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DELTA UNIVERSE AND NATURE PROTECTION IN THE DANUBE DELTA

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Abstract: *Danube, the second longest river in Europe through a tortuous path in the Black Forest to the Black Sea. River arises through union sources: Breg, Brigach, Donau Quelle and joins the sea by three branches: Chilia, Sulina and St. George forming the Danube Delta. As space crosses so large and diverse to establish the International Commission for the Protection of the Danube River which aims to ensure the sustainable use and equitable access to water resources along the river basin, the Commission's work jumpers Danube River Protection Convention which is an important instrument for cooperation and transboundary water management in the Danube basin. Romania was in 2007 president of the International Commission for the Protection of the Danube River. Romania is interested to protect the water of the river, given the length that it crosses the country and the fact that the arms of the Danube flows into the Black Sea forms one of the most rare and beautiful wetlands, named Danube Delta. It is appreciated that the Danube Delta Biosphere Reserve has become as compared to other deltas of Europe and the Earth has retained a high biodiversity, that a multitude of species from a variety of systematic units. In the European continent, Delta retained natural habitat. This area has special significance both ornithological aspect and morphological and climatic factors have described it as a very important reserve. Nature reserves in the area of 41500 ha were delineated in three different biotypes of the delta and was placed in the international studies program "Man and Biosphere" attached to UNESCO to recognize the importance of Romanian scientific nature reserves and the richness and variety of flora and fauna elements.*

Keywords*: biosphere, convention, delta, flora, river.*

1. INTRODUCTION

Nature recommences same things again, every year, day, hour, so it creates a kind of infinity and eternity – Blaise Pascal Danube from its source at the river mouths- Danube Delta.

The Danube River is the second largest in Europe after Volga and it is formed by the confluence of the rivers Briegach and Brege that arise from the Black Forest. The Danube has a length of 2 840 km; an area of its basin is about 817 000 km2; the incoming flow into the Delta is of 6350m3/s and is divided in the three branches: Chilia 58%, Sulina 19%, Sf. Gheorghe 23%. The Danube Delta is shared by Romania and Ukraine and has a total area of 4178 km2, of which 82% (3446 km2) in Romania and 18% (732 km2) in Ukraine.

Because of its route, the Danube can be called the river of ten countries (Germany, Austria, Slovakia, Hungary, Croatia, Serbia, Romania, Bulgaria, Republic of Moldova, and Ukraine) and also the river of four capitals (Vienna, Bratislava, Budapest, Belgrade).

2. MATERIALS AND METHODS

2.1. The International Legal Regime of Danube

Water is an indispensable element of the existence of life on the planet, a renewable, vulnerable and limited natural resource, a raw material for productive activities, an energy source and a transport pathway, a key factor in maintaining the ecological balance for the existence of life and the realization of all human activities (Dutu, 2010). “This scarce resource essential for life should be considered a natural treasure that is part of the common heritage of the mankind”.

2.2. The international regulations on the protection of the Danube

The international regulations on the protection of the Danube appeared relatively late in comparison with those for other continental waters. For a long time the international legal regime of the Danube referred exclusively to the freedom of navigation, to the economic and technical use of waters and to the fishing (Marinescu, 2003).

Since it crosses a vast space it was set up the International Commission for the Protection of the Danube River. The Commission aims to ensure sustainable use and equitable access to water resources along the river basin. The Commission's activity has the Convention of the Danube River Protection as a starting point, which is an important instrument for cooperation and trans-boundary water management in the Danube basin.

An important moment in the history of Danube´s protection efforts is the signing of the Declaration of Cooperation between the Countries of the Danube in the Management and Protection of the Waters of the River against Pollution on 13 December 1985 in the Conference of Bucharest (Dutu, 2010).

After 1990, the riparian concern regarding cooperation in order to protect the river from pollution, both bilaterally and multilaterally grew. The situation materialized with the signing of several conventions and agreements, among which the Convention on Cooperation for the Protection and Sustainable Use of the Danube River - signed in Sofia, at June 29, 1994.

2.3. Current International Legal Framework

The international legal framework for protection against pollution of the Danube border currently has three categories of international norms: rules and principles on trans-boundary pollution, specific regulations targeting watercourses and international lakes, and regulation governed by coastal states within bilateral and regional cooperation.

2.3.1. Principles on trans-boundary pollution

Most of these principles are rooted in customary international law. The Stockholm Declaration on the Human Environment in 1972 established the fundamental rule which provides that the states must proceed in such a way that activities within their jurisdiction do not damage the environment of other states. This rule was taken up and proclaimed subsequently in the texts adopted at the 1992 Rio de Janeiro Convention on Environment and Development (Cobzaru, 2013).

Other principles and rules were set out in the Espoo Convention -1991- on environmental impact assessment in a trans-boundary context. The same category of principles on trans-boundary pollution includes rules concerning the responsibility of polluters, the duty to inform immediately the states likely to be affected by any event which may cause adverse effects on their environment, the rule of equal application of the national law, regardless of the place producing the environmental damage.

2.3.2. Specific regulations regarding watercourses and international lakes

The development of this category of regulations occurred through two framework agreements: the Helsinki Convention -1992- on the protection and use of trans-boundary watercourses and international lakes and the Convention on the right of use of waterways for purposes other than navigation -New York, 1997.

The concept of trans-boundary waters and of trans-boundary impacts was explained and regulated according to the terms of The Helsinki Convention which is the international regulatory framework on the subject. The injurious effect of the trans-boundary impact can "take many forms: attacks on human health, flora, fauna, soil, air, landscape and historical monuments, buildings; the interaction among these factors may also means a breach of cultural heritage and of socio-economic conditions resulting from alterations of those factors."

The Helsinki Convention has created a general legal framework that was an incentive for the elaboration of agreements between riparian of international watercourses to prevent and reduce trans-boundary pollution.
The New York Convention aims "to enable to use, highlight, devote, manage and protect international watercourses and promote optimal and sustainable use for the benefit of current and future generations".
The general principles of the previously mentioned conventions are equitable and reasonable use, the obligation to not cause significant damage, paying special attention to meet the essential needs in conflict resolution etc.

The Sofia Convention -1994- on the sustainable protection and conservation of the River was signed by the ten Danube countries and the European Community, and it has a sub-regional integrative character.
The fundamental objectives of cooperation between the Danube countries, the basic principles of the river protection, and so on were thus established. (Dutu, 2010)

A series of bilateral documents aimed preventing and combating the pollution of the river was agreed between riparian states. Such documents are: in 1991 the Convention between Romania and Republic of Moldova, in 1991- the Convention between Romania and Bulgaria in 1993 the Agreement between Germany and Romania, in 1993 the Convention between Romania and Slovakia, in 1998 the Convention between Romania and Yugoslavia on operation and maintenance of hydropower and navigation systems "Iron Gates I" and "Iron Gates II".

Community environmental law is constantly growing. The member states of the European Community have already assimilated the Community rules into law while the candidate states are in the process of harmonizing and assimilating those; the adoption of EU legal regulations (represented by about 20 directives on water) is an important milestone, especially for determining the water quality objectives and the regulation of water discharges.

The International Day of the Danube is celebrated every year on the 29th of June, as initially proposed by the Danube countries and under the auspices of the International Commission for the Protection of the Danube River (ICPDR in Vienna). This day marks the signing of the Convention on Cooperation for the Protection and Sustainable Use of the Danube River, an event that took place in Sofia (Bulgaria), on June 29, 1994.
Danube Day celebrations take place in all Danube states to mark their mutual desire to join forces in support of protecting this unique river in Europe.

The International Commission for the Protection of the Danube River launched "Danube Box", an educational project in the domain of the water protection. This project is designed as a tool (kit) to be use by teachers and students in the education process at the level of elementary school.

"The Book of the Blue Danube" has a special role to inform and educate children on values and traditions belonging to the Danube area and increase their awareness regarding the need to protect and preserve the aquatic ecosystem of the river basin.

The Danube creates a delta with three great branches at its mouth to the Black Sea. The first branch is Chilia. With a length of 120 km it is the most vigorous as it accounts for 58% of the Danube's flow. Chilia, with its many biffs and islets, has the greatest depth of the three channels, 39m.

Sulina, the second branch, is mainly used for navigation because there was done extensive work to deepen and to correct the meanders. The channel length decreased from 93 km to 64 km because of these works which took place between 1862 and 1902.

The third branch, Sfântul Gheorghe, is the oldest and it carries 24% of the volume of water and river deposits (alluvia). The branch has undergone significant transformations, namely the cutting of six meanders, which brought its length down to 70km.

Remarkably, the Danube Delta has become a biosphere reservation. It has retained a high biodiversity (a multitude of species from a variety of systematic units) in comparison with other deltas in Europe and even on Earth. The Danube Delta has become a Biosphere Reservation due to the fact that compared to other deltas on Europe or on the Earth; it has retained a rich biodiversity, ie a multitude of species from a variety of systematic units. Given the importance of this unique space, since 1991 the Romanian government started a comprehensive program to inventory the flora and fauna of the Danube Delta Biosphere Reservation. The purpose of this ample effort is to gain a better understanding of an important component of the natural heritage in a biosphere reservation and identifying species that require protective measures and / or conservation.

As a result, this huge puzzle represented by the Danube and its delta is a habitat for a wide variety of plant and animal communities estimated at 30 types of ecosystems and 7405 animal and vegetal species.

Given the unique nature of the Danube Delta, the concerns about environmental protection, rational use of resources and preservation of its ecological balance have increased.

Regarding the delta, technical and scientific research revealed two relationships that are fundamental from an ecological point of view. These relationships affect an area far beyond their geographical boundaries, namely:
a.- the key position for the ecology of fish fauna in Danube Floodplain and the Black Sea coastal zone;
b.- the key position in the life of migratory avifauna in Europe, taking into account that delta is situated at the crossing of the main bird migration routes.

3. CONCLUSION

The Danube Basin contains various riparian countries and a total population of about 250 million inhabitants, which generates pressure on the river environment. Generally, Coastal States have not sufficiently developed economies and they do not give due consideration to environmental issues; from the point of view of the industry, agriculture and technology, the most developed is the upper basin, followed by the middle basin and the lower basin.

The Cooperation of the Danubian states is influenced by reporting to the process of European integration in the context that a part of riparian countries are members of the European Union (Germany, Austria, Czech Republic, Hungary, Romania, Bulgaria).

The Conservation of the natural conditions and historical and cultural monuments aligns with the basic concerns of our state: "It is necessary to take rigorous measures to control the industrial hazards, to prevent water and air pollution, to protect the forests, rivers, mountains and lakes considered monuments of nature. Within the European committee, the Danube Delta maintains its natural biotope and thus it has an exceptional significance taking into account the ornithological rapport and the morphological and climatic factors that have made from it an important reserve with many rare vegetal and animal species. These features have made the delta to be considered absolutely unique compared to any first rank touristic area in our country.

The Danube Delta integrates:
- Resources of reed (cane) for cellulose and paper manufacturing industries;
- Areas for hunting and fishing;
- Recreation places for tourists;
- Areas of scientific interest.

In 2000, due to the favorable conservation status of the ecological systems and species in the Danube Delta, the Council of Europe awarded the European Diploma for this reserve, diploma renewed in 2005. Home to a wide variety of plant and animal species as well as associations and communities particularly interesting and valuable, the Danube Delta remains one of the best preserved deltas in Europe, being declared Natura 2000 site both as Special Area of Conservation and Avifaunistic Special Protection Area.

The objectives that we have set through the establishment of the Danube Delta Biosphere Reservation are based on the principle of sustainable development whose primary goal is re-naturalization of the delta by removing the disastrous effects of the past. Parallel efforts were made to preserve the entire Delta ecosystem's potential fauna and flora, to be able to offer to people loving the nature not only eco-tourism, but also the opportunity to enjoy - now and in the future - the benefits of nature.

The fragility and the active dynamic of the deltaic system aroused for a long time the interest of scientists. At the same time, all actions that must carry ARBDD require a scientific foundation for a rational, environmental management, ensuring both biodiversity conservation and sustainable development. The Danube Delta is the chosen place by nature and people, where all actors involved are trying to understand and learn how to use natural resources and, at the same time, preserve them for the future.

The Romanian wetlands were defined as stretches of swamps, marshes, natural or artificial, permanent or temporary waters, where the water is stagnant or flowing, fresh or salted, including the marine water bodies whose depth at low tide does not exceed six meters. The above mentioned areas are areas where the saturation with water is the main determinant of the soil nature, and of the types of plant and animal communities living in the soil or on the soil surface.

The Convention on Wetlands signed in Ramsar, Iran, in 1971, established February 2nd as World Wetlands Day; the document was ratified by Romania through Law 5/1991. This year, the World Wetlands Day is celebrated under the slogan “Without wetlands there is no water" and is the occasion to draw attention to the fact that the sustainable use and conservation of the wetlands must be part of any solution to reduce the global drinking water crisis.

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ALTERNATIVE – RSE ENERGETIC RESOURCES IN SLOVENIA AND SERBIA AND ITS POSSIBILITIES OF EXPLOATATION IN PRACTICE

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Abstract: *Energy represent important source on the whole parameters of life. For human and other living organisms-give us an imortant souce for growth, progress, industry for resources, and production, nature for its survive. In this time and place, so many states, reduce its own consumption and with energy dependence and on the other hand with searching alternative sources, which will replace gas, oil, coal. Because of market demands, reducing fosil fuels, economic circumstances and in connection with political dependence and not at the end growth of environment senses. Countries have different nature possibilities depends of geografical, geological and generally economical situation. Many resources are have been disregarded, because of different reasons and energetic lobies. Today in time of many crisis with those alternative resources, countries can improve better and reliable use of energents. In this paper we will represent comparative possibilities two states Slovenia and Serbia, as future members of EU and compare with European. We will try to represent greath potention of exploatation sources in the case of development and economical potential two countries*.

Keywords*: energetic dependence, fosil fuels, alternative sources, European union, ecological minds*

1. ENERGY AND RENEWABLE SOURCES OF ENERGY (RSE)

The word energy derives from Greek words *ergon* which means work, power and vitality, and from the word *energeia* which means activity. Because of this the concept of energy is connected with the ability of a body to perform a work (Rant, 2008).

Renewable sources of energy (RSE) are sources which can restore and replace utilized resources as are wood-biomass, wind, hydro energy, sun energy.

Various states use different strategies to fulfil everyday needs of energy. These strategies depend on energy needs, trends in future, own resources etc. Slovenia for a certain period of time balances between criteria and demands resulted from the membership in European Unity, its own resources and dependence from foreign resources which presents about 50% of total energy need. Because of facts which have been already mentioned it is urgent to chose the adequate energetic scenario as soon as possible.

- **Fossil-nuclear scenario** with supposes energy increase for 30-40%. These scenario incorporates considerable increase of capacity of thermal power plants (TPP) using coal or gas; extension of operation of Nuclear power plant in KRŠKO (NEK – Nuklearna Elektrarna Krško) and construction of the second block Nuclear power plant Krško, construction of gas terminal in Koper, or construction of wind power plants and hydroelectric power plants.

- **Bad sustainable scenario** which assumes stabilization of electric energy use, continuation of operation for existing thermal power plants with the change of fuel (transition from coal to gas), eventual extension of operation for nuclear power plant in Krško, construction of hydroelectric plants along the entire Slovenian section of the Sava river, and smaller wind power plants and considerable number of photovoltaic power plants.

- **Significantly decentralized sustainable scenario** which assumes continual decrease in the use of electric energy and increased number of thermal plants for district heating– power plants (co-generation of thermal and electric energy) which will use gas and biomass as a fuel, closing of nuclear power plant in Krško until 2030, more hydroelectric power plants along the entire Sava river, increased number of small hydroelectric plants as well as use of geothermal energy and photovoltaics (Plut, 2010).

According to the available information and the facts that a new block in Thermal power plant Šoštanj (TEŠ 6) is in construction and there can be also observed strong tendencies to build additional block in nuclear power plant Krško it seems that the centralized and intensive fossil-nuclear scenario is the most probable (Plut, 2010).

In the long term energy balance for Slovenia until 2030 it is expected that 580 GWh of electric energy will be provided from dispersed renewable energy sources and 1.555 GWh from intensive centralized sources. The main contribution to the increase in the production of electric energy is expected from small hydroelectric power plants, wind power plants and from the use of biogas and wooden biomass.

1.1 Renewable Energy Sources in energetic balance of Slovenia until 2030

According to demands of EU which suppose continuous growth of production and use of energy from renewable sources in Slovenia it is expected that until 2030 the production of electric energy will increase on the following segments:

- Small hydroelectric power plants 72 MW (construction of new plants and extension of existing plants)
- Biogas power plants 41 MW (landfill gas, gas from agriculture and waste water treatment plants)
- Wind power plants 150 MW
- Photovoltaic plants 100 MW
- Wooden biomass plants 35 MW
- Big hydroelectric power plants 350 MW (finalization of plants in the lower Slovenian part of the Sava river 154 MW, construction of plants in the middle part of Sava 189 MW and reconstruction/finalization of plants in the upper part of Sava 12,5 MW).

In the period until 2030 it is expected that the total use of energy from renewable sources from existing 32,3 PJ will increase on 53,8 PJ (increase of 67%) (SURS, 2014)[1].

