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THE INFLUENCE OF CLEAN TECHNOLOGIES ON NEW SOCIETY

Abstract: Clean technologies include four main fields: power engineering, transport, water supply and material. Some of the well-known technologies, such as solar photovoltaic panels, wind energy, biofuel, contemporary lithium-ion batteries and high capacity devices for desalination of sea water on the basis of reverse osmosis belong to the group of clean technologies. These technologies also include nanotechnology-based materials. Even today certain indicators are present that show an increased interest in ecologically clean products and services. In addition to an explosive growth of organic food, clean technologies such as solar energy, energy of the wind and of biofuel, have also sustained a growth which exceeds 30% on the annual level.

This paper will analyze the clean technologies sectors, such as: solar energy, wind energy, energy of biomass and biogas. It will outline the current situation and perspectives of using the renewable energy sources in the world and in the Republic of Srpska will be presented as well as their influence on creation of new jobs and other social and economic aspects.

Key words: *clean technology, solar energy, wind energy, biomass and biogas.*

INTRODUCTION

The concept of clean technology includes any product, service or process which brings the use value with minimal or no expending of non-recyclable resources and at the same time produces significantly less waste products compared to classical solutions. Clean technology implies a vast array of products and services ranging from solar supply systems to hybrid electrical cars. These products use recyclable materials and energy sources, reduce or eliminate pollution and toxic waste and offer identical or even higher performances compared to classical products.

The world today is facing the problems of expensive energy, exhausted natural resources, unreliable foreign oil sources, and the economy suffering from deficit and facing big problems in the environment and safety fields. That energy changes the environment in which we live and work, the products that we create and buy,

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as well as the plans of development of cities, regions and nations throughout the planet Earth.

All expenses incurred for clean technologies-based solutions originate from the equipment necessary for collection and supply of energy. The main investors in clean technologies of 70 s of the last centuries were primarily state-owned research institutions, while today these are the leading multinational companies. Developing countries also go through a serious transition when it comes to the investments in clean technology. Majority investments in clean energy and clean technology in such developing economies originated from different governmental or other international organizations. Development of clean technologies also represents a basis for solving the problem of limited global energy sources and drinking water sources. This development helps reduce general geopolitical and terrorist threats that are a consequence of relying on resources located in politically sensitive regions, such as the Middle East and West Africa. The revolution of clean technologies largely depends on a long-term and stable government policy, as well as on subsidizing solar energy, energy of the wind and other new technological solutions. For clean technologies to make progress, the authorities bodies at all levels must accept and support the industry based on new solutions, through different political solutions and tax reliefs. Thus, the central Chinese authorities are making efforts at achieving a goal of producing three times more energy from renewable energy sources compared to the nuclear ones by the year 2020. Iceland plans on becoming the first country the economy of which will not depend on fossil fuels at all, but will be based on natural sources only such as geothermal energy and hydrogen, with the latter taking a significant place in its economy. A big number of developing countries have an elaborated policy of promotion, incentives or direct investment in clean energy sources.

Problems with the climate are becoming a central issue for numerous companies, government and individuals. Human influence on climate is clear – large quantities of carbon dioxide are today emitted in the atmosphere by the people, much more than before. Such trends encourage the investments in clean technologies and their application; at the same time they are an important factor when it comes to evaluating the investment risks. A business environment has been created by current governments and different private initiatives in which the companies make extra profit if they decrease emission of carbon dioxide in the atmosphere or pay the penalties if they do not. The influence that the climate changes have on business circles and investors is two-fold. Making the criteria on emission of CO_2 and other harmful gases causing the greenhouse effect more stringent will increase demands for energy and transport technologies that do not emit harmful gases, so that a growth of these technological markets can be expected.

