Nišu, Aleksandra Medvedeva 14 , Niš, Srbija, tel: 018 588 200, e – mail: [dušan.grdic@hotmail.com](mailto:dušan.grdic@hotmail.com)

<sup>2</sup> Nenad Ristić, dipl.građ.inž., Univerzitet u Nišu, Građevinsko- arhitektonski fakultet u Nišu, Aleksandra Medvedeva 14 , Niš, Srbija, tel: 018 588 200, e – mail: [nenad.ristic@gaf.ni.ac.rs](mailto:nenad.ristic@gaf.ni.ac.rs)

<sup>3</sup> Gordana Topličić- Ćurčić, dipl.građ.inž., Univerzitet u Nišu, Građevinsko- arhitektonski fakultet u Nišu, Aleksandra Medvedeva 14 , Niš, Srbija, tel: 018 588 200, e – mail: [gordana.toplicic.curcic@gaf.ni.ac.rs](mailto:gordana.toplicic.curcic@gaf.ni.ac.rs)

<sup>4</sup> Zoran Grdić, dipl.građ.inž., Univerzitet u Nišu, Građevinsko- arhitektonski fakultet u Nišu, Aleksandra Medvedeva 14 , Niš, Srbija, tel: 018 588 200, e – mail: [zoran.grdic@gaf.ni.ac.rs](mailto:zoran.grdic@gaf.ni.ac.rs)

can be expected, such as: dry and extremely hot summers, incidents such as floods and hail and other [1].

Majority of people lives in structures countering the climate rather than using it. They are energy inefficient, excessively cold or hot and expensive to maintain. Most of the homes uses more water than required and often are constructed of materials having bad effects on health and environment. Application of environment friendly materials comprises creation of comfortable homes which have minimum impact on the environment, and which are at the same time more cost-efficient and healthier for living. [2].

**Sustainable development** is a development of human society which does not endanger future generations. Sustainable development satisfies our needs today, without compromising the future generations' potential to satisfy their needs.

**Sustainable building** is a building where care is taken that the future generations can use what is built today. It is one of the important segments of the sustainable development, and includes usage of environmental building materials which are not detrimental for the environment, and which preserve the resources, reconstruction of existing and construction of new energy efficient buildings, as well as rational removal of the existing structures and re-use of material from the demolished buildings [2].

## 2. RENEWABLE ENERGY SOURCES

Renewable energy sources, once called as permanent energy sources are such sources used for production of electric or thermal power, i.e. for useful work, whose reserves are continuously or cyclically renewed [1]. Renewable energy sources are: **solar energy, wind energy, biomass, geothermal energy and water course energy.**

### 2.1. SOLAR ENERGY

For decades, the solar energy has been used for heating water, living space but also for cooling. The use of solar energy has multiple advantages. It is a silent, clean and reliable energy source. Because of the increasing cost of fossil fuels, and the growing environmental awareness, the interest for using of solar energy has been increasing. [3].

In the housing structures, there are two types of solar energy systems: **those used exclusively for heating water, and those providing internal heating** (so called combi systems). Solar water heating energy systems are designed so as to be the sole heaters of water in the warm seasons of the year. In winter season, hot water is provided by the heaters fired by oil, gas or wood, supported by the solar heating energy system in the sunny days. This means that each year, around 60% of required hot water can be obtained using solar heating energy systems [4].

One of the big advantages of solar energy is that it can be obtained in the remote locations where there is no power grid. One example is production of energy in space, where the satellites are supplied with power using very efficient solar cells. Seventy thousand of photovoltaic solar panels generate 15 MW of power.

Installation of solar panels in the remote locations is a much more favorable solution, from the standpoint of saving money, than installation of high voltage power mains. Solar panels can be mounted on the roofs of many houses, which eliminates the problem of finding space and of investment in new installations. Another extraordinary property of solar energy is its cost. Even though the initial investment cost is high, once the solar panels are installed, they provide free energy which will, in years of service repay the initial costs. Usage of solar energy provides independence from the global fossil fuel reserves [5].

## 2.2. WIND ENERGY

Wind is a free and renewable source of energy, and wind farms do not use any fuel. Wind power generators do not produce any waste nor create any greenhouse gases. The areas occupied by these facilities can be normally used for agricultural production. Wind power generators are a good way to keep the remote consumers supplied with electric power. [6].