EU demands obligate Slovenia to increase production and use of energy from renewable sources. Nevertheless, there can be observed the influence of certain lobbies which try to limit the use of energy from renewable sources. This presents a step back in the process of green energy production. This is particularly evident in legislative regulations which limit or hinder the construction of small hydroelectric power plants, wind power plants and photovoltaic plants. The most evident regress in promotion of green energy presents the construction of the sixth block in the Thermal power plant in Šoštanj (TEŠ 6).

2. RENEWABLE SOURCES OF ENERGY AND EU

Today become more and more evident two facts: the exhaustion of stocks of fossil fuels and consequential tendencies to reduce energetic dependency as well as increased care for environmental protection and reduced degree of pollution. Therefore, many states turn from conventional energy sources as are coal, oil and gas to alternative sources of energy. They try to satisfy their energy needs with their own resources and thus increase energetic independence. Which energy alternative sources of energy are used depends on natural – geographical specialities of a particular country, by example Iceland exploits geothermal energy, Spain sun energy, countries with rich water resources exploit hydro energy etc.
States, members of EU as well as states which plan to join EU like Serbia have to reach in the period until 2020 certain goals in coordination to the Climatic-energetic package of measures accepted by EU on January 23rd 2008. Renewable sources of energy relate to three fields: electric energy, heating and traffic.

1 Original - SURS Statistični urad Republike Sovenije – english-Statistical office of the Republic of Slovenia

The concrete way on which particular states will reach these goals depend on their own natural and energetic-economic resources. Particular goals, emphasized in EU documents, are:

- At least 10% energy used in traffic should derive from bio-fuels
- Reduction of annual carbon dioxide emissions for 600-900 millions of tons for the entire EU
- Reduction of fossil fuel use for 200-300 millions of tons for the entire EU
- Reduction of dependence from fossil fuel import and thus increased stability of energy supply in EU
- Increased initiatives for the development of high technological industry offering new economic opportunities and creating new working places.

From Figure 1 it can be seen that particular countries have already reached the planned goals (20% of energy from renewable sources, by example Sweden, Finland, Denmark and Austria. On the other hand, countries classified at the frontend of ranking as are Malta and Cyprus will hardly reache the goals. Slovenia with 19,6% of renewable energy used in 2013 approached very close to the fulfilment of planned goals.

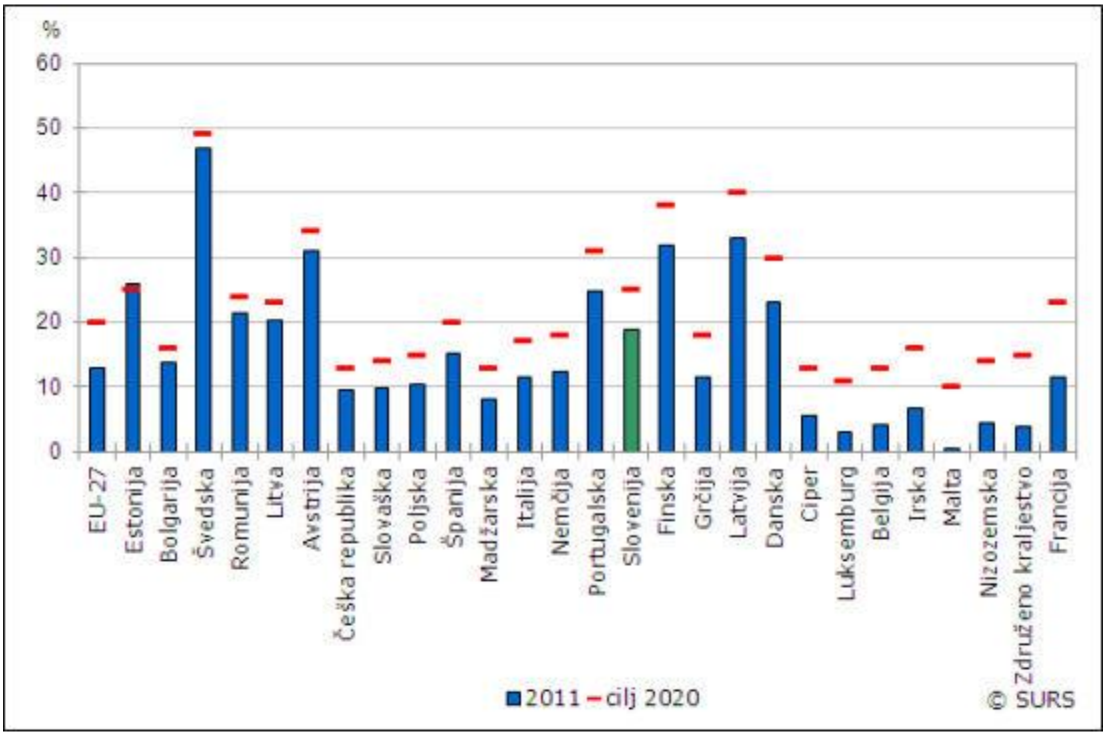

Figure 1: Share of energy from renewable sources in the total energy balance for EU countries (SURS, 2014).

3. SLOVENIA AND RENEWABLE SOURCES OF ENERGY

Slovenia as meber of EU is obligated to reach the following goals in the period until 2020:

- 25% share of crenewable sources in the final energy use
- 20% increase in energy efficiency
- 20% reduction of greenhouse gases emissions
- 10% share of biofuels use in traffic.

Biomass Slovenia has on disposal various potentials to meet the obligations and planned goals. Wooden biomass is one of the most important natural resources in Slovenia. 62,8% of the Slovenian territory is covered by forests. This ranks Slovenia in the third position in Europe, following Finland (73,9%) and Sweden (66,9%) (Bončina, 2013). The entire area of forests in Slovenia is 1.264.000 hectares. The annual increase of wooden biomass is 7.900.000 m^3 or 6,64 m^3 per hectare (Ministrstvo za kmetijstvo in okolje-

Ministry of Agriculture and the Environment and Zavod za gozdove Slovenije- Slovenian Forest Service). Biomass use is reasonable in the case of better utilization of wood and improved systems for combustion in larger as well as in smaller local heating systems.

Hydro-energy On the second place after wooden biomass in Slovenia are water resources. Potentials exist on bigger as well as in smaller rivers which derive in Slovenia, by example the degree of exploitation in Sava is only 34%, in Soča 18,5% meanwhile the greatest unexploited potential exist on Mura and Idrijca (now only 0,3% degree of exploitation). On the other hand, Drava is its Slovenian part (entrance from Austria by Dravograd and exit in Croatia by Ormoţ) already exploited at the degree of 97,8%. Hydro-energy presents the second most important source of renewable energy. The estimated energetic potential of Slovenian rivers is 19.400 GWh/year meanwhile technical potential is about one half of this (9.100 GWh). Economic viability is estimated between 7.000 and 8.500 GWh/year. In the case of construction of hydro electric power plants in the middle and lower part of Sava river the installed power will increase up to 274 MW. This would be reached in the case of construction of hydro electric power plants Blanca at Sevnica, Krško, Breţi ce and Mokrice.

Solar energy and potential of sun energy present additional potential of green energy. Periods of solar irradiation in various parts of Slovenia differ considerably due to the relief specificities. They range from 2.000-2.500 hours/year to 1.650-1.850 hours/year average in the continental part of Slovenia (Ogrin, 2002). The important differences exist among various parts of the year by example in winter valleys are often covered by fog meanwhile in mountain regions is the sunny weather. Sunny regions in the world often reach the average 2.500 kWh/m^2 meanwhile in Slovenia this is only 1. 500 kWh/m^2 (Medved and Novak, 2000, Medved and Arkar, 2009).

Geothermal energy presents very important potential which in Slovenia for certain period of time is already exploited in the North-eastern part of the state. Geothermal sources which were found in the North-eastern Slovenia exhibit considerable possibilities and can be exploited for the operation of 15 to 30 power plants with average capacities of 7-15 MW. In the near future it would be possible to produce 100-200 GWh of electric energy per year in the case of appropriate partnership between state and investors.

4. RENEWABLE SOURCES OF ENERGY IN SERBIA

Serbia as a future member of EU in the field of renewable sources of energy has to follow EU directives and goals obligatory for EU member states. However, Serbia will reach these goals (by example Slovenia has goal until 2020 to use 25% of energy from renewable sources) in a longer period of time. The most important problems in Serbia are low energetic efficiency, outdated technological systems in energetics, lack of investments and various lobbies in energetics.

In Serbia in 2006 only 6% of total energy use derived from renewable sources. The majority of renewable energy is produced in big hydroelectric power plants and a very small part derives from use of geothermal energy or biomass – only 39.272 PJ of 609.096. The most important energy source in Serbia in the year 2006 was coal (55%) followed by oik (26%) and gas (13%). The major part of renewable energy as has been already mentioned in Serbia is produced in big hydroelectric power plants with capacities more than 10 MW and annual production of 10,3 TWh – 25.200 TJ..

4.1 Potentials of Serbia for production of energy from renewable resources

Total technical potential is over 160 PJ per year. The greatest part of this – 62% (100,4 PJ) presents potential of biomass, almost 17% presents solar energy with 26,7 PJ, 10% (16,7 PJ) energy from small hydroelectric power plants, and 5% geothermal energy (8,3 PJ) as well as wind energy (7,9 PJ). According to the official projections the share of renewable energy in the total energy production will remain unchanged until 2015.

Hydroelectric power plants In Serbia exist 900 locations on small rivers with possibilities for construction of power plants. 90% of these power plants would have capacity less than 1 MW. However, there exist also considerable possibilities to reconstruct big hydroelectric power plants as are Đerdap and Bajina Bašta. Small hydroelectric power plants with capacities between 216 kW and 8 MW are planned in Sopočani, Bela

Palanka, Rečica, Rainara, Javor, Sokolovac and Bovan. The total capacity will be 0,5 millions of toe[2] or 5.815 GWh.

Wind energy is another potential form of renewable energy. However, exploitation of wind energy is reasonable only in seven areas in which average wind velocity is about 6-7 m/s. Moreover, only one location – on the Miţo r mountain – can be classified as good. Potential of wind energy is 0,2 millions of toe or 2326 GWh. Other potential locations are Eastern part of Serbia-Stara Planina, Ozren, Rtanj, Vlasina, Zlatibor, Kopaonik, Divčibare and in Panonian plain Vršac and Bela Crkva.

Biomass There exist considerable possibilities for biomass use in Serbia. However, modern advanced combustion systems should be applied. To estimated potential of 314.000 GWh or 2,7 millions of toe potential of 314.000 GWh or 2,7 millions of toe presents more than half of total renewablewable energy resources (except big hydroelectric power plants). Remnants from wooden industry and forestry present about 1 million of toe. The total area of forest in Serbia presents 27,3% of the total Serbian territory: Vojvodina 6,8%, central Serbia 32,8% and Kosovo and Metohija 39,4%. Energetic potential of livestock is about 42.000 toe, in agricultural, vineyard and fruit sector is estimated to approximately 1,7 millions of toe.

Geothermal energy: Geothermal energy in Serbia exhibits great potential which is today exploited in a very low degree. About 100 locations with thermal wells have potential of about 2.300 GWh/year. The regions with the most pronounced geothermal potentials are in Vojvodina, the highest temperature of spring water is Vranjska banja, Jošanička banja and in Sijerinska banja.

Solar energy: The estimated potential of solar energy in Serbia is 0,6 millions of toe or 6.978 GWh and thus presents presents the third most importanr potential of renewable energy. The sun radiation intensity in Serbia is about 40% higher than European average. Nevertheles, the exploitation of solar energy in Serbia is still much less intensive than in many other European countries. Average annual level of solar irradiation in Germany is 1.000 kWh/m^2 meanwhile in Serbia is 1.400 kWh/m^{2}The areas in Serbia which are particularly interesting for exploitation of solar energy are the sorroundings of Leskovac, Pirot, Vranje and Prešovo, but also in 50% of other parts of the state the exploitation of solar energy is reasonable (Despotović, 2009).

5. CONCLUSION

Slovenia and Serbia have considerable potential for production of energy from renewable sources. However, the adequate vision of future energetic policy is necessary. The support of the state and orientation to green energy production is also very important. Slovenia has great potential in wooden biomass and geothermal energy as well as in construction of small hydroelectric power plants. In Serbia there is potential in construction of big and small hydroelectric power plants. However, the realization of these possibilities for green energy production in practice depends on many factors. These factors include economic power of the state, interests, environmental awareness of the citizens etc. Today, unfortunately, to often happens that political-economic lobbies limit expansion of production and use of energy from renewable resources – as shows in Slovenia by example the case of TEŠ 6 (the sixth block of thermoelectric power plant in Šoštanj). Also in the case of exploitation of renewable sources of energy it is very important to take care for protection of environment and wildlife. When locating various objects into the environment there must be paid considerable attention to all possible effects on the nature. In Slovenia exist great possibilities for the so called dispersed regional production of renewable energy which will enable safe supply with energy on the entire territory of the state. There should be emphasized that also in the case of production of energy from renewable sources certain negative impacts on the environment can not be avoided. However, in the case of production of energy from renewable sources these negative impacts on the environment are smaller than in the case of fossil fuels or nuclear energy.

When regarding the production of energy from renewable sources Serbia is in the beginning of a journey. There exist considerable potentials for the production of energy from renewable sources in the state.

2 1 toe is 1 ton of oil equivalent, or 11,360 kWh.

Particularly should be emphasized the potential of hydroelectric power production – big power plants as well as construction of many smaller power plants. There is necessary to restore existing power plants as well as investments in new objects. Besides hydro electric power in Serbia interesting potential exhibits also geothermal energy. The fact that Serbia is still in the beginning has also some advantages as experiences of some other countries can be used and examples of good practice can be followed.

Both, Slovenia and Serbia, must take care of lowering energy consumption. The introduction of systems with more rational energy use is necessary as well as change consumer habits of citizens. The zero degree of energy consumption growth should be reached as soon as possible as well as reduction of personal environmental footprint until 2020.

Trends to exploit alternative and domestic sources of enegy become more and more actual because of recognition that stocks of fossil fuels are limited. The exploitation of domestic energy sources is interesting also because of economic effects as well as because of political independency of imported energy. Appropriate procedures exist, they should only be implemented in practice – however, this depends on economic power of the society. When regarding protection of the nature and sustainable development energy deriving from renewable sources presents undoubtedly the energy of future. energije, su svakako energenti budućnosti.

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THE MODEL OF AN ORGANISATION OF THE EFFECTIVE PUBLIC COMMUNICATION IN HAZARDOUS WASTE MANAGEMENT

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Abstract: *The presenting paper maps the problem of communication in hazardous and industrial waste management. It discusses the model of successful waste management with the support of communication strategy. The case of remediation of acid tar dump explains the necessity to accommodate the rising democratic expectation of public participation in deliberations over the incineration waste policy. Accordingly the transparency and the communication of the process with the dissemination of results is an important element in the successful model of hazardous waste management. The technical elements of the process are discussed with the explanation of successful communication model. The waste management in the case of acid tar remediation in Slovenia stresses the need for investment at the level of public participation and public communication.*

Keywords*: communication, public communication, waste management, model of communication, public, communication tool*

1. INTRODUCTION

Environmental activities that are part of any industrial projects need the strategy of communication as part of public interest. The public communication about the waste management, particularly hazardous waste, has often been excluded from policy processes.

People's responses to different risks are determined by psychological factors and technical information would rarely have a very strong impact to people's reaction. Awareness and understanding of public concerns must be the basis of an effective risk management strategy. (Frewer, 2004)

In oil refinement process, based on the treatment with sulphuric acid, a bituminous residue, called acid tar, is formed. With such a treatment, linear paraffin molecules (desired fraction) are divided from undesired additions (aromatics, iso-paraffines, heterocyclic compounds). Acid tar is a mixture of liquid, paste-like and solid hydrocarbons, containing free and bound sulphuric acid (Nanut, 2010). The remediation of acid tar dump in Slovenia can be analyzed as hazardous waste management. This was the basis for our investigation about public communication in this sphere of action (Ţilič-Fišer, Dvoršak 2010). As a case study we analyzed the remediation of the area, called Pesniski Dvor that is situated in North East part of Slovenia, close to the border of Austria. The project was coordinated by company Gorenje Surovina which is a leading company in the field of waste management in Slovenia. The technical elements of hazardous waste management were included in the process in production but are not key elements for the aim of this paper. Our focus was to present the importance and the potential of the public communication in the field of waste management. For the aim of public communication we produced the documentary film that was discussed as important communication tool in the hazardous waste management.

In Maribor the re-refining of the used motor oils with the process of treatment with concentrated sulfuric acid was done. Refinery disposed the acid tar, which is the residue after the treatment with sulfuric acid since 1967 in landfill in Pesniski dvor. Acid tar is a thick, viscous substance with an acidic smell; it can contain 10-50% sulfuric acid and a noticeable amount of oil and resin and is highly corrosive toward metals. Acid tars are amenable to oxidation and solidification in air; therefore, their properties could substantialy vary during storage (Kolmakov, 2007).