1. CLEAN TECHNOLOGIES

The clean technologies revolution has been in the focus of interest for 60 years already. The first conversion of solar energy into electrical energy by solar panels was performed in Bell laboratories in 1954. Further development of clean technol-

ogies has included alternating stages of high leaps and mild gradual changes. In a world in which natural resources are more and more limited, it is hard to neglect these sectors that offer higher profits in a long term. Although the development rate in this field exceeds other technological sectors, due to infrastructure-related challenges in the fields of energy, material and drinking water we can already see that the clean technology revolution will last for much longer compared to almost instantaneous development of ICT. Table 1 summarizes the research of Clean Edge for global market of bio-fuel, wind energy, solar energy, fuel cell and distributed hydrogen in 2006 as well as the project for 2016. The market of solar energy, energy of the wind, hydrogen and bio-fuel is estimated to be over US$ 226 billion worth by the year 2016 [1].

Table 1.

Energy	2006	2016
Bio-fuel	20,5 bill.$	80,9 bill.$
Wind	17,9 bill.$	60,8 bill.$
Solar energy	15,6 bill.$	69,3 bill.$
Fuel cells and distributed H	1,4 bill.$	15,6 bill.$
TOTAL:	54,4 bill.$	226 bill.$

Having in mind that the clean technologies revolution has gathered a large momentum, this will determine which regions will take a lead and progress and which will drown in their own waste waters, suffocate in their exhaust gases and try to survive in a cleaner and greener world, less dependant on fossil fuels. Benefits from clean technologies may be numerous and very lucrative. They include, among others: creation of new jobs with high profit and long-term rising of general level of skilled workers, overall economic development, increased investments at all levels and an opportunity to create such an image of a city or a region that will attract new business forums, more tourists and people who will want to live in such towns.

Solar energy market offers probably most possibilities in the overall clean technologies field; the energy of the wind has seen a quick progress since the mid-90 s of the last century in parallel to solar energy, and production of energy from wind currently takes a lead among the renewable energy sources.

Over 30% of fuel for cars is produced from sugar cane in Brazil today, while in USA 5% of total consumption of petroleum is produced from ethanol.

Despite the abundance of water on Earth today, clean potable water is becoming an increasingly rare resource. However, thanks to clean technologies it is possible today to have clean water. So for example, water that was treated as unusable before, is today successfully filtered by using nanotechnology. Taking into account that about one billion of people have no drinking water as well as the fact that drinking water shortage occurs more and more often due to pollution and increased consumption, it is obvious that more extensive use of new clean technologies in filtration and cleaning of drinkable water is to be expected in the next decades.

2. RENEWABLE ENERGY SOURCES

Since the break-out of the great world energy crisis in 1973, an increasing attention has been paid worldwide to the use of renewable energy sources, which are known to include solar energy, wind energy, geo-thermal energy, energy of biomass and biogas, etc. Renewable energy sources are an energy resource that any country in the world has, to a lesser or greater extent. Utilization of renewable energy sources has been on the rise in many countries, because they are ecologically clean, because they contribute to a more efficient use of earth's energy potentials, to decreasing the emission of greenhouse effect gases, reduction of use of fossil fuels and energy import, and at the same time contribute to the development of local industry and creation of new jobs.

Renewable energy sources give rise to the development of clean technologies that have proved to make the biggest economic and technological progress in the modern history: transition from fossil fuels to clean energy sources such as the sun, the wind, waves and biofuel; introduction of new technologies for filtration and purification of water in order to deal with the shortages and uneven distribution of drinking water at the global level; development of new materials without pollutants and replacement of raw materials dependant on fossil fuels with new renewable raw materials with higher efficiency and performances.

Clean technology includes any product, service or process that increase the use value with minimum expending of non-recyclable resources, and that produce less waste products compared to traditional solutions. Clean technologies cover four main fields: energy industry, transport, water supply and materials.

The Sun is the biggest energy source that has kept both the earth and the life on it alive for almost five billion years. In addition to constant heating of the Earth's surface, thanks to the radiation of the sun constant renewal of energy of the wind, ocean currents and waves, water courses and thermal gradient in oceans takes place. The energy of solar radiation is more than enough to meet all the energy needs in the world.