Wind has a stochastic characters, so the wind generator power is a stochastic parameter. The most convenient locations for installations of wind generators are: on the coastline, river banks or mountains. In the first case, the land lease is expensive, in the second case, the construction cost investment is high. There are opinions that covering of terrain with wind farms mars the appearance of the landscape, that they pose threat to birds (especially if they are constructed across their migratory routes). Also, the operation of wind generators can interfere with the reception of television signal. Wind power generators produce a continuous, weak and unpleasant hum [6].

Unpredictability of electric power production in wind generators, limits their maximum share in production of an electric power system, are calls for increase of backup supply in an EPS. Development of long term and short term forecast of wind is of great importance for a reliable planning of production in EPS with powerful wind generators. [7].

## 2.3 BIOMASS

Usage of biomass, or fuels or waste matter obtained from biomass as an energy source requires their combustion and release of heat powering the electric power generators. The energy stored in biomass is chemical so there is no discontinuity in its usage, as it is the case with solar or wind energy. The environmental aspects biomass energy usage are as follows:

- biodegradability of biomass in soil is excellent, since almost 95% of biomass matter is decomposed within 28 days;
- bio-fuel contain only negligible amounts of sulfur so there is no sulfur-dioxide in the combustion products (and it is an inevitable product of fossil fuel combustion);

- burning biomass yields only pure ash;
- There is no carbon-hydrogen emission, as of products of incomplete combustion;
- biomass is a fully renewable energy source;
- biomass exists on the Earth, and it is not necessary to produce it, but its usage should be planned, and its regeneration should be supported [8,9].

## 2.4 GEOTHERMAL ENERGY

Below the surface of the earth, there are immense reserves of thermal energy – **geothermal energy**. Geothermal energy is a renewable source of energy, since the heat is perpetually generated inside the Earth, in different processes.

One of the greatest advantages of geothermal heating is the low heating cost (saving can amount up to 80% in respect to fossil fuels) and the small amount of consumed energy in respect to the standard heating systems. The efficiency of geothermal heating is significantly higher than in the standard forms of heating. Geothermal energy is 48% more efficient than the gas boilers and more than 75% more efficient than the oil boilers. Using the geothermal energy emits very little (sometimes none) harmful gases into the atmosphere, so accordingly, geothermal heating is environmentally very acceptable form of heating. [10].

The main downsides of geothermal heating are very high initial costs and scant areas where such energy source can be used. Such areas are positioned on the rims of tectonic plates, while outside these regions, the Earth's crust is simply excessively thick for any commercial usage of geothermal energy. According to the data of the US ministry of energy, the initial investments can be repaid in the range from 2 to as much as 20 years. As a downside, it should be mentioned that geothermal heating is not 100% pure form of heating, because of the heat pumps which use electric power for their operation, and that electric energy is produced in a regular way, thus certain amount of harmful gases is released into the atmosphere [8].

## 3. SOME EXAMPLES OF ENVIRONMENTAL MATERIALS

**Straw** The advantages of straw as a construction material are: good thermal insulation, fire resistance, relatively good compressive strength, low construction cost and good earthquake resistance.

Straw walls must be plastered so that the straw would be protected from the external effects, and it would remain hidden among the layers of mortar, and the only proof of its presence is considerably lower heating bill. The mortar used on the straw walls must not be based on cement. The mortars with additives cannot be used, either. Such mortars are not vapor-permeable and they prevent “breathing” of the walls. Because of this only the mortars based on lime or gypsum can be used for plastering of straw walls. [11].

**Soil** Building with soil is based on construction a formwork into which the soil is compacted, creating in this way the bearing walls. After compacting, the formwork can be immediately removed, and it takes several warm and dry days for the wall to dry up

and acquire necessary strength. The wall may acquire strength up to two years after construction, depending on the thickness, climate conditions and other. The thickness of such wall was once more than 30 cm so that they would have the necessary strength. However, today, using modern tools and machinery, the formwork can be set at 10 - 25 cm. For compaction, pneumatic or hand tool is used, compacting earth at around of 50% of its original volume in the formwork. The compaction process is done in layers, until the wanted height is reached. [12].

**Bamboo** Usage of bamboo in construction engineering is very widespread, especially in the tropical regions. Apart from energy efficiency and preservation of waters, bamboo brings a revolution in the construction industry, as it provides a sustainable basis for the projects, regardless whether it is a humble residential house or a skyscraper support frame. Contrary to other types of timber, bamboo is very lightweight and at the same time has excellent characteristics, while it is fully mature after only 3 to 7 years (depending on the subspecies). In civil engineering, it can be used for construction of buildings, scaffolding and even for reinforcement of the road substructure. [13].