The landfill was built in accordance to the applicable regulations and permits of the competent administrative authorities in 1966, an operating permit was issued in 1967. The refinery disposed the acid tar until the year 1983. Since then, the old abandoned landfill is a burden, which represented a significant risk for the environment and required the intervention for the remediation. Historically, acid tars have been disposed with or without prior treatment in worked out quarries, clay or gravel pits, or landfills, normally referred to as acid tar lagoons. This dumping is not environmentally sustainable because of the potential risk posed by the components of acid tars to human and ecological receptors (Leonard, 2010). Once acid is generated, it may contaminate receiving water, lowering the pH and increasing the concentration of dissolved elements (particularly metals) of environmental concern. If unchecked, acid drainage can result in acute and chronic impacts on aquatic ecosystems, as well as community health risks. The paper maps the communication importance in the hazardous waste management and presents the business model that can be applied into area in the broader region.

2. RESEARCH OBJECTIVES

The first research objective was to analyze the results of the technology solution for the acid tar remediation in Pesniski Dvor during the whole process. The remediation of the dumping site of the acid tar at Pesniski Dvor includes the preparation works, excavation of the acid tar and contaminated soil, process of the solidification and energy recovery of the solidificate, recycling of the contaminated soil into construction materials, dismantling of the technological equipment and removal of the objects and revitalization of the dumping site.

The second research objective was to analyze the public participation and integrating environmental monitoring results in effective public communication. Public participated in the complete process of the remediation of the disposal site of acid tar in Pesniski Dvor from the obtaining of the construction and environmental permit until the end of project activities and revitalization of the disposal site. The project activities and objectives were transparent and all the monitoring results were published.

The third research objective was to examine the appropriate communication tool for presentation of acid tar remediation to broad audience and to design the model of communication that can be implemented in the hazardous waste management in Balkan area. Public concerns influence consumer behaviours, citizens' support of environment pressure groups, and political preferences of voters during elections. Therefore, the effective risk communication and successful communication to broader public should be the priority in hazardous waste management.

The model of acid tar remediation in Pesniski dvor explained the importance of dissemination of results in the way that could be easily perceived by the broader public. Moreover, the research and the explanation of the remediation with the audio-visual product resulted in the positive attitude toward the waste management.

3. METHODS TO DESIGN THE MODEL OF WASTE MANAGEMENT: CASE STUDY OF PESNISKI DVOR

3.1. Method of technological solution for the remediation of acid tar in Pesniski Dvor

The main criteria for selecting the technological solution for acid tar remediation were the sustainability of the technology. Due to these criteria different technological solutions were examined. The technology was approved by the investor and the Ministry of Environment in Slovenia. The chosen technology had the minimal environmental impact during the construction of the equipment for the solidification on site, operating and dismantling of the equipment.

The technology for solidification of the acid tar had the capacity of the 10t/h and was installed in the immediate vicinity of the dumping site. The excavated acid tar was delivered to the receiver-mixer, where waste wood, stones and bulky waste were sorted out non-reactive additives (saw dust, coal dust...) were added to the acid tar and the consistence of the mixture was adjusted. The pre-mixture went through the metal separator into the lamella mixer where reactive additives were added and neutralized the acid substances in the mixture. To achieve the best results of the neutralization it was necessary to have the suitable mixing and exact time. The type of added reactive additive depends on the analyses of the acid tar, availability, price and distance from the local sources of supply. The mass flow diagram is shown in Figure 1.

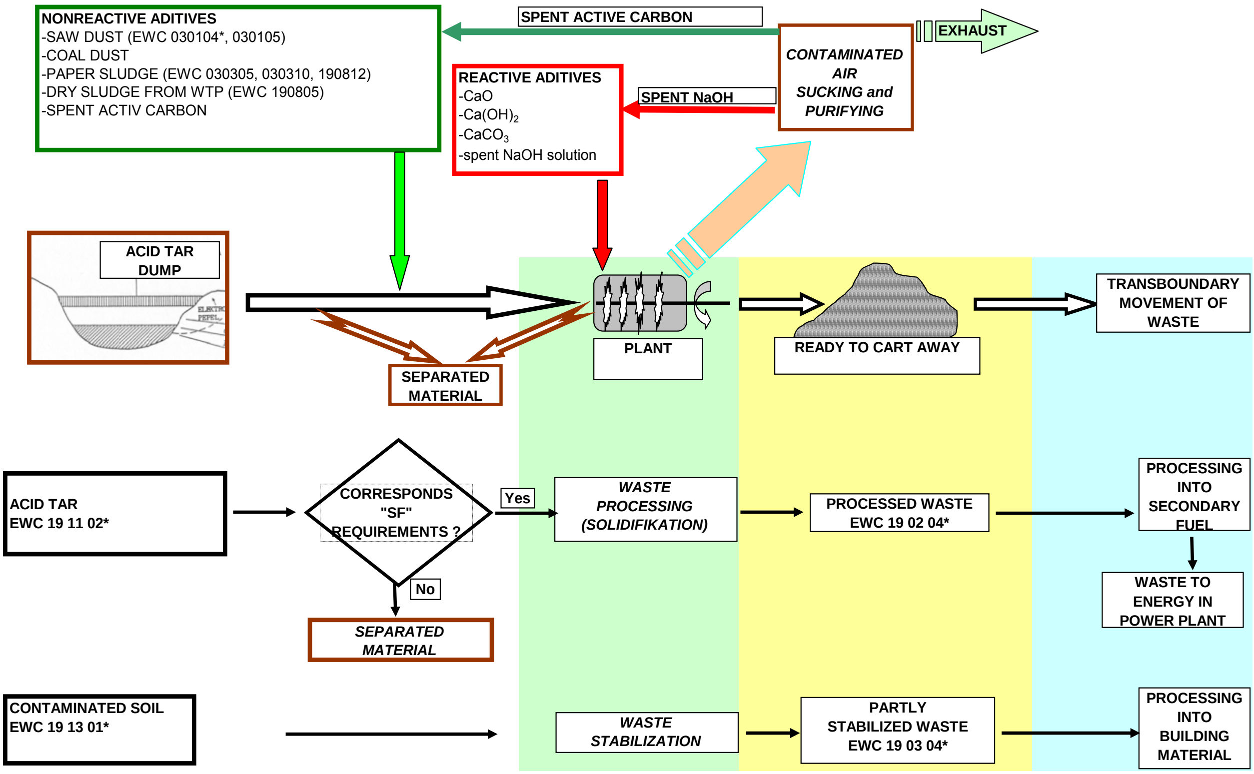

Figure 1. Mass flow diagram (Lipovšek, 2007)

A number of serious and highly publicized pollution incidents associated with incorrect waste management practices, led to public concern about lack of controls, inadequate legislation, environmental and human health impact (Giusti, 2009). Monitoring is essential to assess changes in the environment, to provide early warning of potential problems, to assess efficacy of remedies, and to assess possible future adverse effects on humans and the environment (Burger, 2008). Due this reason a detailed monitoring plan was prepared, that include all environmental parameters.

3.2. Organization of communication model for acid tar remediation

The information about technical risks alone does not form the basis for coherent management policy that is also acceptable by consumers. Researchers as Slovic (Slovic, 2000) has consistently demonstrated that factors such as whether a risk is perceived to be involuntary, potentially catastrophic, or uncontrolled are more important determinants of public response that technical risk information alone. Risk communication and waste management must also take into account of societal concerns and values. Risk perception also has a direct impact on how citizens respond to risk management activities. It is public concerns and attitudes that have direct consequences for human health, food safety and security, economic expansion and international regulation (Frewer, 2004, Petts 1992). The issue of public participation and the engagement of the broad public at different level of process is the priority in the hazardous waste management. Some authors (Gusti, 2009) stressed the need for public participation in waste management at the local and regional level.

Moreover, the level of social responsibility of waste industry is becoming the priority issue in democratic modern world. In modern democracy citizens should be educated and included in political process. The criteria for democratic political process (Dahl, 1998) are effectiveness of participation, voting equality, control over the agenda, equal opportunity and most important enlightened understanding. To realize all the steps of democratic political process, education and awareness of citizens has to be considered. The awareness about the environmental issues is high on the agenda of modern global and national political processes.

Best practices in risk communication encompass developing ways to communicate these to broader public. Institutions and organizations must consider how to develop and maintain public confidence in risk management practices. Trust and confidence is particularly important under circumstances where people feel that they have very little personal control over their personal exposure to potential hazards. This was the case with public perception of the case of Pesniski dvor where local community opposed to any waste management industry in the area. Accordingly, the principle of N.I.M.B.Y (not in my backyard) is widely accommodated in the perception of citizens when issue of waste management is discussed. In the local communities in Slovenia the rebellion towards any waste management practice came from citizens, particularly after the early 90s when political system with new national state developed. The political democratic development of new government supported any public debate regarding the economic, political and environmental issues.

It is important to communicate the uncertainty about the risk with the explicit and understandable way that is focused on the information needs of target audiences. There is little evidence that elite groups in the scientific and policy community have underestimated the ability of non-experts to understand uncertainty (Frewer et al, 2002.)

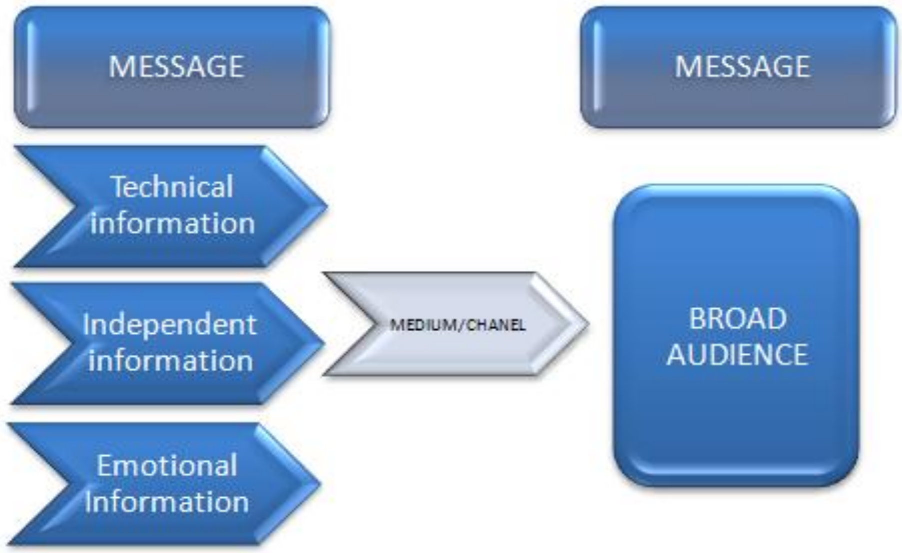

Figure 2. Model of communication in documentary case of acid tar

The non-experts need the communication in the way to establish trustworthiness and certainty about the waste management. For the successful communication of this matter the appropriate tool of communication should be chosen. For the case of Pesniski Dvor the audiovisual documentary (Zavrl, Zilic, 2008) was chosen as a tool of communication. The documentary film covered all the stages of remediation. Research behind the documentary film included interviews with experts from different companies, experts from independent and governmental institutions, local inhabitants and opinion makers from the region.

The audiovisual product, which based on the presented model of communication, could describe the best practices in the way that are successfully perceived from broader public (Figure 2).

The situation of the audiovisual viewer is paradoxical. There is a sense in which person is living in two places, and sometimes two times, at once – in the world in which he is physically situated and the world that documentary presents to him (Scannell, 1991). The media with the sound and the picture could bring the waste management closer to the individual.

The best practices in waste management described in journals are well perceived by experts; however the broader public could get closer to the issues with the (media) product that better appeals to the emotions. The medium for communication that has strong effect is television/screen where picture and sound bring the “reality” to the audience.

3.3. Results of the waste management process

The final result of the acid tar remediation in Pesniski Door was excavation and recovery of all acid tar, contaminated soil, the removal of complete facility used for the processing of acid tar and re-cultivation of the area.

The results of the environmental impact assessment before the remediation showed very high risk of the pollution of the soil and ground water near the dumping site. The acid tar remediation was successfully finished due to the effective technological solution that limited any possible negative impact on the environment.

Communication is a two way process and organizations need to learn how to internalize public views and societal values into the process of hazardous waste management. Woolgar (1996) has discussed the ways in which science and social world are often viewed as independent of each other, one result being the discounting of social factors. This separation (Frewer, 2004) produced the decline in public confidence in risk management practices that became the focus of regulatory concern in the 1980s and 1990s. In the paper we wanted to express the importance of public enlightenment regarding risk issues. Moreover, according to Hilgartner (1990) it could often resolve some problems of technology acceptance in waste management businesses.

The documentary about the hazardous waste management in the case of acid tar remediation tried to explain the process of waste management that leads to revitalization of local area. The sound, picture and interviews with independent experts and non-experts combined the successful way of persuasion in the documentary film. The successful waste management method was accompanied with the suitable communication tool as it was shown in the case of acid tar remediation in Pesniski Dvor. The goal of documentary was the development of the effective message for the broad public.

4. CONCLUSION

The conclusions and recommendations of this paper arise from an examination of the waste management, environmental impact and impact of public concerns about waste management in Slovenia. The model of waste management in Pesniski dvor explains the good practice of hazardous waste management. The model of acid tar management in Pesniški dvor brings the sustainable development of the nature. The reference communication model of waste management could be applied into the countries of Balkan region; however the special circumstances of the local area should be taken into account. The elements of the model that comprise of modern technological process, transparency with monitoring and film documentary as a main communication tool are important elements in the suggested model of waste management.

The suggested model of acid tar remediation is successful business model that company Gorenje-Surovina tries to apply into the area of Balkan region. The waste management in the case of acid tar remediation stresses the need for investment at the level of public participation and public communication. The issue of waste management should be discussed to engage participaton of broad audience.

The results of the acid tar remediation in Pesniski Dvor was complete remediation and revitalization of the old disposal site which previously presented high environmental risk for the nature and humans. During the process of remediation 18.200t of acid tar, 14.600t of contaminated soil and 600 m^3 of the waste water from the disposal site was neutralized and recovered. The quality of the nature in Pesniski Dvor increased and the old dumping site is well integrated with the surrounding forest and meadows. The model of communication with suitable communication tool for broader audience was important part of the project. Therefore it can be apply to other projects in the field of waste management where public participation and public awareness is extremely important.

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ENVIRONMENTAL SUSTAINABILITY SCREENING OF SMALL-SCALE URBAN WATER SUPPLY SYSTEMS

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Abstract: *Practitioners and researchers are in need to develop practical tools to quickly measure environmental sustainability of an urban infrastructure system through its life cycle. This paper proposes a framework for an environmental sustainability screening of urban infrastructure systems, which is based on interactions between infrastructure and surrounding environmental systems. One way of quantifying these interaction effects is through use of environmental sustainability indicators selected on basis of simplified life cycle assessment (LCA). A small set of selected indicators was applied in a case study of the urban water supply system of Bratunac, Bosnia and Herzegovina.*

Keywords*: life cycle assessment, environmental sustainability, indicators, water supply systems*

1. INTRODUCTION

Urban water supply systems in developing countries experience difficulties in meeting challenges of increasing population and lack of funding for intensive capital infrastructure solutions. Much of municipal water supply infrastructure which was built during the 1960s and 1970s is now outdated and deteriorated. Municipal authorities are faced with not only with the existing infrastructure reconstruction but also with the demand for its development. Also, national and international development agencies and financing institutions face problems when appraising the commercial viability and sustainability of infrastructure project proposals. Water systems which can satisfy the changing demands placed on them now and in the future without system degradation can be called “sustainable” (ASCE, 1998, p. iv).

Over the last few decades, numerous attempts have been made to describe and measure various aspects of sustainability, with emphasis often being put on the environmental aspects. One approach included environmental sustainability indicators (ESI). Several organizations used frameworks based upon Pressure-State-Response model proposed for use at country, regional or municipal levels by the OECD (OECD, 2001). Pressure indicators measure environmental pressures from human activities influencing the environment through emissions and exploitation of natural resources. State relates to the state of the environment, such as the quality and quantities of natural resources while response measures the extent to which society is responding to environmental changes and concerns. In 1997, another approach, life cycle assessment (LCA), was designed for evaluation and possible reduction of environmental impact of the entire life cycle of products, processes, projects and services (ISO 14040:1997). It is standardized method that includes life cycle impact assessment (LCIA) phase where potential impacts are aggregated and quantified (ISO 14042:2000). Four components of LCA include goal and scope definitions, inventory analysis, impact assessment and improvement analysis (results interpretation). Several LCA studies on urban water systems estimated environmental loads from urban water systems although mainly addressing specific wastewater systems (Lundin et al., 2000, Godin et al., 2011, Feijoo, 2013) while fewer studies on water supply have been published (Lundie et al., 2004).

Although LCA is a rather complex and time-consuming analysis, it can provide a systemic foundation for selection of relevant indicators of environmental performance, including measurement techniques at company level (ISO 14040:1997). In this paper we propose a selection of ESI as a less complicated method through an iterative technique based upon simplified LCA methodology.

2. FRAMEWORK FOR A SCREENING LCA OF URBAN WATER SUPPLY SYSTEMS

Acknowledging that the life cycle perspective is important for environmental sustainability, the challenge is to adapt the LCA methodology and simplify its use. With a simplified or screening LCA it would not be possible to retrieve detailed results of the environmental performance of a product or a system and comparative statements according to ISO 14044 cannot be based upon it. This type of study yields an estimate of environmental performance (EeBGuide Project, 2012). A suggested framework for using the simplified LCA method for urban water supply system is described in Figure 1.

