

SOLAR ENERGY AND SUSTAINABLE DEVELOPMENT

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Abstract. *In this paper attention is drawn to the energy consumption in the world, solar energy, sustainable development, agenda 21 and the influence of the renewable energy sources and solar energy on the sustainable development*

Key words: *solar energy, solar cells, solar collectors, sustainable development*

INTRODUCTION

In the last twenty years sustainable development in different spheres of life and work has been in the limelight worldwide. Regarding this it is essential to look at the relation between energy and sustainable development. Classical sources of energy comprise coal, wood, oil and water. Renewable sources of energy comprise sun, wind and geothermal energy. Apart from these, nuclear energy is used worldwide. The use of burnable sources of energy (coal, wood, oil) and nuclear energy brings forth contamination and environment pollution. From the point of view of eco-physics only those energy sources that contaminate the environment minimally are acceptable. The cleanest source of energy is the sun whose irradiation is free of charge and more or less accessible to the whole Earth and the Solar system [1, 2].

ENERGY CONSUMPTION IN THE WORLD

The industrial revolution at the end of the 19th and the beginning of the 20th century was based on the consumption of great quantities of energy. Economic development of the countries was estimated according to the energy consumption and new production facilities installation.

In modern civilization energy consumption has reached an alarming level. Total primary energy consumption (coal, oil, gas etc.) in the world in 1998 was 8, 477 Mten (million tons of equivalent oil) which is 11, 3% higher than it was in 1990. Accelerated growth of the energy consumption is induced by the population growth and the increase

in energy consumption per capita. Primary energy consumption in the USA in the period 1990-1998 rose by 12,9% and coal consumption by 8%. In the European countries coal consumption has drastically decreased.

With the emergence of industry and the increase in energy consumption the problem of the quality of environment is getting bigger. World is faced with the problem of contamination and environment pollution including higher layers of atmosphere and the ozone layer.

At the conference on the climate change in Kyoto, in 1997, lots of environment protection associations reached an agreement to decrease gas emission which contributes to the greenhouse effect by 5% in 2008-2012 in relation to their level in 1990. Individual obligations were attributed to the NATO countries as well: EU promised decrease by 8%, USA by 7%, Canada 6%, etc.

On the basis of the report of the World Meteorological Organization (WMO) and the EU Programs for the environment it can be concluded that by the end of this century temperature in the world will increase by 1-3,5 °C, sea level by 0,15 -0,95 m and that these changes can have negative effects on the environment [1].

SOLAR ENERGY

Sun is one of 400 billion stars in the Milky Way Galaxy. Astronomers classify it into "yellow" dwarfs. Sun contains more than 99% of the whole matter in the Solar system.

The temperature on the surface of the Sun is 5500 °C. In the Sun nucleus the pressure is 10^7 Pa, and the temperature is $15 \cdot 10^6$ K. Sun energy is generated in its nucleus mainly through the thermonuclear reaction of hydrogen fusion into helium. In the form of electromagnetic waves this energy is then transmitted from the nucleus towards the surface of the Sun and further on in the surrounding space. Only the half -billionth part of the Sun energy reaches the Earth.

Two components of the Sun irradiation reach the Earth. One comes directly from the surface of the Sun (direct irradiation) and the other generated by the Sun irradiation dissipation on the impurity particles in the atmosphere (diffuse irradiation). On the intensity of the incoming energy substantial influence is exerted by meteorological conditions and the angle under which Sunrays reach the Earth. If the sky is crystal clear 10% of the total energy reaches the Earth as diffuse irradiation.

Sun energy is clean, inexhaustible and can be transformed into other forms of energy: thermal, electric, chemical, mechanical, etc.

Passive Intake

Modern solar architecture is based on a direct (passive), indirect (active) and a combined (passive and active) Sun irradiation intake.

Passive sun irradiation intake on the given object is performed without application of any auxiliary devices for the sun irradiation intake and its transformation into other forms of energy. To make this type of sun energy use efficient it is necessary to rightly orient the object towards the sun and to pay attention to: location of the windows, glass veranda, Tromb's wall, etc. thermo-isolation of the object, color of the walls and furniture, shade, thermal shutters, floor storage of heat, etc.

Passive solar objects design implies knowledge of the local climate conditions and their immediate influence on the level of the use of the sun energy in the given object. Most important climate parameters are: number of sunny days in the given area, temperature and air humidity, fog, wind, etc.

Active Intake

Active sun irradiation intake is performed by means of devices for thermal, photovoltaic and hybrid sun irradiation conversion.

For thermal conversion the following is used: flat collectors (water and air), vacuum collectors, concentrators, solar ovens, heliostats, etc.