A set of the rules on climate change was passed by the European Parliament in 2008, aimed at decreasing the emission of greenhouse effect gases by 20% compared to the year 1990, and at improving the energy efficiency, so that the renewable energy sources reach the figure of 20% of share in total energy consumption in EU by the year 2020. All countries members of *International Renewable Energy Agency* – IRENA – which exclusively deals with renewable energy sources – are required to submit, within one year, to the European Commission the plan for the implementation of the Directive 2001/77/ES of the European Parliament and Council of 2001, for the promotion of electricity produced from renewable energy sources as well as the Directive 2003/30/ES of the European Parliament and Council from 2013 for the promotion of use of biofuel or other fuel produced from renewable sources for transport.

In the Republic of Srpska in 2009 the Law on Power Engineering Economics was promulgated and in 2012 the Power Engineering Economics Development Strategy

was passed, which to a large extent, focused on the possibilities of using renewable energy sources in the Republic of Srpska.

In the rest of the paper we will analyze the situation and the perspectives of using solar energy, the energy of wind, biomass and biogas in the world and in the Republic of Srpska.

3. SOLAR ENERGY

Photovoltaic conversion of solar radiation implies conversion of the energy of the radiation of the Sun into electrical energy. Photovoltaic conversion of solar radiation is based on internal photo-electrical effect in p-n junction and takes place on solar cells that are made of semi-conductor materials. Solar cell consists of *p* and *n* semi-conductor, in which, due to the absorption of solar radiation, electron-hole pairs appear in *p*–*n* junction. There are a number of factors that influence the efficiency of solar cells, and they include the reflexion on the surface of solar cell, losses in infrared area, losses in ultraviolet field, losses due to the thickness of solar cell, losses due to voltage factor, losses due to recombination and losses on serial resistance.

Solar modules are a basis of photovoltaic system and comprise a certain number of solar cells connected in a series or in parallel, whereby the output voltage increases by serial connection of solar cells, and output current is increased by solar cells connected in parallel. Monocrystalline, polycrystalline and amorphous silicon is most used to make solar modules. Solar modules of different power are available in the market, most frequently of 50 W, 100 W, 150 W and 200 W [2, 3].

Photovoltaic solar systems connected to electric distribution network consist of solar modules, inverter, current meter and connecting cables for connecting the solar system to electric distribution network. With these systems, the entire amount of produced electricity is passed to the distribution network. These systems include PV solar high power plants and PV small power plants installed on private houses, residential and other buildings.

A PV solar plant is a power plant that uses solar cells to convert the radiation of the Sun into electrical energy. PV solar plant consists of solar cells grouped in solar modules, inverter that converts DC into AC voltage and a transformer, through which the generated electricity is transferred to the electro-distribution network. The operation of a solar plant is automated and controlled by an appropriate computer program. Most used solar modules with PV solar plants are those of monocrystalline and polycrystalline silicon, and more rarely solar modules of thin-layer materials such as amorphous silicon and CdTe are used. The efficiency of solar cells 15%, 12%, about 5% and about 8% for solar cells made of monocrystalline silicon, of polycrystalline silicon, of amorphous silicon and of CdTe, respectively. Solar modules of monocrystalline and polycrystalline silicon are appropriate for the areas with predominantly direct radiation of the Sun, while solar modules with solar cells made of thin-film materials are more suitable for the areas with predominantly diffuse solar radiation.

Besides the fact that the growth of the solar energy market in the world has an annual rate of 30–50%, this market uses the same technologies that enable revolutionary development of semi-conductors and computers. It is estimated that the price of solar energy will become competitive with retail price of classical energy before 2020 and that the solar energy industry will be ruled by those who are capable of decreasing the solar panel prices and installation costs.

More than 1000 PV solar plants of lower or higher power on a flat surface have been built worldwide. Solar plants of nominal power higher than 500 kW have been installed in USA, Spain, Germany, Italy, Japan, Holland, Portugal and other countries. California, as the strongest federal US state in terms of economy and in the seventh place in the world by the economic potential, is trying to take a lead in the global list of users of electricity generated from renewable energy sources, as soon as possible. Spain is currently on top of the list with 23 installed PV plants. Close to the place Hisperia in California in 1983 Company Acro Solar Co. set in operation the solar power plant of 1 MW of power which produces 3 million kWH of electricity per year. Solar plant consists of 108 fields of which each should contain 8960 solar cells made of monocrystalline silicon. The biggest solar plant in Germany, *Waldpolonez*, of nominal power 52 MW, produces 52 GWh of electricity per year. The plant covers the area of more than 2 km^2 and consists of over 550 000 solar modules made of amorphous silicon as well as of CdTe solar modules.