The screening LCA commences with specifying the goal and scope of the iterative process, as presented in Figure 1. The goal here is to conduct an initial overview of the environmental sustainability of the urban water supply system in order to support investment decision-making at the level of a water utility and beyond. Attempts to define general sustainability criteria for urban infrastructure systems have been presented in several studies e. g. Sahely et al (2004) but here we limit to the quick screening of environmental sustainability of an urban water supply system which include major environmental impacts along life cycle.

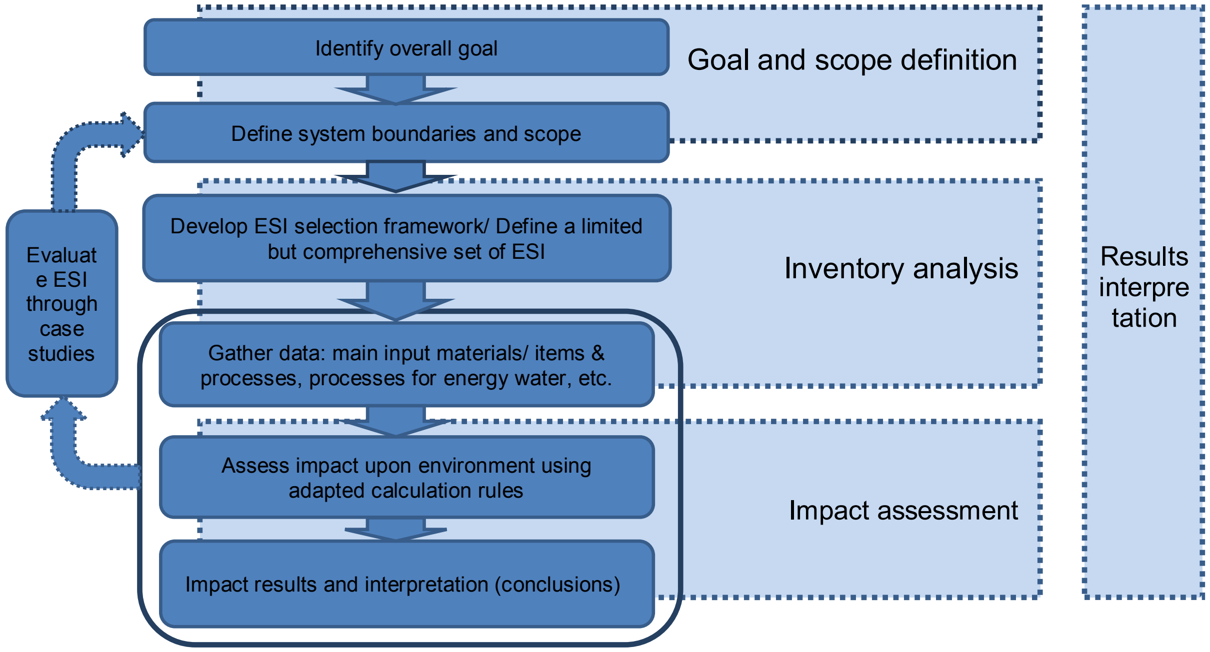

Figure 1 – Framework for environmental sustainability screening of an urban water supply system based on the Life Cycle Impact Assessment phases (square dotted), *source ISO 14040/14044*

The next step is definition of system boundaries, which encompasses time, spatial and life-cycle boundaries. In the planning and design of an urban water supply system a time perspective of several decades is usually considered. Spatial boundaries of a water supply system are limited to include one or several municipalities or watershed area. The life cycle boundaries define the unit processes which are to be included in subject system and for a water supply system life cycle starts with extraction of water from groundwater or surface water source including water treatment. In this case, the lifecycle ends with distribution of potable water to consumers: households and industry. Of course, different choices could be made for system boundaries to include wastewater treatment, disposal of sewage sludge to landfill or agricultural land and surrounding technical and agricultural system.

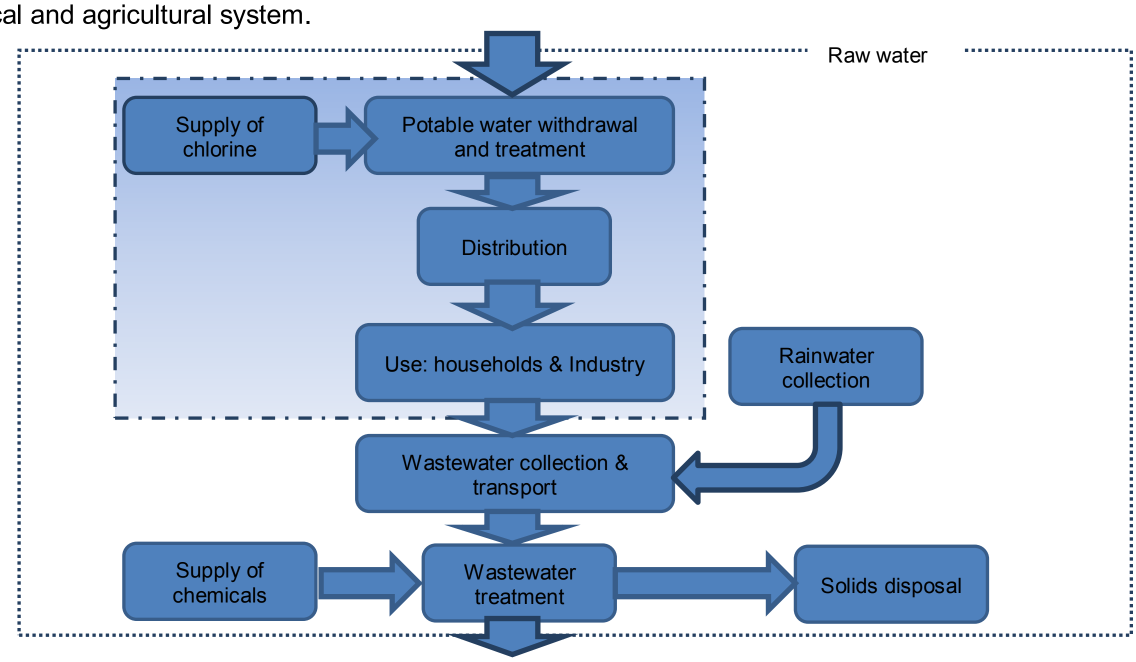

Figure 2 – System boundaries used in this paper (dash-doted rectangle)

The following step is developing framework for selection of ESI, which is a kind of a structure from which relevant indicators are selected through identifying most important issues for the stated purpose, such as the water quality, water resources and energy use. General frameworks used for sustainable development indicators have adopted a conceptual driving force-state-response approach widely used for environmental indicator development, such as the Pressure-State-Response (PSR) model developed by OECD (2001). This has led to selection of 10 key environmental indicators extracted from the OECD Core Set of environmental indicators (approx. 40 indicators), which covers the issues of climate change, ozone depletion, air and freshwater quality, waste generation, freshwater, forest and energy resources and biodiversity. Examples of indicators related to water quality and resources are presented in Table 1.

Table 1 – OECD indicators related to water quality and resources and their place in PSR framework (source OECD Environmental Indicators, 2001, pp 41-51)

Set of indicators	Selected Indicators	Place in framework
Water quality	Quality of surface waters (oxygen and nitrate content)	S
	Sewerage treatment and network connection rates	R
	Public expenditure on waste water treatment	R
Water resources	Intensity of use of water resources	P
	Water supply prices	R

Similar frameworks have evolved from PSR approach to one focusing on four primary dimensions of sustainability - social, economic, environmental and institutional. Within these categories, indicators were then classified in accordance to their driving force, state and response characteristics (UNCSD, 2001). LCA framework includes all major impacts/ benefits on environment occurring throughout the life-cycle, and relates them to functional units or performance characteristics, such as per person, day, etc. Functional units set the scale for comparison of two or more systems including improvement to one system (EEA, 1997)

Following framework development, appropriate ESIs can be selected from the previous LCA case studies, literature reviews and indicators already used within an organization. It is important that a limited but comprehensive set of ESIs is selected so that the most important aspects are addressed. The indicators should allow for comparisons through use of aforementioned functional units. In this paper we have chosen a list of 20 indicators for urban water systems categorized in terms of four environmental and technical systems: freshwater resources, potable water, waste water and development, proposed by Lundin (1999, p. 37). Each system was represented by certain dimensions broken down into indicators. Then, 6 of 20 initially proposed environment sustainability indicators have been short-listed in order to quickly appraise environmental sustainability of Bratunac water supply system (Table 2). Of course, hereunder proposed set of indicators does not include all aspects of environmental sustainability of an urban water supply system.

Table 2 - ESIs used in this paper (adapted from Lundin, 1999, p. 37)

Suggested indicator	Data availability	Type	Suggested reference value
Freshwater withdrawal	Available	Pressure	<100% of raw water quantity
Water consumption	Available	Driving force	Above WHO standard (20 l/capita/day)
Potable water quality	Available	State	% of tap tests within WHO or national regulation
Energy use for water supply	Available	Efficiency	As efficient as possible
Chemical use	Available	Efficiency	As efficient as possible
Leakage/ water losses, %	Moderately available	Efficiency	Low

After selection of ESIs, data were collected for the period available, and the impact upon the environment was assessed using different weighting methods. Data gathering and data quality is important for LCA as well as for EPI. Lundin and Morrison (2002, p. 149) conceptually described various levels of environmental sustainability for urban water systems as shown in Table 2.

Table 3 – Environmental sustainability levels of urban water supply infrastructure (adapted from Lundin, Morrison, 2002, p. 149)

Level	Infrastructure characteristics
A	Environmental and health objectives are met. Efficient use of resources.
B	Environmental protection standards are fulfilled and exceeded but focus is still on compliance with standards and end-of-pipe solutions. Potable water is regularly monitored.
C	Minimum environmental and health protection standards are fulfilled.
D	Basic standards ensuring human and environmental health and adequate water supply are not met. There is uncertainty in water supply on daily basis. Minimum environmental monitoring

3. EXAMPLE OF A SCREENING LCA: BRATUNAC URBAN WATER SUPPLY SYSTEM

The use of environmental sustainability indicators in infrastructure decision making is not applied widely in Bosnia and Herzegovina and surrounding countries. Main challenge here is collection and compilation of data at the urban water supply system level. A walkthrough energy audit of Bratunac urban water supply system is used as an example where data were compiled and synthesized from utility and municipal officials and from measurements taken in the field (Kovacevic et al. 2013).
The area of the municipality of Bratunac is supplied with potable water through an urban water supply system and several rural water supply systems. “Bjelovac” water source, located in the vicinity of the Drina River supplies the urban area with drinking water after chlorination treatment at the Bjelovac water intake plant. Urban water supply system covers the city area and most of the suburbs with a total population of 11,000 or 2,945 households, which is approx. 51% of the entire municipal population. The rest of population is supplied through rural water supplies which are not under jurisdiction of the “RAD” Bratunac Public Utility Company. Water supply system operates without major restrictions with maintained water quality regardless of annual rainy or draught periods. Apart from chlorination, water is used without any additional treatment.

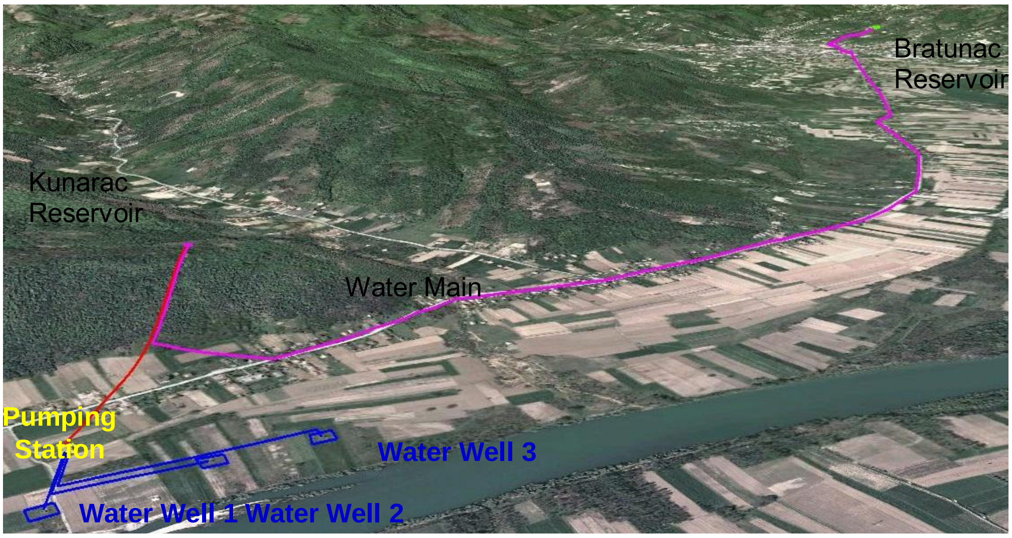

Figure 3: Bratunac water supply system

There are three freshwater wells of 3 meters in diameter and average depth of 10 meters, and of total capacity of 65 l/s. The wells are located in the protected area with strictly enforced sanitary rules. Withdrawn water is pumped through the 800 meters long thrust pipeline into the retaining reservoir of 100 m³, adjacent to the pumping station from which the water is pumped up to the Kunarac Reservoir of 120 m³ and further gravitationally transmitted into the Bratunac storage reservoir of 1.350 m³ through water main of 200, 300 and 350 (mm) in diameters and total length of 9,560 meters. Total length of distribution mains is around 30,500 m, made of pipelines of 50 through 350 (mm) diameters.

Major deficiencies of the existing water supply system are: inadequate quantities of extracted raw water at the water source, especially in the summer period, lack of adequate reservoir storage, undeveloped distribution network with under-dimensioned pipeline sections which causes unequal pressure distribution as well as high water losses of 55-60%. Urban water supply network is outdated and dilapidated as it was mostly built in 1962 through 1964. Detailed design for rehabilitation and reconstruction of Bratunac water supply distribution network was funded by United Nations Development Programme (UNDP) in 2011 while the funds for reconstruction were secured through European Investment Bank (EIB) in 2012. The works are foreseen to commence in 2014.

3.1 Purpose of the screening LCA and system boundary definition

The aim of this screening LCA was to assess environmental performance of the Bratunac urban water supply over the last few years for which most of data were available. In accordance with the proposed framework, the water system was divided into two technical sub-systems following the life cycle of urban water management: (1) withdrawal and treatment of raw water and (2) distribution and consumption of potable water. For both sub-systems ESI were adopted in terms of environmental performance and pressure on the environment (Table 2).

3.2 Environmental Sustainability Indicators (ESIs)
3.2.1 Freshwater withdrawal

The freshwater withdrawal indicator is calculated by dividing the annual freshwater withdrawal by the annual available amount. It shows whether or not withdrawal is at an acceptable level or future shortages are expected. The withdrawal indicator also relates to population and population growth, the future demands for agriculture and industry and water losses in the system.

Total raw water withdrawal in 2011 was 1,903,673 m^3 with average withdrawal 61.20 l/s. Average daily quantities of withdrawn water were 5.400 m^3 a day. In accordance with the Long-term programme for drinking water supply of the population and industry in Bosnia and Herzegovina (Water management institute of BiH, 1988), Bratunac water supply system should completely rely on Bjelovac water source, with forecasted yield of 300 l/s, which satisfies the needs for water until the end of the programme period by 2020 and beyond. The reference value for this indicator is that the withdrawal should be less than 100% of the raw water quantity. Collected data show that the withdrawal volume has been around one fifth of total available water resources which is at the satisfactory level.

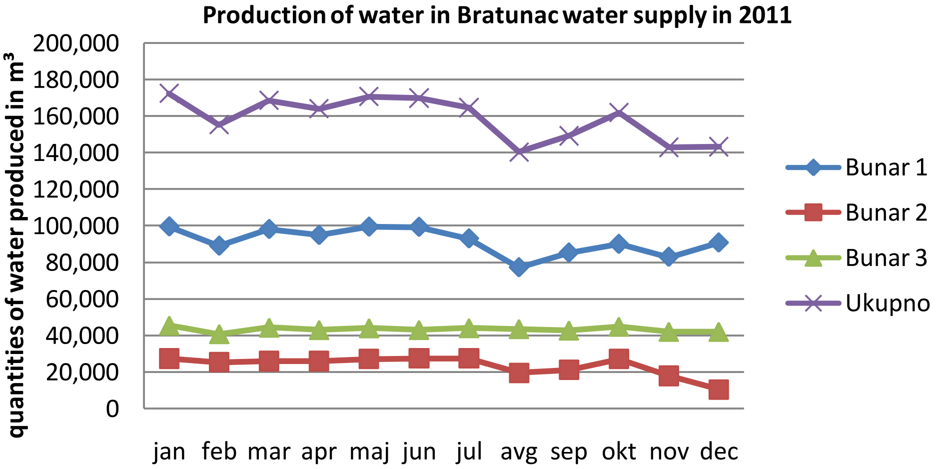

Figure 4 – Monthly production of water in 2011 in m^3 (Kovacevic et al. 2013)

3.2.2 Water consumption

With population increase and economic development increased quantities of water will have to be supplied for domestic and industrial purposes. Since the consumption of potable water affects use of energy and resources, it is directly linked to the environmental sustainability of the water system. Suggested water use indicator is *l/capita/day*, which is compared to target.