For photovoltaic conversion of the sun irradiation the following is used: mono-crystal, poly-crystal and amorphous solar cells made of silicium and other materials. Solar cells generate direct current and voltage.

Hybrid Conversion of the Sun Irradiation

Hybrid conversion of the sun irradiation means simultaneous conversion of the sun irradiation into thermal and electrical energy. For hybrid conversion of the sun irradiation one uses hybrid collectors which differ from thermal collectors in the absorber construction. Hybrid collector absorber is made of metal stem, water flow tubes and solar cells made of mono-crystal or amorphous silicon mechanically fixed to the metal stem.

Hybrid collectors can be used in private houses, block of flats, tourist objects, hospitals, schools, sanitary water heating objects and electric energy generation objects. Heated water is by means of thermo-siphon or circulation pump taken to the solar boiler. Electric energy is through battery charging regulator taken to the battery and then directly or through DC/AC inverter submitted to the end user. Hybrid collectors make possible better space usage, savings during supporting construction building and simultaneous conversion of the sun irradiation into thermal and electric current in one device. Hybrid collectors are contemporary, ecologically clean, integral source of thermal and electric currency [1, 2].

SUSTAINABLE DEVELOPMENT

Under the auspices of the Norwegian Government and UN Economic Committee for Europe a ministerial conference took place in Norway, Bergen, in 1990 which issued a declaration proclaiming a term sustainable development.

This concept of the sustainable development was accepted by the European Union in 1990. Strategy of the sustainable development was accepted at the UN Conference on Environment and Development, UNCED, in Rio de Janeiro in 1992.

A notion of the sustainable development is defined as an integral economic, technological, social and cultural development adjusted to the needs of the environment protection, which enables current and future generations to meet their needs and improve their life quality.

Underlying principle of the sustainable development is establishing of the effective resource distribution and application system for a long period. Sustainable society is the

one that lasts for more generations, is farsighted, flexible and wise enough to prevent destruction or undermining of the physical and social system it lies on.

Sustainable development is focused on the preservation of the natural eco-systems and on the rational use of the natural treasures of the Earth. Thus this concept is oriented towards the upgrading of the life and environment quality. Sustainable development implies nature preservation by man on sustainable basis and its use to the extent of its reproduction. Overuse and uncontrolled use and exploitation of the natural resources can cause a violation of the ecological balance and thus ecological disasters as well.

The basic principle of sustainable development is that natural resources can be exploited only to the level that provides their reproduction. This idea encompasses interregional and intergeneration equality.

Problem of sustainability comprises several aspects: energy consumption, population, agriculture and biodiversity, global warming and contamination, equality in the use of resources and urbanism.

At the UN Conference on Environment and Development held in Rio de Janeiro in 1992 a fundamental action program was passed on reaching sustainable development, better known as Agenda 21.

Agenda 21 is comprised of four parts and 40 chapters, which consider attitudes of the international community of different question of environment protection and development in the world. Its basic message is a request for urgent changes and adaptation of all activities on the Planet to the possibilities and capacities of the single environment segments.

The first part of Agenda 21 deals with social and economic issues (international cooperation on establishing a sustainable development in the developing countries and a corresponding local policy, fight against poverty, change in consumption, demographic dynamics and its sustainability, human health protection and upgrading, upgrading of sustainable development of human settlements, inclusion of environment and development in decision making, etc.)

The second part of Agenda 21 deals with protection and management of development resources (atmosphere protection, integral approach to planning and management of country's resources, fight to preserve forests, management of tenable ecosystems: fight against draught and desert expansion, saving of biodiversity, ecologically healthy managing of biotechnology, ocean and all kinds of seas, by- the- sea region protection, rational use and development of their live resources, protection of the water quality and water supply sites: use of integral approach in development, management and use of water resources, management of toxic chemicals. These include the following as well: prevention of illegal international traffic of toxic and dangerous products, environmental friendly management of toxic waste including prevention of illegal international traffic of dangerous waste, environmental friendly management of solid waste, safe and environmental management of radioactive waste.)

The third part of Agenda 21 contains the role of significant social groups (global action of women for sustainable and right development, children and youth in the sustainable development, strengthening of the role of autochthonous population and their communities, greater role of nongovernmental associations: partners for sustainable development, local supporting initiatives for Agenda 21, greater role of workers and their unions, strengthening of business and industry, scientific and technological communities and farmers as well).

The fourth part of Agenda 21 deals with means for the realization of Agenda 21 (financial sources and mechanism, non-polluting and healthy technologies: transfer, cooperation and institutional improving, science for sustainable development, education and national awareness upgrading, national mechanism and international cooperation on institutional reinforcement of developing countries, international institutional arrangements, international instruments and mechanisms, information necessary for decision making.)