## 5. CONCLUSION

Sustainable development is such a development which satisfies our needs today, without compromising the future generations' potential to satisfy their needs [14]. It comprises usage of renewable energy sources such as: solar energy, wind energy, biomass, geothermal energy and water course energy, as well as environment friendly materials. Usage of renewable energy sources, apart from an environmental, also has an economic importance – it can contribute to the reduction of import of fossil fuels, development of local industry, creation of jobs, and provide savings to the households.

Sustainable buildings is certainly one of the more important parts of sustainable development, and it includes usage of building material which are not harmful for the environment, and application of recycled materials. Concerning the sustainable development, sustainable building must ensure durability and quality along with financial, economic and environmental acceptability.

## ACKNOWLEDGEMENTS

The work reported in this paper is a part of investigation within the research project TR 36017 „Utilization of by – products and recycled waste materials in concrete composites in the scope of sustainable construction development in Serbia: investigation and environmental assessment of possible applications“ supported by Ministry for Science and Technology, Republic of Serbia. This support is gratefully acknowledged.

## REFERENCES

- [1] Šljivac, D., Šimić, Z.: Obnovljivi izvori energije:vrste, potencijal, tehnologije. *Ovaj project je financiran od EU*
- [2] Vodič kroz energetski efikasnu gradnju, siječanj 2005., Zagreb
- [3] Radosavljević, J., Pavlović, T., Lambić, M.: Solarna energetika i održivi razvoj. *Građevinska knjiga, 2004*, Beograd
- [4] Lambić M.: Priručnik za solarno grejanje. *Naučna knjiga, 1992.*, Beograd
- [5] Stamenović, Lj.: Korišćenje solarne fotonaponske energije u Srbiji. *Jefferson Institute, 2009.*
- [6] Zlatanović, M. Korišćenje energije vetra u Srbiji – prirodni uslovi i praktična politika. *Jefferson Institute, 2009.*
- [7] <http://www.tfb.edu.mk/files/materials/4a31809e4415f.pdf>. 12.10.2013.
- [8] Cakić, M., Veljković, V., Stamenković, O.: Održive tehnologije. Tempus 158989-Tempus-1-2009-1-BE-Tempus-JPHES
- [9] Jordanović-Vasić, M.: Upotreba biomase iz poljoprivrednog otpada kao obnovljivog izvora energije. *Nauka + praksa, 2009.*, Niš
- [10] Janković, V.: Geotermalna energija: Kako iskoristi skriveni potencijal Srbije. *Jefferson Institute, 2009.*
- [11] Glasnović, Z., Horvat, J., Omahić, D.: Slama kao superiorni građevinski material. *Zaštita okoliša. 3/2008, svibanj.*
- [12] Krnjetic, S., Mrkajić, V.: Nepečena stabilizovana zemlja – građevinski materijal. *kgb 3 2008, BI-BLI-D 0350–1426 (206) 37:3 p. 45–48*
- [13] Vračić, T.: Najveća gospodarska građevina od bambusa. *GRAĐEVINAR 64 (2012) 5, 2012*
- [14] Grdić, Z., Topličić-Ćurčić, G.: Ekološki materijali – komponente održive arhitekture. *Zbornik radova Građevinskog fakulteta u Nišu, br.25.pp 87-94.2010.*

## ОБНОВЉИВИ ИЗВОРИ ЕНЕРГИЈЕ И ЕКОЛОШКИ МАТЕРИЈАЛИ У ФУНКЦИЈИ ОДРЖИВОГ РАЗВОЈА

**Резиме:** Обновљиви извори енергије су природни извори енергије који се у потпуности или делимично обнављају. У ове изворе енергије спадају: сунчева енергија, енергија ветра, биомаса, геотермална енергија и енергија водотокова. Еколошки материјали су материјали који најмање штетно утичу на околину, захтевају једноставнију технолошку обраду, мању потрошњу енергије, добављају се из локалних извора, обновљиви су и могуће их је рециклирати. Одржива градња је свакако један од значајнијих делова одрживог развоја, а укључује употребу грађевинских материјала који нису штетни по животну средину, као и примену рециклираних материјала. У вези са одрживим развојем, одржива градња мора осигурати трајност и квалитет уз финансијску, економску и еколошку прихватљивост.

**Кључне речи:** Обновљиви извори енергије, еколошки материјали, одржива градња