Consumption was calculated by dividing inflow values at the Bjelovac reservoir by Bratunac population estimate, which was adjusted in accordance with the projected population increase (1.30%). Water consumption (including industrial use) has increased from approximately 166 l/capita/day (2005) to 175 l/capita/day (2013) and is forecasted to 200 l/capita/day for the next two decades (Table 1), which significantly exceeds a minimum for basic level of service given by WHO (2003, p. 25). This is slightly above the European average as urban water use has decreased in the 1990s in many European countries as a result of measures to reduce demand and because of economic restructuring. The largest amount of household water used is found in Spain with 265 l/capita/day (Figure 5.11), followed by Norway (224 l/ capita/day), Netherlands (218 l/capita/day and France (164 l/capita/day). Lithuania, Estonia and Belgium with

85, 100 and 115 l/ capita/day, respectively, have the lowest household water use in those European countries with available information.

Table 4 – Calculation of needed quantities of water for Bratunac water supply system (Kovacevic at al. 2013)

Description of consumption	Unit of measure	**Projected population increase**				
		2005	**2013**	**2015**	**2025**	**2035**
Number of residents connected to system		**11,436**	**12,199**	**13,013**	**14,807**	**16,848**
Average specific residential consumption	l/capita/day	166	175	180	190	200
Access to urban water supply system	%	100.00	100.00	100.00	100.00	100
Average household consumption	l/s	21.97	24.71	27.11	32.56	39.00
Average industrial consumption - 20 % of household consumption	l/s	4.39	4.94	5.42	6.51	7.80
Total average consumption: households + industry	**l/s**	**26.37**	**29.65**	**32.53**	**39.07**	**46.80**
Total daily average consumption: households + industry	**m^3/day**	**2,278**	**2,562**	**2,811**	**3,376**	**4,044**
Total monthly average consumption: households + industry	**m^3/month**	**69,291**	**77,921**	**85,494**	**102,686**	**122,993**
Total annual average consumption: households + industry	**m^3/year**	**831,489**	**935,047**	**1,025,924**	**1,232,227**	**1,475,916**
Seasonal household consumption unevenness coefficient		1.50	1.50	1.50	1.50	1.50
Maximum daily household consumption	l/s	32.96	37.06	40.66	48.84	58.50
Seasonal industry consumption unevenness coefficient		1.25	1.25	1.25	1.25	1.25
Maximum daily industry consumption	l/s	5.49	6.18	6.78	8.14	9.75
Total maximum daily consumption: households + industry	**l/s**	**38.45**	**43.24**	**47.44**	**56.98**	**68.25**
Total average water losses in the system	%	57.84	40.00	35.00	30.00	25.00
Total average needs for water in the Bratunac water supply system	**l/s**	**62.54**	**49.42**	**50.05**	**55.82**	**62.40**
Total maximum needs for water in Bratunac water supply system including losses	**l/s**	**91.20**	**72.07**	**72.99**	**81.40**	**91.00**

3.2.3 Energy use

Data relevant for use of energy were gathered from water utility officials and measurements of electrical parameters were taken, such as currents, voltages, powers (active, reactive and total power) and actual energy use. Also current, voltage and power waveforms were measured at the engines running the thrust pumps in the Bratunac water supply system. Engines and pumps were scanned using a thermal camera. Energy consumption analysis was based on monthly electrical energy use bills taking into account energy tariff group of the consumer as well as changes in energy prices during the observed period.

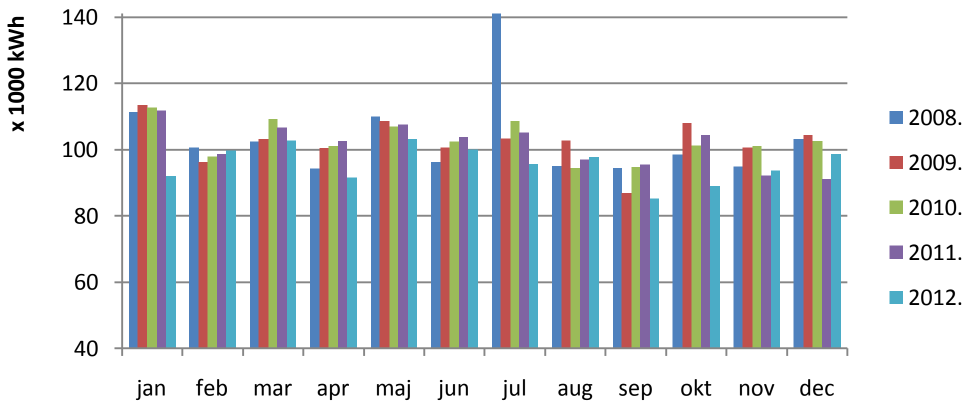

Figure 5 – Monthly electrical energy use in kWh for period from 2008 to 2012

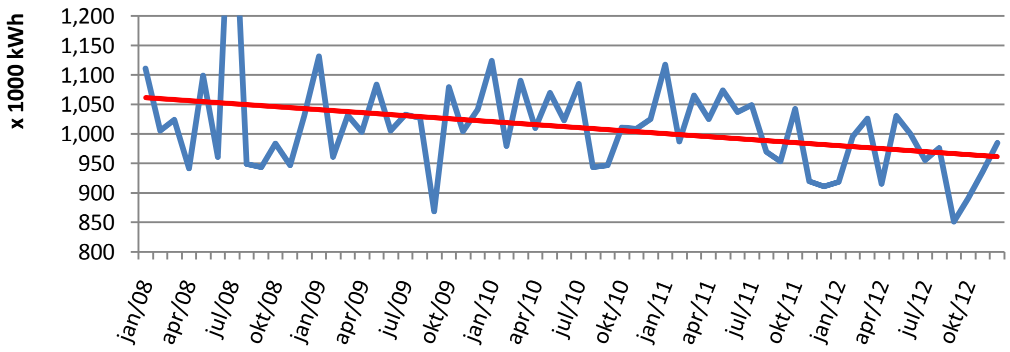

Figure 6 - Electrical energy use in kWh for period from 2008 to 2012

Electrical energy use was quite equally spread throughout the year and there was no typical division between summer and winter months. However, a general notion of decrease in energy use can be observed, especially since January 2011. This trend seems to have been influenced by the changed regime in power supply system i.e. third thrust pump was occasionally shut down during the night hours. Energy Use Assessment Tool developed by the US Environmental Energy Agency (EPA) for assessment of energy use in small to medium water supply systems was utilized in the analysis of electrical energy use, produced water and costs in order to determine the areas with the highest potential for savings. The highest energy consumers were the thrust (circulating) pumps with 85% of total consumption then the water well pumps with 11% while the remaining 4% of energy relates to other consumers (lighting, heating, etc.).

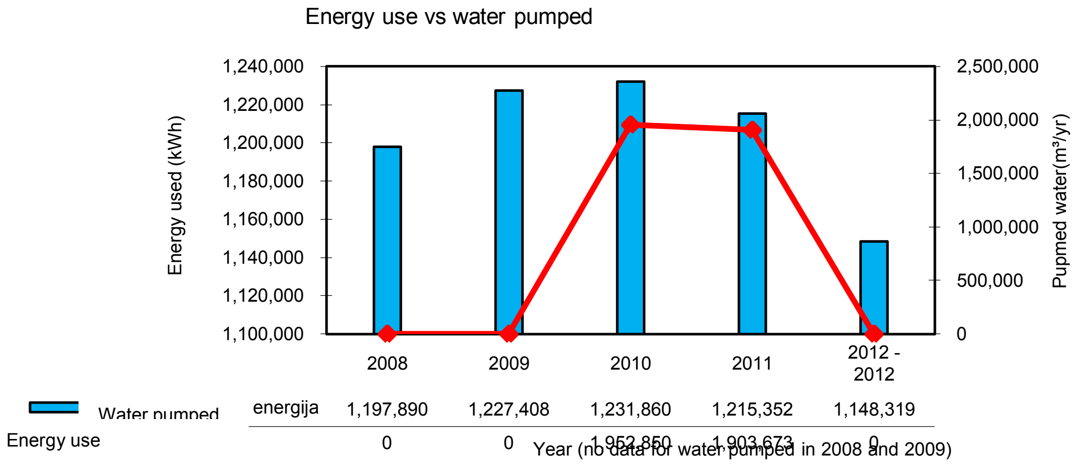

Figure 7 – Energy use vs. water pumped (source Kovacevic et al. 2013)

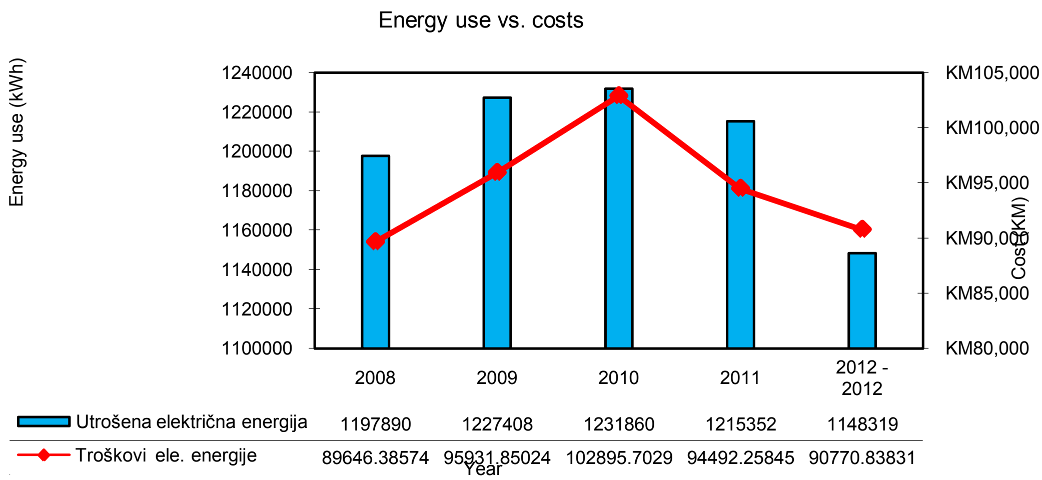

Figure 8 – Energy use vs. costs (source Kovacevic at al. 2013)

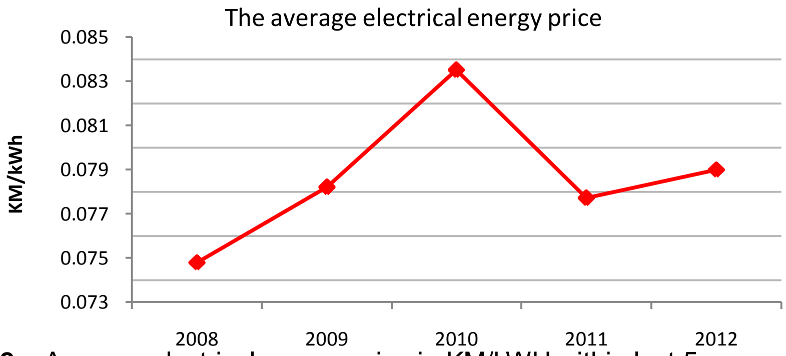

Figure 9 – Average electrical energy price in KM/kWH within last 5 years

Water distribution is therefore the most energy intensive process in the urban water supply system. In 2010, average electrical energy use to operate pumps was 0.63 kWh/m^3. This average is above the average value in the engineering literature, which is around 0.48 kWh/m^3 although this value is illustrative since it does not incorporate critical elements such as the distance the water is transported, which vary greatly from site to site (World Business Council for Sustainable Development, Water, Energy and Climate Change, 2009). During 2010, 1.952 Mm^3 was pumped directly from Bjelovac pumping station into the transmission system.

Higher or lower electrical use costs (Figure 8) appear to be directly related with the average annual electrical energy price expressed in KM/kWh (Figure 9).

3.2.4 Potable water quality

The quality of potable water is highly important as it directly impacts human health. It should be within tolerable limits of bacteria and chemicals. Bulk potable water is sampled at the water intake facility but because it may deteriorate before reaching consumers due to corrosion or contaminations caused by leakages, water is also sampled at the tap at 2 independent locations within the system twice a month.
Bratunac water utility performs regular water quality tests through the Public health institute of Republika Srpska and the test results satisfy in over 95% cases. The results of recent physical-chemical analysis from February 2014 showed that the level of nitrate are below the hygienically regulated maximum of 50 mg NO_3/l and that the concentrations of residual chlorine seem to be below regulated maximum of 0.5 Cl_2 mg/l.
Generally, potable water quality in Bratunac is considered to be good. The recently conducted microbiological analysis from February 2014 showed that there were no either coliform of other bacteria in water system.

3.2.5 Chemicals use

This indicator is affected by raw water quality and the degree of protection of freshwater resources. Since the raw water withdrawn from Bjelovac water wells is of high quality, only chlorine is utilized in the water treatment for Bratunac water supply. The dosage of chlorine has been relatively stable during the observed period (0.3 mg/l Cl_2). Efficiency improvements introduced gas chlorinators which apply dosage in accordance with the withdrawn water quantities. The current chemicals use for water quality in Bratunac water supply system can be considered efficient.

3.2.6 Leakage/ water losses

Large volumes of water are lost due to leakage in pipes which leads to increased pumping costs, loss of water (and revenue), loss of pressure and increased risks of contamination by bacteria and corrosion products (e.g., copper, iron and zinc). Data on water production is obtained through a water flow meter installed at the water intake facility next to the water pumps on thrust pipelines. The meter displays cumulative flow values recorded on daily basis. Also, at the exit of Bratunac reservoir there is a flow meter which registers data on quantities of water flowing into the distribution system. Accuracies of both meters having been checked through ultrasound flow meters, it was concluded that the flow values were identical; however, the installed meters need to be calibrated. Water use, namely quantities of water delivered to consumers, is registered through water meters and where there is no water meters installed water use is calculated as flat rate service. Water meters are read quarterly.

Table 5 – Water losses in the distribution system (source Kovacevic et al. 2013)

Time of year		*Water production*			*Water losses in the system*					
					Distribution network			*Household installation*		
Month	*No. of days*	*m^3/month*	*m^3/day*	*l/s*	*m^3/mth.*	*l/s*	%	*m^3/mth.*	*l/s*	%
January	31	157,140	5,069	58.67	59,366	22.16	37.77	26,255	9.80	16.71
February	28	148,150	5,291	61.24	58,898	24.35	39.76	23,715	9.80	16.01
March	31	172,090	5,551	64.25	74,316	27.72	43.14	26,255	9.80	15.26
April	30	175,100	5,837	67.55	80,167	30.93	45.79	25,408	9.80	14.51
May	31	171,420	5,530	64.00	73,646	27.50	42.97	26,255	9.80	15.32
June	30	170,210	5,674	65.67	75,271	27.68	42.15	25,414	9.80	14.93
Total	**181**	994,110			421,664			153,303		
Average:			**5,492**	**63.57**		**26.96**	**42.42**		**9.80**	**15.42**

Month		*Total losses*		
	No.of days	*m^3/mth.*	*l/s*	%
January	31	85,621	31.97	54.49
February	28	82,613	34.15	55.76
March	31	100,571	37.55	58.44
April	30	105,575	40.73	60.29
May	31	99,901	37.30	58.28
June	30	100,685	38.84	59.15
Total	**181**	574,967		
Average			**36.77**	**57.84**

Data from Table 4 shows that water losses in Bratunac water supply system are in range 55 - 60 % i.e. water losses exceed water loss levels from European urban water networks level (Figure 9) thus increasing costs and decreasing revenues of the water utility and negatively impacting raw water resources.

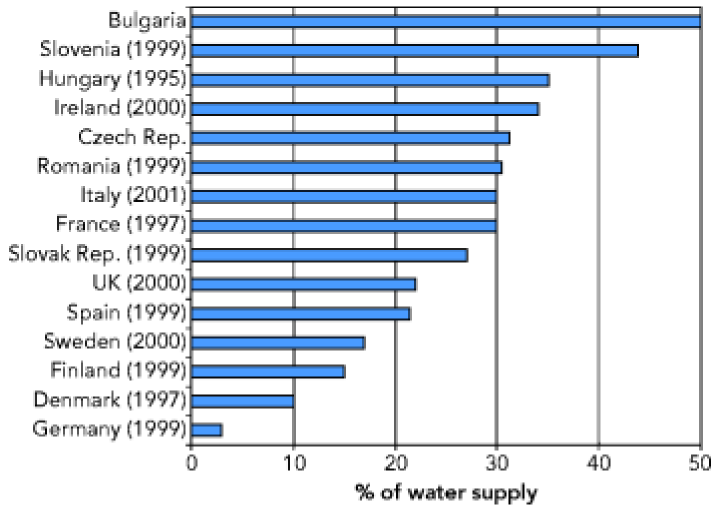

Figure 9 – Losses from urban water network in Europe (source EAA, factsheet, 2003)

Such high losses negatively impact upon the water balance within the Bratunac water supply system as shown in Table 6. This indicates that there is no point in pumping additional quantities of water into the system until the leakage is reduced down to acceptable level.