Countries which signed Rio Declaration took over their obligations to make possible concept of sustainable development, i.e. guidelines given in Agenda 21 to continue the way towards a sustainable development. According to Agenda 21 aims of the sustainable development that should be taken into account in future development decision-making are:

- a) regarding resource preservation:
 - use of natural resources should be based on rational use of land,
 - saving wise use of non- renewable energy sources and their substitution by the renewable energy resources whenever possible,
 - maintenance and protection of biological balance,
- b) regarding environment quality:
 - It is essential to prevent or diminish degrading processes or those that contaminate environment in order to protect regenerating abilities of ecosystems and to prevent development dangerous to human health or diminishes the quality of life.

Aiming at viability of sustainable development, planetary preservation and improvement of degraded atmosphere layer there were held several world meetings of governmental associations and several protocols on survey and monitoring of environmental quality were signed (Rio, Montreal, Kyoto,) under the auspices of United Nations [1-7].

SOLAR ENERGY AND SUSTAINABLE DEVELOPMENT

Serious problems of the air pollution are connected with the use and combustion of natural fuels, first of all solid (coal) and liquid (oil and oil derivatives).

Having in mind ever-growing importance of the use of sun energy on Earth a world congress on sun energy was held in September 1996 in Harare (Zimbabwe). This congress was held in the year proclaimed by UNESCO's World movement for the use of solar energy (WSSP) as the beginning of a "Solar decade". The congress has gathered together 117 Prime Ministers and 20 representatives of the leading international and regional governmental and non-governmental organizations as well as representatives of the leading industries and experts on the energy worldwide.

The congress has pointed out that 79% of mankind in a developed part of the world disposes with 30% of the global energy consumption and that more than two billion people has almost no energy for other needs. At the same time developed world comprising 21% of the world population consumes 70% of the commercially produced energy. This is 17 times more than the average energy consumption of the poorest world population. For the current population number of 5.5 billion to have the same average energy consumption per capita world energy production should be quadrupled.

The congress issued two documents: Solar Declaration and World solar plan of action for the period of 1996-2005.

In order to establish sustainable development, prevent over consumption of conventional energy sources and to preserve environment it is necessary to provide for sustainable energetic.

This means that future technical-technological development should be based on the strict control and lowering of the pollutant emission into the environment, extended use of eco-technologies and renewable energy resources.

Development and expended use of renewable energy resources (OIE) in energetic is essential for the establishment of sustainable development on Earth. EU member countries activities in the field of application of OIE are continuous. In 1994 in Madrid a conference was held and for the first time a European plan for the OIE development was adopted. It contains clear aims of the development and strategies to apply them until 2001.

At the conference in Milan, in 1996 a White Book on OIE was issued. Basic assumptions are doubling of the existing funds for the development of OIE so as to increase its part in the meeting of EU energy needs. It was planned to increase OIE from the current 6% to 12,5 % in 2001. Financial funds of 95 billion euros in the period of 1998 to 2010 are envisaged.

In May 1999 in Amsterdam at the conference on the renewable sources of energy (Renewable Energy in the 21st Century) it was pointed out that in order to fulfill promises of the White Book:

- It will be installed 1,000,000 Solar cells systems until 2010, half of it on the EU territory and the rest to be used for the electrification of rural regions of tropical countries;
- 10,000 MW of big windmills will be installed;
- 10,000 MW of biomass steam power plants will be installed;
- 15 million m² of heat collectors will be installed;
- 1,000 MW biogas installations [7, 8].

CONCLUSION

In the light of the above mentioned it can be concluded that a great attention is drawn to the use of clean sources of energy and sustainable development in the world. At the UN conference on environment and development, held in Rio de Janeiro in 1992, Agenda 21 was issued giving basic guidelines for the sustainable development.

The cleanest source of energy is the Sun that for the 5 billion years has been enabling and sustaining life on Earth. In biosphere sun energy through the process of photosynthesis is used for the growth and development of plants. Besides, sun radiation can be transformed into thermal energy in passive and active photo-conversion systems. Passive photo-conversion systems encompass building objects constructed on the solar architecture principles. In active photo-thermal conversion systems we classify flat collectors, vacuum collectors, concentrators, etc. For the conversion of sun radiation into electric energy solar cells are used. For the simultaneous conversion of sun radiation into thermal and electric energy hybrid collectors are used.

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SOLARNA ENERGETIKA I ODRŽIVI RAZVOJ

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U radu je pažnja posvećena potrošnji energije u svetu, solarnoj energetici, održivom razvoju, agendi 21 i uticaju obnovljivih izvora energije i solarne energetike na održivi razvoj.

Ključne reči: solarna energetika, solarne ćelije, solarni kolektori, održivi razvoj.