In October 2009 one of the largest solar power plants was installed in USA, DeSoto, with 30 MW of power. More than 90.000 single-axis trackers were installed in the area of 180 hectares, which generate 42 GWh of electricity per year, sufficient to supply 3.000 households with electrical energy [4–6].

Solar power plant *Olmedilla*, installed in Spain in 2008, is the largest solar power plant in the world. This plant with installed power of 60 MWp consists of over 160.000 solar modules producing 85 GWh of electricity annually, which is sufficient for supplying 40.000 households. *Lieberose* solar plant with 71,8 MW of installed power was put in operation in Germany in 2009. This plant consists of 700.000 solar modules producing 53 GWh of electrical energy per year, sufficient to supply 15.000 households. *Serpa* solar power plant with 11 MW of power was installed in Portugal in 2007. This plant consists of 52.300 solar trackers that produce 20 GWh of electrical energy per year, which is sufficient to supply 8.000 households with electrical energy as well as to reduce CO_2 emission by 30.000 tons a year.

The on-grid 2 kWp solar plant with solar cells of monocrystalline silicon and with modern equipment for monitoring, acquisition and data processing was installed on the roof of the Republic of Srpska Academy of Sciences and Arts in October 2012. [7–9]. The solar plant is used for scientific, research and educational purposes. Besides, a solar plant Solar 1 was installed in Kozarska Dubica, of company Titanium Power and with 49 kW of power. Having in mind that in the Republic of Srpska there are locations in which the intensity of direct solar radiation is over 3500 Wh/m^2/day and in the south of the country even up to 5250 Wh/m^2/day, we can conclude that both experimental and commercial PV plants may be installed in the Republic of Srpska [10]. Using the PVGIS program, it was calculated that the

values of mean annual energy of solar radiation in the Republic of Srpska falling on 1 m^2 of horizontal surface ranges from 3450 – 4220 Wh/m^2, with the value of mean annual energy of solar radiation falling on 1 m^2 of surface tilted at the optimum angle compared to the horizontal plane between 3930 – 4890 Wh/m^2, and with the value of mean annual energy of solar radiation falling on 1 m^2 of vertical surface between 2570 – 3240 Wh/m^2.

4. ENERGY OF THE WIND

The wind power plant implies a system that consists of a number of interconnected wind generators (wind generator farm).

Based on research it was found that wind generators in wind plants should be placed at distances equal to a tenth part of the diameter of their rotors.

A wind power plant may consists of a few hundreds wind generators and can have a power of 300 MW. Wind plants may be installed both on the land and at sea, where strong and stable winds are blowing [11]. Electrical energy generated by wind plants is passed to the electrical distribution network. The biggest wind plant installed on the land, Norse Nollow Wind Energy Center, with total power of 735,5 MW, is located in Texas. This wind plant consists of 421 wind generators of which 130 are wind generators with individual power of 2.3 MW and 281 wind generators with individual power of 1.5 MW. The biggest wind plant installed at sea *Q 7* is located in the Northern Sea, near the harbour Ijmuiden (The Netherlands). It consists of 60 wind generators of individual power of 2 MW. The wind plant *Q 7* produces 435 GWh of electricity annually, which is sufficient for supplying 125.000 households with electrical energy [2].

The combinations of wind generators with other sources of electrical energy are usual in the world. A wind generator connected with solar cells represents a hybrid photovoltaic system for supplying electrical energy to consumers.

It is most frequently used in isolated locations that are far away from electro distribution network, but is also used with residential and business buildings.

There are two approaches used to estimate the energy potential of the wind in the world: one is based on the assessment of the part of the Solar energy that is spent for creation of general circulation of atmosphere and another, based on measuring the wind speed at a number of points and on processing of this data. Of total energy of the Sun that reaches the Earth, about 2% is spent for creation of air currents which is about 2·1016 kWh. However, this amount of energy cannot be considered as being capable of being fully used as wind-energy potential.