Table 6– Water balance within Bratunac water supply system (source Kovacevic et al. 2013)

Water supply system	**Max. Daily needs for water (l/s)**				**Water intake withdrawal In Bjelovac (l/s)**				**Needed quantities of water (l/s)**			
	2005	**2013**	**2020**	**2035**	**2005**	**2013**	**2020**	**2035**	**2005**	**2013**	**2020**	**2035**
Bratunac	91.20	72.07	82.18	91.00	63.57	63.57	63.57	63.57	-7.63	-8.50	-18.61	-27.43

4. CONCLUSION

In this paper an LCA based, iterative procedure for selecting ESIs for environmental sustainability screening of urban water supply systems has been proposed and exemplified by a screening LCA on Bratunac water supply. The concept of environmental sustainability has been defined by a small set of quantifiable and measurable indicators that enabled quick overview of environmental sustainability of the water supply system over time. Most indicators were easy to apply as data were readily available. All indicators were found to be useful for the subject water supply system and were recommended for future studies.

By taking a look at the chosen set of environmental indicators (Table 1) and the levels of environmental sustainability in Table 2, Bratunac urban water supply system falls within the level C of environmental sustainability, characterized as a reactive decision-making system which meets minimum environmental protection standards and health objectives and which relies on consumer complaints. This means that the system is not moving towards sustainability and there is much room for improvements in terms of water and energy efficiency, primarily in the management of water losses.

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SUSTAINABLE WASTE MANAGEMENT - SURVEY ON WASTE COLLECTORS' WORK SATISFACTION IN THE PUBLIC UTILITY COMPANY

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Abstract: *In this paper, the main research subject is sustainable waste management, and consequently utility workers' perception on public behaviour in regards to habits they perform in waste disposal. Due to the increasing amount and harmfulness of waste to the environment, it is considered to be one of the most important problems of the modern world. Waste is generated at all levels, national and local, in households, manufacturing facilities, public administration, retail stores, educational institutions, tourism organizations and enterprises, medical institutions, military institutions, etc. Disposal of municipal and industrial waste without any impact to the environment is one of the major issues facing modern society. More than 150 waste collecting workers covering the territory of 10 Belgrade municipalities participated in the survey. In order to evaluate the results of the survey, statistical software package SPSS 20 was used. And discussion on results is presented in the conclusion of the paper.*

Keywords: communal waste, municipal workers, job satisfaction, cost effectiveness, waste management, environment.

1. INTRODUCTION

Waste management is the implementation of measures prescribed for the treatment of waste within the collection, transport, storage, treatment and disposal of waste, including supervision of such activities and maintenance of waste management facilities.

Waste is generated at all levels, national and local, in households, manufacturing facilities, public administration, retail stores, educational institutions, tourism organizations and enterprises, medical institutions, military institutions, etc. Waste generation depends on the level of industrial development, living standards, lifestyles, social environment, energy and other parameters within every community. The amount of waste can vary significantly between countries, but also within the parts of the same country.

The basic classification of waste is the following:

According to the place of origin:

- Municipal waste - household waste, as well as other waste which, based on its nature or composition, is similar to waste from households.
- Commercial waste - waste generated by businesses, institutions and other organizations that are wholly or partially engaged in trade, services, office affairs, sport, recreation or entertainment, except for household and industrial waste.
- Industrial waste - waste from any industry, except for the tailings and associated minerals from mines and quarries.

According to characteristics that affect human health and the environment, waste can be (UNESCO – UNEP., 1993; UN., 1992):

- Non-hazardous waste - waste which, because of its quantity, concentration or physical, chemical and biological nature, as opposed to hazardous waste, does not threaten human health or the environment and does not have the characteristics of hazardous waste.
- Inert waste - waste that is not subject to any physical, chemical or biological changes; Insoluble, does not burn or in other ways physically or chemically react, is not biodegradable or adversely affect other matter which it comes into contact with in a way that could lead to pollution of the environment or endanger human health; does not possess any of the characteristics of hazardous waste (acute or chronic toxicity, infectivity, is carcinogenic, radioactive, flammable, explosive); the content of pollutants in its water extract may not exceed the statutory level.

• Hazardous waste - waste which by its origin, composition or concentration of hazardous substances can cause harm to the environment and human health, and has at least one of the hazardous characteristics (explosive, flammable, tendency to oxidation, organic peroxide, acute toxicity, infectivity, tendency to rust in contact with air, releases flammable gases in contact with air or water, releases toxic substances, contains toxic substances with delayed chronic action and eco toxic properties), including the packaging in which hazardous waste is or was packed.

Municipal waste is divided into (Marković Luković Lj., 2010):

- organic (biological or biodegradable waste - food scraps, yard waste, grass, leaves, cut off branches, trees, and paper packaging contaminated with food, paper towels, and dust from combustion of wood);
- paper and cardboard (newspapers, books, magazines, commercial printing, office paper, wrapping paper, cleaning paper, corrugated paper);
- plastics (packaging materials, boxes, bottles, plastic bags, foil and other plastic products);
- glass (bottles, jars, containers for beverages, flat glass);
- metal (tin cans, aluminium, iron and other metals);
- textiles and leather;
- other (dirt, ashes, street sweepings, dust, unidentified materials).

Waste material is usually found in solid state, but can also take the form of liquid and the form of sludge. Collection, transport and treatment of the latter require special equipment.

Table 1: Quantity and composition of municipal waste by countries, (EC., 2002).

Waste characteristics		Countries	
		Developed	Developing
quantity per resident	kg/day	0.8-2.2	0.3-1.0
	t/year	0.3-0.8	0.1-0.4
Density	kg/m3	100-200	200-500
Humidity	% mass	20-40	40-80
calorific value	MJ/kg	8-12	3-10
composition:			
• paper, cardboard	% mass	20-40	10-30
• glass, ceramics		4-10	1-10
• metals		3-13	1-5
• plastic		4-10	1-8
• leather, rubber		1-5	1-5
• wood		1-5	1-5
• textiles		2-5	1-10
• bio-waste		20-50	40-85
• hazardous waste		0.5-3	0.5-1
• other inert waste		1-20	1-40

2. ENVIRONMENTAL INFLUENCE OF COMMUNAL WASTE

The impact of solid waste on the environment has multiple negative effects, and the primary reason for such impact in the Republic of Serbia is insufficient coverage of municipal services, which is causing illegal dumping, landfills, major disorders and low public awareness of the environmental issues.

Therefore, illegal dumping sites that are spreading uncontrollably on the municipal territories are created. Main landfills in villages and small urban areas are usually overloaded and without proper cattle burial grounds, all of which are potential source of infectious diseases affecting population and the environment.

Waste affects all categories of the environment: air, land and water. During the breakdown of organic matter, under aerobic and anaerobic conditions, gases are usually released from the waste into the environment: methane, which is explosive, and carbon dioxide. When decomposing, animal carcasses and food remains of animal origin release ammonia, hydrogen sulphide, aromatic acids and other substances that make the air extremely unpleasant to breathe and at higher concentration can be toxic or cause shortness of breath, impaired blood flow, fatigue and sleepiness.

Landfills that are poorly maintained and rarely treated with clay are prone to spontaneous combustion. Gases formed by rotting or by burning of landfills are released into the atmosphere and pollute the environment. Besides gas, the air is polluted with dust and odours. Thus, air pollution and harmful substances accumulated in the atmosphere can adversely affect human health. In places where organic matter decomposes regularly, flies, insects and various birds, rats and other rodents gather. Flies and rodents can become carriers and spread infectious substances (SEPA, 2013).

The key principle of waste management is the principle of sustainable development and it is based on six sub-principles. Sustainable waste management implies more efficient use of resources, waste minimization and handling of waste in such a way that it contributes to the objectives of sustainable development. Sustainable development is a coordinated system of technical-technological, economic and social activities in the overall development in which the principles of cost-effectiveness and the reasonableness of the use of natural and man-made values are met in order to preserve and enhance the quality of the environment for present and future generations (Dţozef & Ţarden, 2006; Đukanović.,1996; Milutinović., 2005; Đukić., 2008)

Waste management is based on the following principles:

- The principle of proximity and regional approach to waste management,
- The precautionary principle,
- The "polluter pays" principle,
- Principle of the hierarchy of waste management,
- Principle of the optimal option for the environment,
- The principle of accountability.

2. COMMUNAL WASTE MANAGEMENT IN THE REPUBLIC OF SERBIA

Disposal of municipal and industrial waste without any impact to the environment is one of the major issues facing modern society. Some villages and local communities, due to limited resources, are unable to independently provide all the services that should be a concern of municipal waste management and other projects that are of public importance. One of the strategies usually developed by the municipalities in order to increase the efficiency of service delivery is regionalization.

Also, the strategy discusses a need for institutional strengthening, development of legislation, education and public awareness. The National Strategy is the basic document that provides the conditions for the rational and sustainable waste management at the national level. In the next phase, the strategy should be supported by several implementation plans for the collection, transport, treatment and disposal of controlled waste.

In the Republic of Serbia there is a need for strengthening of the institutions, development of legislation, education and public awareness ("Sl. glasnik RS", br. 36/2009 i 88/2010). Furthermore, there is a need to determine economic and financial mechanisms necessary to maintain and improve waste management, and to ensure the system for domestic and foreign investment in the long-term sustainable activities.

The implementation of the basic principles of waste management set out in the strategic framework is essential (EEA., 2003), i.e. solving the problem of waste at the source, the principle of prevention, separate collection of separate materials, the principle of neutralization of hazardous waste, solving regional waste disposal and remediation of landfills, implementation of the basic principles of the EU in the field of waste and prevention of further danger to the environment and future generations.

The stated goals express strategic choices and main priorities of the Republic of Serbia for the next few years. A long-term strategy for the country in the field of environmental protection is to improve quality of life by providing desired environmental conditions and nature conservation based on sustainable environmental management.

Data on municipal waste of the Republic of Serbia is shown in Table 2 (NWMS, 2010)

Table 2: Data on municipal waste of the Republic of Serbia for the year 2012.

Waste quantities and composition			
1.	Total yearly quantities of collected waste	1... Measured 2... Estimated	Quantity t/year.
	Municipal waste, except bulky waste		583.738
	Municipal bulky waste		2.471
	Waste from businesses and institutions (except industrial)		No available data
	Industrial waste		143
	Waste from public areas		No available data
2.	Quantities of specific waste materials	t/year	%
	Paper	341	<1,00
	Glass	0	
	Plastic	159	<1,00
	Rubber	184	<1,00
	Metal (iron)	112	<1,00
	Metal (aluminium, etc.)	466	<1,00
	Organic waste (food, grass, etc.)	0	
	Construction waste	142.959	19,60
	Textile	0	
	Other	454	<1,00
	Total:	144.675	100%

Municipal waste is household waste, as well as other waste which, because of its nature or composition, is similar to waste from households. It is estimated that around 60 percent of municipal waste in the Republic of Serbia gets collected. The collection is organized mainly in urban areas, while rural areas are much less covered by the services of the municipal waste collection services. The largest number of local governments has the mechanisation and vehicles for waste collection, however, there is a lack of proper equipment.

Table 3: Data on generated municipal waste in 2012 in the Republic of Serbia (SORS., 2012)

Municipality	Number of residents	Mass of generated waste	Mass of waste per resident daily	Mass of waste per resident yearly
		(t/week)	(kg/resident/day)	(kg/resident/year)
InĊja	49 258	363	1,05	383
Sombor	56 734	269	0,67	246
Novi Kneţ evac	9 648	40	0,59	214
Šabac	123 155	463	0,59	209
Topola	25 292	51	0,29	105
Kragujevac	185 000	897	0,70	252
Bor	55 817	125	0,32	116
Niš	239 596	1 230	0,73	266
Novi Sad	314 192	2 560	1,16	424
Beograd	1 392 691	10 382	1,08	394

The social aspects of the national waste management strategy refer to:

- Use of materials, the generation and disposal of waste and other needs and requirements for waste management;
- Public participation in waste management through a variety of activities;
- Social conditions of workers employed in waste management.

Waste generation in the population is primarily a consequence of their consumption and thus their socio-economic characteristics. At the same time, the generation of waste is largely related to the attitude of people towards waste: their use of materials and waste handling, their interest for the reduction and minimization of waste, the extent to which they separate the waste and the level of unauthorized waste disposal. Their attitude affects not only the characteristics of the waste, but also the effective demand for waste collection services, and their interest and willingness to pay for waste collection. Their relationship can positively influence the development of public awareness campaigns and educational measures for avoiding the negative impacts of inadequate waste collection on human health and the environment and the value of the effective disposal. Such campaigns should also inform people about their responsibilities as waste producers and their rights in relation to waste management services.

3. SURVEY OF WASTE COLLECTORS IN PUBLIC UTILITY COMPANY ON WASTE COLLECTION IN THE REPUBLIC OF SERBIA

The sample of this research is formed out of permanently employed municipal workers which work on waste collection in Belgrade, Serbia. According to the current data, the company has around 620 full-time employees working on waste collection. The sample used in this research consists of approximately 25 percent of full-time employees. More precisely, 150 waste collecting workers covering the territory of 10 Belgrade municipalities participated in the survey. Municipalities taken into account by the survey are Novi Beograd, Zemun, Zvezdara, Savski Venac, Rakovica, Stari grad, Vraĉar, Voţdovac, Ĉukarica and Palilula. The age range of the survey participants was 18 – 58. Out of 150 participants, 7,33 percent haven't graduated from elementary school, 63,33 percent have graduated from elementary school, while 27,33 percent have graduated from high school.

More than 78 percent participants states that citizens are extremely negligent when disposing their waste, while only 11.33 percent stated that citizens dispose their waste in a satisfactory manner.

Almost 90 percent of participants state that their job is so crucial for regular City functioning, that they believe that in only five days without proper waste disposal services, serious health and environmental threats would arise.

More than half of the participants involved in the survey state that the biggest problem that leads to the inappropriate waste disposal by citizens is the general lack of environmental and health awareness and the lack of awareness of the effects waste have towards environment and general public.

In the survey, some cases are noted where workers found weapons, hand grenades, dead animals, bricks, car parts and all other sorts of waste which certainly does not have its place in a container - a shot, stones, ashes etc. Improper sorting of waste can lead to various diseases among the workers, and most of them at least once in a lifetime encounter with a health care problem related to their profession.

More than 96 percent of participants believe that inappropriate waste disposal should be penalised in one way or another. On the question of what they think would be sufficient penalisation of inappropriate waste disposal, participants stated in 64 percent of cases that financial fine should be imposed, while 18 percent believe that community service (street cleaning, waste collection) would do better and 5.33 percent states that such behaviour in some cases should be treated as a criminal act as it can be health threatening to the entire public.

In order to evaluate the results of the survey, we used statistical software package SPSS 20. The relationship between two categorical variables was explored by chi-square test. Correlation, between two scale variables was done by parametric Pearson correlation, while correlation between two nominal variables was evaluated with non-parametric Spearman's rho correlation. A p value is used to indicate if the differences between two particular groups that were in this research are statistically significant (where $p<0.05$ is considered statistically significant at 95 percent confidence level). In order to calculate effect size we used Cohen's interpretation of Pearson correlation.

- When participants were asked whether they would participate voluntarily in educating the citizens through educational projects, seminars, public demonstrations by explaining their experience and elaborating on their attitudes in order for overall waste disposal improvement, statistically significant difference was noted in comparison of groups of waste collectors who have suffered certain health problems because of their profession and the ones that have not. The results are given in the following table ($p<0,01$).

We can note that 93.88 percent of the workers that experienced health problems would be willing to participate in educational process of the broader public on the proper waste disposal, while only 66.33 percent of those who haven't experienced health problems due to lack of public awareness would do the same. We see that both groups agree that further education and increasing awareness of the citizens would ease up the job that they do, but those that even had health problems significantly more have such belief. According to Cohen (1988), the influence of these differences is medium to large r=302 ($0.3<r<0.5$ medium to large effect size).

Table 4: Correlation of health experienced and willingness to participate in educating broader public

Experienced health problems and willingness to participate in education of the public					
Willingness to participate in education of the public					Total
			Yes	No	
Experienced health problems	Yes	Count	46	3	49
		Expected Count	37.0	12.0	49.0
	No	Count	65	33	98
		Expected Count	74.0	24.0	98.0
Total		Count	111	36	147
		Expected Count	111.0	36.0	147.0

4. CONCLUSION

Due to the increasing amount and harmfulness of waste to the environment, it is considered to be one of the most important problems of the modern world. The public shows willingness to participate in solving this problem only when threatened by it or when this is in their immediate interest. We must remember that each of us every day produce waste which means that every individual is responsible for the creation and disposal of waste. Today, the idea prevailed entirely, that the waste should not be destroyed, but it should be used. Waste is not garbage, but good natural resource with a small percentage of garbage that has no practical value.

Without greater involvement of the government, the economy and all the inhabitants of the country waste management plans cannot be achieved. The opening of new landfills to suit environment and sanitation is not the ultimate solution. The solution is to reduce huge quantities of waste production, technological advances in processing of waste and the development of civic environmental awareness, changing old habits and adopting new ones. This study has achieved its goal, to prove that we need to act now in order to preserve the environment for the future and future generations that have to be educated from an early age on how to properly manage waste.

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TOWARDS A FRAMEWORK FOR EVALUATION OF SUSTAINABLE SOCIETY INDEX

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Abstract: *The Sustainable Society Index describes social progress along three dimensions: human, environmental and economic. Being a composite indicator, its aim is to be a comprehensive and quantitative measure of sustainability and a quality of life of a nation. The objective of this paper is to offer a new approach to a framework for objective evaluation of the SSI. To this end we have improved the SSI by implementing a statistical I-distance method that synthesizes several indicators into one quantitative indicator. The applied I-distance method offers the possibility to obtain an optimal set of variables for future revisions of the Sustainable Society Index. In addition, the differences in ranks between countries have been discussed. We hope that our results may initiate further studies concerning the framework of the Sustainable Society Index.*

Keywords: *Sustainable Society Index, I-distance, Ranking of countries, Sustainable development, Country's welfare*

1. INTRODUCTION

Since the 1992 United Nations Conference on Environment and Development in Rio de Janeiro, the limitations of Gross Domestic Product (GDP) as a measure of *sustainable development* have been frequently elaborated (Davidson, 2000; Pissourios, 2013; Cameron et al., 2013). Therefore, many different frameworks for evaluating socio-economic development and welfare of countries have been introduced (Cracolici et al., 2010), with majority of them concerned with economic indicators (UNDP, 2008). As a counterpart of economic growth philosophy, the concept of sustainable progress was introduced in 1980's. It was defined by the Brundtland report as *"development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs"* (WCED, 1987; Petrovic et al., 2011). Social and ecological factors as well as economic ones must be taken into account for defining *sustainable development* (IUCN, UNEP and WWF, 1980). Over the past decades there has been considerable interest in analyzing the relationship between economic growth and environmental impact (Wang et al., 2013).

During the World Summit on Sustainable Development in 2002 (UN, 2002) sustainability was formalized on three pillars – social, environmental and economic. Economic sustainability, as economists see it, is focused on various kinds of ―capital" (man-made, natural, human, social) that should be sustained (World Bank, 2006). *Sustainable development* is fundamentally perceived as the use of renewable natural resources in a manner that does not eliminate or degrade them or otherwise diminish their usefulness for future generations. Furthermore, it requires a sufficiently slow-rate of depletion of non-renewable energy resources to ensure the high probability of an orderly social transition to renewable ones. A specific definition of a social dimension of *sustainable development* is a less clear-cut (Martin, 2001). Understandably, the diversity of economic, social and cultural conditions in individual countries makes development of a uniform definition of social sustainability very difficult. Black defined social sustainability as *"the extent to which social values, social identities, social relationships and social institutions can continue into the future" (Black, 2004)*. It is precisely the social ―pillar" of sustainable development that is probably the most important and critical for long-term survival of human civilizations as shown in Jared Diamond's insightful study of the past (and contemporary) societies (Diamond, 2005). Last of the ―three pillars" concept, the environment, has not been closely scrutinized as the previous two pillars. According to Goodland, environmental sustainability *"seeks to improve human welfare by protecting the sources of raw materials used for human needs and ensuring that the sinks for human wastes are not exceeded, in order to prevent harm to humans" (Goodland, 1995)*. He also identifies environmental sustainability as a set of constraints on the four major activities regulating the scales of the human economic subsystem: *"the* *use of renewable and nonrenewable resources on the source side, and pollution and waste assimilation on the sink side".*

Given the above mentioned it can be concluded that the problem of sustainability is multi-dimensional. Besides being formalized on three pillars, sustainability is more than a mere aggregation of the indicators because it encompasses their interlinkages (Singh et al., 2012). Also, the indicator should be able to serve as a benchmarking instrument, to show trends in time and set targets. Accordingly, there is a need for indicators that could cover the linkages between the environmental and the other two dimensions of sustainability (Moldan et al., 2004). To this end composite indicators have been used to measure sustainability.

According to *KEI (2005), "Indicators and composite indicators are increasingly recognized as a useful tool for policy making and public communication in conveying information on countries' performance in fields such as environment, economy, society, or technological development"*. According to *Meadows (1998) "Indicators arise from values (we measure what we care about), and they create values (we care about what we measure)"*. Another definition states that a composite index is a combination of multiple sources of information measured in or off a system in order to provide a summary of the system that itself is not directly measurable (Dobbie & Dail, 2013).

There is a strong political desire for the comprehensive assessment of changes in economic, environmental, and social (including institutional) conditions: an issue that cannot be clearly measured and difficult to improve (Böhringer and Jochem, 2006). The construction of a composite index is a dynamic process, which may be roughly simplified in three steps. In the first theoretical step, experts are often involved to select the most representative underlying variables (Yuan et al., 2003; Esty et al., 2005). The second step (operational step) involves data collection and handling. Once the variables are normalized, the resulting variables could be aggregated into an overall index by an aggregating method. Then, in the final step, the collected data are aggregated leading to a composite index.

Many of the sustainability composite indicators fail to meet fundamental scientific requirements. There are three central issues to be addressed. Firstly, in selecting input variables one should be conscious that the themes determine a thematic aggregation method, and the units determine a technical aggregation method. Secondly, as there are no general rules for normalization of these variables and their weighting these procedures should be treated in a transparent way, with a great reserve, and be subject to comprehensive sensitivity analysis. Thirdly, commensurability of input variables should be assured (Ebert and Welsch, 2004).

Bearing this in mind our paper will try to address several topics. Firstly, we will point out the significance of socio-economic composite indicators and how they are constructed. Secondly, we will review the *Sustainable Society Index* which has been developed since 2006 with the aim to be a comprehensive and quantitate method to measure and monitor the health of coupled human-environmental systems at national level worldwide.

In search of an adequate set of indicators to measure the level of sustainability of a country, the main existing indexes have been examined. However, the conclusion appears to be that none of them seem to fit the needs completely. The main shortcomings are a limited definition of sustainability, a lack of transparency, and absence of regular updates. For this reason, a new index — the *Sustainable Society Index (SSI)* — was developed in 2006. It aims at describing social progress along all the three pillars – human (social), economic and environmental. Since then the SSI has been refined methodologically in order to arrive at an index that is both conceptually and statistically sound (Saisana, Philipapas, 2012). Sustainable Society Foundations was released for the fourth time in 2012, having undergone a revision by the Joint Research Centre. The latest update concerns the used aggregation method which has been changed from arithmetic to geometric mean. The SSI integrates the most important aspects of sustainability and the quality of life of a nation in a simple and transparent way. Consisted of 21 indicators, grouped into 8 categories, three Wellbeing dimensions, it is based upon the definition of the Brundtland Commission, measuring and summarizing the complex concepts underlying a sustainable society.

The paper is organized as follows: Section 2 focuses on the methodology used to perform the analysis. Section 3 features the comparative analysis of the latest SSI rankings based on the revised methodology (Saisana and Philipapas, 2012) and the *I-distance* method applied on the 2012 database. The final section of the paper underlines conclusions of the paper.

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2. METHODOLOGY

Subjectivity in creating composite indicators may affect the measurements to a great extent. In order to overcome this problem the *I-distance* method can be used. It was originally defined by Ivanovic (Ivanovic, 1977) who devised this method to rank countries according to the level of development based on several indicators, where the main issue was how to use all of them in order to calculate a single synthetic indicator which will afterwards represent the rank.

The *I-distance* measurement is based on calculating the mutual distances between the entities being processed, whereupon they are compared to one another so as to create a rank (Seke et al., 2013). It is necessary to fix one entity as a reference in the observed set using the *I-distance* methodology. The ranking of entities in the set is based on the calculated distance from the referent entity (Jovanovic at al., 2012).

For a selected set of variables $X^T = (X_1, X_2, \ldots X_k)$ chosen to characterize the entities, the I-distance between the two entities $e_r = (x_{1r}, x_{2r}, \ldots x_{kr})$ and $e_s = (x_{1s}, x_{2s}, \ldots x_{ks})$ is defined as

$$D(r,s) = \sum_{i=1}^{k} \frac{|d_i(r,s)|}{\sigma_i} \prod_{j=1}^{i-1} \left(1 - r_{ji.12\ldots j-1}\right) \qquad (1)$$

where $d_i(r,s)$ is the distance between the values of variable X_i for e_r and e_s e.g. the discriminate effect.

$$d_i(r,s) = x_{ir} - x_{is} \qquad i \in \{1, \ldots k\} \qquad (2)$$

σ_i the standard deviation of X_i, and $r_{ji.12\ldots j-1}$ is a partial coefficient of the correlation between X_i and X_j, $(j < i)$ (Radojicic et al., 2012).

To overcome the problem of negative coefficient of partial correlation, which can occur when it is not possible to achieve the same direction of variables, it is a suitable to use the square I-distance (Jeremic et al., 2013). It is given as:

$$D^2(r,s) = \sum_{i=1}^{k} \frac{d_i^2(r,s)}{\sigma_i^2} \prod_{j=1}^{i-1} \left(1 - r_{ji.12\ldots j-1}^2\right) \qquad (3)$$

3. RESULTS OF THE ANALYSIS

Within the aim of the paper to provide an appropriate framework for evaluating countries' sustainability, we applied the *I-distance* method on 151 countries and compared it to the official SSI rankings. The input data was obtained from the official 2012 SSI database. Table 1 contains 21 variables that enter the SSI framework, which are divided into eight categories and three wellbeing dimensions. This framework aims at picturing the global landscape of societies in regard to their sustainability level.

Table 1: Human, Environmental and Economic indicators for countries' wellbeing

Wellbeing dimensions	Categories	Indicators
Human Wellbeing	Basic Needs	Sufficient Food
		Sufficient Drink
		Safe Sanitation
	Health	Healthy Life

		Clean Air
		Clean Water
	Personal & Social Development	Education
		Gender Equality
		Income Distribution
		Good Governance
Environmental Wellbeing	Nature & Environment	Air Quality
		Biodiversity
	Natural Resources	Renewable Water Resources
		Consumption
	Climate & Energy	Renewable Energy
		Greenhouse Gases
Economic Wellbeing	Transition	Organic Farming
		Genuine Savings
	Economy	Gross Domestic Product
		Employment
		Public Debt

The above variables have been chosen in an iterative process during the framework revision carried out by Joint Research Centre and the SSI team in order to achieve a conceptual and statistical coherence and arrive at SSI components that are relatively balanced (Saisana, Philipapas, 2012). We have applied the proposed *I-distance* method on the first ten officially ranked countries in 2012. Table 2 shows the results of the I-distance method, square I-distance value, I-distance ranks and official SSI ranks. According to the I-distance method Norway and Sweden top the list.

Table 2 : The results of the I-distance method, square I-distance value, I-distance ranks and official SSI ranks for year 2012

Country	I^2 - distance	I^2 - rank	SSI - rank
Norway	110.90	1	5
Sweden	107.95	2	2
Switzerland	107.02	3	1
Finland	103.77	4	8
Austria	100.04	5	3
New Zealand	94.50	6	11
Denmark	91.47	7	34
Luxembourg	91.04	8	27
Iceland	90.53	9	92
Netherlands	89.90	10	44

Table 2 shows that Sweden and Switzerland remained in the top three countries regardless the method applied. Countries among the top 10 by the official SSI ranking that are not in the same rank after applying the I-distance method are: Latvia (4), Costa Rica (6), Slovenia (7), Slovak Republic (9), Sri Lanka (10). They are replaced by New Zealand (6), Denmark (7), Luxembourg (8), Iceland (9) and the Netherlands (10). Several countries have significantly improved their ranking, with Iceland and the Netherlands leading the way.

Before we continue with the comparison of rankings and reasons for the differences in them, we should analyze a correlation between the official SSI ranking, the ranking obtained by applying arithmetic mean on the 2012 database, and the I-distance ranking. We carried out the Spearman's correlation test on these rankings to determinate whether there is a correlation and whether it is positive or negative.

As expected, the correlation between the 2012 SSI official and 2012 SSI arithmetic ranks is very strong ($r=0.835$, $p<0.01$). What makes the difference between them is the fact that the arithmetic mean approach does not penalize more uneven performance of countries, whilst the geometric does. Geometric mean is far better in representing the improvements of indicators, while the arithmetic mean compensates a good performance in one indicator by a poor performance in another indicator (Saisana and Philippas, 2012). The correlation important for this paper is the correlation between the 2012 SSI official and I-distance ranks, which is strong (r=0.666, p<0.01).

The SSI official methodology takes into account all three Wellbeing dimensions equally, while same do not apply to the *I-distance* method. Implicitly, SSI official methodology provides equal weight to all three wellbeing dimensions which could easily be challenged. The countries to top the list in official ranks have had a similar level of all three Wellbeing dimensions, while other countries performed well in the Economic, but at the expense of the Environmental Wellbeing. This inverted shaped relationship is named Kuznets curve (Kuznets, 1955), which is seen in most developing nations who still have economic growth corresponding to a degradation of environmental wellbeing.

We already pointed out that the *I-distance* approach proposed here, besides providing the ranking list of countries, can also explore in-depth significance of each observed indicator and its contribution to the final rank. By applying our method, we are able to point out crucial indicators of countries' sustainability and determine their significance. Thus, the dataset was further examined and correlation coefficients of each indicator with the I-distance value were determined. The crucial indicators which correlate highly (r>0.6) with the I-distance values are given in Table 3.

Table 3: The correlation between I^2-distance and input indicators

Indicators	r
Good Governance	0.851
Gross Domestic Product	0.760
Healthy Life	0.738
Gender Equality	0.734
Education	0.718
Organic Farming	0.692
Clean Water	0.667
Clean Air	0.615
Sufficient to Drink	0.606

The correlation coefficients between the *I-distance* and initial indicators demonstrate which indicators are important in analyzing a country's socio-economic and environmental development (Milenkovic et al., 2014). (Un)surprisingly the most important indicator for measuring countries' welfare is Good Governance with r=0.851 (p<0.01), followed by GDP r=0.760 (p<0.01) and Healthy Life r=0.738 (p<0.01). Countries that improved their ranks have significantly better scores in these indicators. The fact that more than 50% of top 10 countries are from northern Europe can be explained by the Scandinavian welfare model that has been in practice in these countries since the beginning of their development in 1960's and 1970's. At the core of this welfare model stands the principle of universalism and broad public participation in various areas of economic and social life, which is intended to promote an equality of the highest standards rather than an equality of minimum needs (Magnussen et al., 2009). Since in the Scandinavian model the state has a crucial role as a supplier of social service, it follows that the model leaves relatively high support for low-wage groups (Torben, 2004). Nordic health care systems are intrinsically related to the development of the welfare state, building on the same principles of universalism and equity. Central features have traditionally been an egalitarian ideology, promoting equal access to health services, low levels of cost sharing and high levels of tax-based financing to realize this ideology, public ownership of hospitals and decentralized responsibility for managing the services (Magnussen, Vrangbaek et al., 2009).

Luxembourg entered the top 10 nations in the list according to the I-distance method. These results are in compliance with previous studies which emphasized Luxembourg's welfare and economic openness as the goals other countries should try to achieve (Koster 2013). In particular, its GDP per capita is the highest in the EU and numerous researchers emphasize its importance as a driving force of socioeconomic development while still taking into account renewable energy and sustainable development aspects wherein Luxembourg excels (Djuran et al., 2013).

New Zealand, a country that moved up for 83 places, ranks above the OECD average in terms of health spending, with 10.3% of GDP spent on health in 2011. One of the key reasons New Zealand changed its rank so dramatically is not Healthy Life, but Good Governance indicator. Namely, its score on this indicator is 8.52 compared to the country which holds the same rank in the official SSI ranks with the score 6.22 (Costa Rica). Policy makers are increasingly attuned to social equity and welfare. Welfare reforms, besides education and training of youth at risk, have a goal to improve

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education, health, employment and social outcomes for large groups of Maori and other Pacific indigenous people in order to reduce social disparities (OECD Economic Survey, 2013).

The Netherlands found its place in the top 10 thanks to its high GDP (9.58) and Healthy Life (8.89) score. In 2006, the country's government introduced a structural health care reform. The reform can be seen as the realization of a long-standing political struggle to unite the health insurance fund and the voluntary private health insurance scheme. This reform gave results and health spending as a share of GDP in Netherlands was 11.9% in 2011 (OECD Health Data, 2013). The European Commission predicts a growth rate of 1 per cent in 2014, which is a recovery from rate of -0.8 per cent in 2013 (European Commission, 2013). Although it had a negative growth rate in the previous year, the Netherlands was ranked 17th on the World list based on the GDP in millions of US Dollars (UN, 2012).

4. CONSLUSION

Since the Rio Earth Summit environmental and sustainable development indicators have proliferated. All that with the purpose of providing decision-makers with tools for assessing sustainability from global to local integrated nature–society systems in short- and long-term perspectives in order to assist them to determine which actions should or should not be taken in an attempt to make society sustainable (Kates et al.,2001). While composite indicators are usually used to present sustainability, they still have drawbacks such as subjectivity, due to the assumptions in estimating the measurement error in data, mechanism for including or excluding indicators in the index, transformation and/or trimming of indicators, normalization scheme, choice of imputation algorithm, choice of weights and choice of aggregation system (Pissourios, 2013). Although there are international efforts on measuring sustainability, only few of them have an integral approach which takes into account environmental, economic and social aspects (Singh et al., 2012). Amongst many, the *Sustainable Society Index* stands out as a simple instrument, based on a solid definition, which is used for assessing a country's present sustainability, as well as its distance to full sustainability (Van de Kerk, Manuel, 2007)

This paper covers an assessment of the *Sustainable Society Index* by applying the *I-distance* method to it. This methodology can easily integrate economic, social and environmental variables with different measurement units into one composite indicator (Isljamovic et al., 2014) which represents the rank. As the SSI synthesizes 21 social, economic and environmental indicators in eight categories, then to three wellbeing dimensions and finally to one single number, we suggest that I-distance method be applied not only to all indicators, but also to these categories in order to get a deeper insight of rankings of countries within a category. Not only does this approach enable *ranking of countries*, but it also allows for a better exploration of the differences between them. The results obtained by applying I-distance method to the official SSI 2012 database clearly demonstrate that Scandinavian and certain Western European countries lead the rank list due to their high level of living standard.