One of the first assessments of the overall world wind potential was provided by IASA experts (*International Institute for Applied Systems Analyses*) in 1981. Based on these estimates, the world's technical potential for utilization of the wind energy is 26.000 TWh annually in the geographical area between 50 º of Northern and Southern Hemispheres. Due to economic, physical and esthetic limitations, about 1/3 of this potential may be used, i. e. about 9000 TWh annually. Total usable wind energy potential in Europe can currently cover about 50% of the electri-

cal energy needs in the European Union. In a strategic document of the European Wind Energy Association (Wind Energy in Europe, A Plan of Action) the European Commission is recommended to set a goal of using 20% of total usable wind energy potential by the year 2030.

German State Company for Sustainable Development *GTZ* (*Deutsche Gesellschaft für Technische Zusammenarbeit GmbH*) developed in 2004 the Atlas of Energy Potential of the Wind in BiH. During the development of regional Wind Atlas in BiH (*REGIONAL RE-ANALYSIS*) meteorological data from a number of years in BiH were used, and the results obtained may be considered sufficiently representative for selecting and macro-locating the areas for building of wind farms.

Based on the wind atlas, one comes to a conclusion that the available wind potential in the territory of the Republic of Srpska is significant with the most suitable area for building the wind plants in the southern part of the Republic of Srpska, between Kalinovik and Trebinje. Theoretically speaking, wind plants of total power of about 64 MW and with total annual production of electrical energy of about 1200 GWh can be built at 13 locations in this area. At present wind is not used for energy generation purposes in the Republic of Srpska. According to available information, in the Republic of Srpska there are currently no wind plant projects that would be at the stage of designing, issuing permits or construction. In the Republic of Srpska Power Utility Company two projects are currently underway for the wind plants with power of 20 MW and 25 MW or for one wind plant with the power of 45 MW in the area between Trebinje and Kalinovik. Based on the *Strategy of Development of the Republic of Srpska Energy Sector by 2030,* it was estimated that in terms of wind plants it was possible to implement up to 350 MW or about 620 GWh out of the envisaged total potential of about 1200 GWh.

5. BIOMASS AND BIOGAS

When biomass is processed into bio-briquettes, its specific heat is significantly increased. The specific heat power of clean bio-briquette ranges from 13570–19303 MJ/m^3, and of bio-briquette in bulk from 5990–12889 MJ/m^3. Based on the results obtained from experimental research, one may conclude that specific heat of bio-briquettes was close to specific heat of high quality fossil fuels [3].

The market for briquettes and pellets has been extensively developing in Europe since 2002. At the beginning 12 countries took part in the development of that market and today this figure is 29 countries. The European market for briquettes and pellets is based on using forest and wood processed waste biomass, and to a lesser degree agricultural and the mix of biomass. A great problem in the development of the European market is presented by limited quantities of forest and wood processing biomass. The European Pellet Center (www.pelletcentre.info) with the seat in Denmark has been making a great contribution to the development of the market of briquettes and pellets. In addition, the development of the market for pellets and briquettes was furthered by the results of two research projects *Altener* (2003–2005) and Pellets for Europe (2007–2009. These projects had a goal to form the

European pellet atlas in real time (www.pelletsatlas.info), to develop a transparent European market and the platforms of major market data on energy pellets, etc. [2]. By collecting data as part of these projects, information was gathered on geographical distribution of the plants producing wood pellets, size of production, production capacities of machines and devices, size of consumption and prices of pellets.

The size of production of pellets from biomass mix equals to about 8.000 t in Europe. Every year Poland has 15 million tons of straw and it produces 80.000 pellets a year. There are two pellet producers in the Great Britain. This market still does not exist in Austria. Despite such a situation, some producers of furnaces and boilers are already offering their solutions for burning pellets from agromass. In Slovakia, Czech Republic, Holland and France, the situation is better. Pellet production in Slovakia is expected to increase from 1000 t/a year to 50.000 to 100.000 tons in the next 5 to 10 years. High demands of the market in Slovakia can be met with parallel production of agro pellets. In the Czech Republic a few thousand tons of pellets are currently produced on the annual level. In Holland about 15.000 t of pellets from soya hull were bought from the Danish industry. The Dutch companies gathered about 250.000 pellets from the mix of biomass during 2013. In France there are 8 agro pellet producers, with the production of 70.000 t of pellets a year. According to the information of EIA (*Energy Information Administration*) in 2007 in the United States, a share of consumption of the energy produced from biomass was 3.6% of total energy consumption in that year.

The existing consumption of biomass for burning is 19.69 PJ, which is 92% of potential from the sources in the area of the Republic of Srpska. Further increase of utilization of wood mass for energy needs will focus on increasing the efficiency of the existing furnaces and boilers run on wood and transition to pellets. Production of pellets in the RS has been encouraged thanks to a legal obligation for storing and disposal of wood waste. More extensive use of pellets for heating the space is expected after 2020. Using pellets for heating the households is anticipated only after 2030, more precisely about 1 PJ for urban households and 0,056 PJ for the needs of service sector. The energy value of 1,06 PJ of pellets is 62 600 t of pellets a year (17 MJ/kg pellets). There is a plan to build two more pellet factories with the capacity of 50.000 tons a year.

The most important characteristic of biogas is heat power. By heat power biogas belongs to the medium class of fuels. Lower heat power of biogas depends on the amount of methane and ranges from 19,7–26,87 MJ/m^3 under normal conditions. Biogas is produced in anaerobic digesters in which fermentation of organic matters (biomass) is carried out. Production of biogas in digesters will take place as long as all the necessary conditions for the process of substrate fermentation are met, of which the most important is keeping constant temperature. At optimum temperature of 32–35 °C, extraction of biogas lasts for 18–22 days. Different types of digesters are used in the practice, and they differ by their construction. (design).

About 150 m^3 of biogas a day should be provided in order for an investment to be effective. This amount of biogas enables daily production of 400 kWh of ther-

mal energy, 210 kWh of electrical energy, 3 m^3 of liquid organic fertilizer and 10% of dry organic fertilizer.

By the year 2020, the use of 4% of total potential for production of biogas is envisaged, by constructing four agricultural plants for electrical and thermal energy (with the size 0,5–1 MW) and four industrial cogenerations on biogas next to the food and drinks factories (with the size of 1 MW). Heat from agricultural plants will be used for smaller rural systems of distant heating. Industrial plants will use the heat in their own production processes. By 2030 the capacities of the said plants are expected to double [15]. In the Republic of Srpska there is a factory for production of biodiesel from the rape with the capacity of 50.000 tons a year. Since January 2009, biodiesel has been used in small quantities in public bus transport in Banja Luka.

CONCLUSION

This technological process has had an effect on all spheres of human activity. Therefore it is necessary to persist in increasing a share of clean energy sources in total energy production, as this has many positive social repercussions, such as: reduction of emission of pollutant matters, disposal of waste, creation of new jobs and keeping the existing ones, and the possibility of development and increasing competitiveness of domestic industry. It is exactly the influence on creation of new jobs and on other social and economic aspects (regional and local economic activity, circulation and keeping the money in the society, i. e. the local community, investments, earnings and taxes) that is an advantage of clean energy sources. A transitional movement has been taking place around us – a movement toward localization instead of globalization, in which cooperation, creativity and exchange, as opposed to competitiveness and pattern-based behaviour, represent a basis for communication and new economy – thus forming a foundation for transition to a "new society".

More precisely, it is exactly the development of financial power – creation of general wellbeing by exploitation of new business opportunities in the field of clean energy, water and material – that forms a precondition for building a stable and sustainable human community. With an adequate support of capital, politics and different subsidies from all authorities' levels, technological market will become the main driving force behind such revolutionary changes in the way to do business.

The possibilities of meeting the needs of the growing human population by the application of clean technologies are amazing. However, big changes in the energy and water supply sectors do not happen on a weekly or monthly basis, but take many years, even decades to happen. This is exactly the main difference between the revolution of clean technologies and the sector of computers and the Internet. Transition to the energy system in which 25 to 50% of total energy needs will be supplied from renewable and efficient sources requires a time period of 25 to 30 years.

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