The difference in ranks between the SSI official and I-distance rankings can be explained by the fact that the SSI official rewards a balanced score in all three Wellbeing dimensions, in contrast to the I-distance method which rewards the countries with the higher score in the indicators which have greater significance. The reason the SSI official uses this kind of methodology is that *"the sustainability of the whole depends on mutual assistance and reciprocity among the parts"* (Moldan et al., 2011).

Indicators of sustainable development should be selected, revisited and refined based on the appropriate communities of interest (Singh et al., 2012). As the I-distance approach can identify crucial indicators for the ranking process, which means it can be used to reduce the number of indicators used to calculate a certain indicator (Milenkovic et al., 2014). This feature can be used to further reduce the number of indicators of the SSI, which was already done in 2012 when the index was revised by JRC (Saisana and Philippas, 2012).

We hope that our research will contribute to further improvements of the SSI, all with the purpose of creating a complete *"equilibrium between social, economic and environmental goals which is needed to reach a true index of sustainable development"* (Bravo, 2014).

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THE RESEARCH ON THE DEVELOPMENT OF ENVIRONMENTALLY RESPONSIBLE LOGISTICS IN SERBIA

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Abstract: *This paper presents the research on how environmentally responsible logistics will develop in Serbia, in the period of the following 10 years. According to the ways of application of environmentally responsible logistics, a Delphi research was conducted, in order to have a clear picture of occurrence of different, strategically important events. The result of the research shows that the most important aspects of environmentally responsible logistics and supply chain management are supposed to occur by the end of 2018, which will allow the application to progress at a regional level, as well.*

Keywords*: environment, logistics, Serbia, research, development, Delphi*

1. INTRODUCTION

The matter of environmentally responsible logistics is a very complex one, including numerous factors, which affect the creation of such, "green" supply chains. Scientifically, this field has been worked on, especially at the end of the 1990s (Rodrigue, Slack and Comtois, 2001), but the knowledge still remains parted, and the field still remains in the process of development. However, the topic has been connected to the matter of sustainable development, and as such, it has become more up-to-date.

Logistics has been proved to be environmentally the least responsible and the most damaging function of everyday business (Jovanović et al., 2013). Therefore, its development towards sustainability was a logical way of progress (Rodrigue, Slack and Comtois, 2001). The main factors that decide whether a supply chain can be called "green", or environmentally responsible, are the "green" paradoxes of logistics, intermodal transportation systems with all of their components, the development of information and communication technologies in sustaining an overall interconnection and the development of eco-innovations, laws, regulations and standards on an international level (Jovanović et al., 2013).

Since the topic is still new and underdeveloped, the most certain way of forecasting for its crucial events in Serbia was the Delphi method, where the experts were taken from within the educational system, rather than the economy. All of the experts are the representatives of the University of Belgrade and the Faculty of Organizational Sciences in Belgrade.

2. TECHNICAL DETAILS AND THE EXPERT PANEL

The years taken for the framework of the research were all in range from 2014, as the base year, to 2023, as the final year. The research has been conducted from February to April 2014, which included the preparation of the questionnaire, selection of the expert panel, sending the questionnaire, gathering and analysis of the answers, returning the answers and the questionnaire to the experts for the second round and final analysis of all the answers gathered.

The expert panel consisted of professors and teaching assistants of the Faculty of Organizational Sciences, so that different perspectives of the problem would be met. They were selected accordingly to their scientific development and fields of teaching and scientific work, regarding logistics, technological development, innovations, environmental management and other related topics. The final list of the expert panel, arranged according to their titles and Serbian alphabet, is PhD Lečić-Cvetković Danica, PhD Levi Jakšić Maja, PhD Marinković Sanja, PhD Mijatović Ivana, PhD Stošić Biljana, MSc Jovanović Milica, MSc Milutinović Radul, MSc Petković Jasna, MSc Rakićević Jovana and MSc Rakićević Zoran.

With the opening of the research, the maximum potential number of rounds was three, where the first round would contain 3 answers (o, m and p), and all the others only 1 (x). However, with a high level of consolidance for most of the questions after round 2 and close similarity of respective answers from both rounds, it was decided that the research ends after round 2 (Somerville, 2007).

3. THE QUESTIONNAIRE

The questions sent to the expert panel were followed by additional information. This was sent due to the fact that environmentally responsible logistics is still not very developed in the world, and the scientific contribution is what can best be relied on. There were 10 questions, examining the time of occurrence of 10 different factors, which affect the settlement of an environmentally friendly supply chain (Rodrigue, Slack and Comtois, 2001). The questions, along with their respective additional information, are in the following text.

1. When do you think the topic of environmental responsibility within logistics and supply chain management will become a syllabus part of subjects, related to the matter, in technical faculties in Serbia?

Additional information 1: Even when it comes to worldwide renowned Universities, there is not much data about mandatory subjects, which study this matter in particular (Rodrigue, Slack and Comtois, 2001). However, many papers concerning it, in the past few decades, show us that there is progress in this area. Furthermore, lately there has been interest for this topic, which can be infered from the SPIN'13 conference in Belgrade and other, similar symposia.

2. When do you think a hub-and-spoke network will be developed in Serbia, in the transportation of goods and people?

Additional information 2: A hub-and-spoke network considers merging a number of small terminals to one, much bigger and more complex, especially an airport or a haven. This structure has a negative impact on the environment, focusing a large number of people and quantities of goods to one point, thus increasing the level of pollution (Rodrigue, Slack and Comtois, 2001). Furthermore, according to population listings from 2011. almost ¼ of overall population of Serbia lives in Belgrade.

3. When do you expect the companies in Serbia will start developing their own “green” programs within supply chains?

Additional information 3: DHL Serbia has already started implementing the GoGreen program, but on a worldwide basis, DHL has been actively implementing other CSR programs. The GoGreen program was started five years ago in the world. Within this program, DHL sends CO_2 emission reports to their clients, according to which it forms eco-optimization of fuel spending for their own vehicles. Furthermore, they offer “become carbon-neutral” services. For more information, you can open the following link http://www.dhl.rs/sr/about_us/green_solutions/gogreen_products_services.html.

4. When do you believe the laws, which regulate certain rights and obligations related to “green” logistics operations, will be implemented in Serbia?

Additional information 4: In Serbia, there are already certain environmental laws, such as the Law on environmental protection, but there are still no laws that regulate the development of intermodal transportation, limitations of E-commerce etc. in the Parliament’s agenda.

5. When do you expect that E-commerce will start exponentially growing in Serbia?

Additional information 5: Although E-commerce has started to develop in Serbia during 2011 and 2012, many believe that it will never live in its real form. E-commerce has a negative impact on the environment, since it means increasing the number of shipments and thus using additional fuel (Jovanović et al., 2013).

6. When do you believe the companies in Serbia could start implementing intermodal supply chains?

Additional information 6: Intermodal transportation means using more than one type of transportation for the shipment of the same goods, in such a manner that the overall effect is not only related to the increase of efectiveness, but also environmental responsibility (Rodrigue, Slack and Comtois, 2001). For example, transporting one shipment by truck to the closest railway station, after which it will be transported further by train to the city of its final destination, and then by truck again to the warehouse is much more environmentally responsible than transporting the same shipment by truck entirely (Jovanović et al., 2013). Some of worldwide renowned companies, such as DHL and COSCO already use their own intermodal supply chains (LiSiyi and WeiYi, 2011).

7. When do you suppose the first company in Serbia will be able to manage its own intermodal supply chain?

Additional information 7: Bear in mind that this is how COSCO and DHL function globally (LiSiyi and WeiYi, 2011). By opening the following link http://www.coscologam.com/page/view/intermodal you can see how the intermodal supply chain of COSCO, which is based on a number of different services, works.

8. When do you expect that the first international and other standards for the development of ICT in the transportation sector (especially intermodal) will be acknowledged?

Additional information 8: The Strategy of development of rail, road, water, air and intermodal transportation in the Republic of Serbia for the period from 2008 to 2015 already exists. More information on it can be accessed to by clicking the following link http://www.putevi-srbije.rs/strategijapdf/Strategijatransport_lat.pdf. Global coordination is one of the key points in the development of intermodal transportation, which could lead to harmonizaton and seamlessness in organizing such a transportation model. Even when it comes to a global level, there are still only ideas about solving this problem (Jovanović et al., 2013).

9. When do you believe that there will be competition in the railway sector in Serbia?

Additional information 9: Intermodal transportation cannot be adequately developed as long as the railway sector is downsized to monopoly (Rodrigue, Slack and Comtois, 2001). This way, the consumers of railway transportation are "condemned" to not only one price, but also the applying quality and reliability (Jovanović et al., 2013). In 2013, the government in Serbia was discussing opening the railway market.

10. In which year do you believe the companies in Serbia will start working on eco-innovations, especially within transportation systems?

Additional information 10: The question relates primarily to local Serbian companies, which do not have a central counterpart, from which they could take over the ideas. On the other hand, when it comes to the eco-innovations of big worldwide companies, DHL has developed its own programs of waste decrease, especially in the manner of paper and packaging, water consumption and increase in biodiversity. For more information, you can access the following link http://www.dpdhl.com/en/responsibility/environmental-protection/improving_efficiency/other_environmental_impacts.html.

4. RESEARCH RESULTS – ROUND I

Once again, as mentioned before, the Delphi research was conducted in two rounds. The results will be shown and elaborated on, in order for the whole concept to be understood. After the results of the second round have been shown, the results of both rounds will be analysed in comparison to one another, in order to best present the conclusions of the research. The results of the first round will be presented in Table 1, the results of the second round in Table 2, and the comparative results will be presented in Table 3.

Table 1: Research results in round I

Question/ Indicator	Expected time of occurrence	Year of occurrence	Dispersion	Standard Deviation
1	3.1	2017	1.3085	1.1439
2	3.9667	2017	1.1348	1.0653
3	2.3333	2016	0.9832	0.9916
4	2.2667	2016	0.9638	0.9817
5	2.85	2016	1.0723	1.0355
6	3	2017	1.3081	1.1437
7	2.7833	2016	0.996	0.998
8	3.6333	2017	1.2991	1.1398
9	4.3667	2018	1.1542	1.0743
10	4.15	2018	2.0179	1.4205

As we can infer from the table, all of the events are supposed to occur in a range starting in 2016 and ending in 2018. What can further be inferred is that the level of dispersion is relatively low, meaning the experts have a high level of consolidation in their own opinions, especially since the answers were 3 values – o (optimistic), m (expected) and p (pessimistic). On the other hand, many questions still do not fulfil the condition of consensus, which is dispersion having a value lower than 1 (Hsu and Sandford, 2007).
Analysing the answers one by one, we can say that "green" logistics should become a part of teaching syllabus in technical universities in Serbia in early 2017. However, the value of dispersion is about 1.3, so this question will have to undergo a second round, in order to reach a more accurate answer.

With a similar level of agreement as for the first question, we can say that a hub-and-spoke structure will be created in Serbia at the end of 2017. With hub-and-spoke network being an environmentally damaging structure, the authorities should take care of this problem in the early stages, as soon as possible (Jovanović et al., 2013). However, a second round will have to prove the accuracy of this answer.

When it comes to environmental responsibility in logistics, within the corporate sector in Serbia, it is expected to occur at the beginning of the second quarter of 2016. Furthermore, the level of consensus is reached for this question, so it can be treated as the final answer. However, since the value of dispersion is close to 1, the question will be repeated in round II.

The law is expected to change, in a more environmentally responsible manner for logistics, at the beginning of the second quarter of 2016. Again, the consensus, with the dispersion value close to 1, has been reached, and therefore another round will be conducted for this question as well, in order to verify the result.

The exponential growth of E-commerce is predicted for the end of 2016. The level of dispersion is 1.07, which means the answer could be tolerable. However, it will undergo a second round, as well, since the result needs to be verified when the experts can only use one answer.

When it comes to companies in Serbia using intermodal transportation systems, we can say that this is expected to occur at the beginning of 2017. However, the dispersion level is not as low for this answer as it is for the ones prior to it, and thus round II will verify it.

In contrast, there is a high level of agreement, a consensus on the matter of the first company in Serbia using an intermodal supply chain for its own operations, and this event is predicted for the end of 2016. However, round II will provide a sharper image of this matter.

The time of implementing standards of ICT within the transportation sector in Serbia is expected in the second half of 2017. The dispersion level is 1.29, which means that a more accurate answer is expected in round II.

The level of agreement on the matter of appearance of competition in the railway sector in Serbia is not very high. The value of dispersion is close to 1, but it can still not be taken as consensus. The proximity of the answer from round II will show a more precise picture. For now, it is predicted for the second quarter of 2018.

Finally, companies are predicted to start working on eco-innovations, in terms of transportation systems, with the beginning of 2018. However, this answer has the highest dispersion of all 10 answers, and since the value is higher than 2, the second round will have to show a more accurate result. Again, the proximity of the answer from round II followed by a lower level of dispersion will have the same effect.

Generally speaking, the level of dispersion was not very high for most questions, especially since all the questions were supposed to be answered with 3 answers, thus creating internal dispersion. It is expected that the dispersion level will decrease in round II and that the answers will present a sharper image (Hsu and Sandford, 2007).

5. RESEARCH RESULTS – ROUND II

In the following text, Table 2 presents the answers from round II.

Table 2: Research results in round II

Question/ Indicator	Expected time of occurrence	Year of occurrence	Dispersion	Standard Deviation
1	3.1	2017	0.69	0.8307
2	3.7	2017	0.61	0.781
3	2.5	2016	0.65	0.8062
4	2.3	2016	0.61	0.781
5	2.9	2016	0.49	0.7
6	2.9	2016	0.69	0.8307
7	2.6	2016	1.04	1.0198
8	3.5	2017	0.65	0.8062
9	4.3	2018	1.21	1.1
10	4	2018	1.6	1.2649

As noticeable, the figures from Table 1 were sharpened, meaning they have fewer digits after the comma. This is conditioned by using only one answer, instead of an optimistic, the most expected and a pessimistic one. This has decreased the dispersion level of each answer, and thus the overall dispersion, per question. What we can also notice is the fact that almost all questions have reached a level of consensus, indisputably. Another conclusion is that the answers have almost not been changed.

In order to better present both rounds of the research, a new table, showing answers from both rounds, and the final year of occurrence of each event will be presented and elaborated on. As of now, what can be mentioned is that round III has not been undertaken, since respective answers from rounds I and II are have not been changed significantly, and the levels of dispersion, in almost all cases, have been reduced relevantly. As of questions 9 and 10, for which a consensus has not been reached in either round, and explanation of why round III has not been undertaken will follow.

6. COMPARATIVE RESEARCH RESULTS FROM ROUNDS I AND II

In the first round, consensus has been reached for only 3 out of 10 questions, while in round II consensus was reached for 7 out of 10 questions. Furthermore, the figures in round II are more precise than the ones in round I and the answers have been either slightly changed, or completely unchanged. The comparative results, comparing the expected times and dispersions for each respective question in the two rounds and the final year of occurrence of each event, follow.

Table 3: Comparative research results from rounds I and II

Question/ Indicator	Expected time I	Dispersion I	Expected time II	Dispersion II	Year of occurrence
1	3.1	1.3085	3.1	0.69	2017
2	3.9667	1.1348	3.7	0.61	2017
3	2.3333	0.9832	2.5	0.65	2016
4	2.2667	0.9638	2.3	0.61	2016
5	2.85	1.0723	2.9	0.49	2016
6	3	1.3081	2.9	0.69	2016
7	2.7833	0.996	2.6	1.04	2016
8	3.6333	1.2991	3.5	0.65	2017
9	4.3667	1.1542	4.3	1.21	2018
10	4.15	2.0179	4	1.6	2018

Once again, we can claim that environmental responsibility as an aspect of logistics and supply chain management will become a part of subjects in technical faculties in Serbia at the beginning of 2017. However, despite the fact that the answer is the same in both rounds, consensus has been reached in round II. In case that the answers were different, the one from round II would have been taken as final.

There was a slight change in the hub-and-spoke structure occurrence answer. Namely, round I suggested the structure would occur at the very end of 2017, while round II infers it will occur some time earlier, at the end of the third quarter of 2017. With dispersion of 0.61 from round II being lower that 1.13 from round I, the end of the third quarter of 2017 will be taken as the final answer, rather than the very end of 2017.

Eco-awareness programs in Serbian companies were almost certain to start being worked on at the beginning of the second quarter of 2016. However, with a higher level of precision, the experts have decided that this will rather occur a few months later, at the beginning of the second half of 2016.

The consensus for question 4 from round I has also been corrected, or, better said, sharpened. The laws that define certain rights and obligations when it comes to logistics operations are expected to be implemented in the second quarter of 2016. The answers from both rounds are very approximate, but a higher agreement level has been reached in round II.

The exponential growth of E-commerce was expected for the end of 2016, and the second round has confirmed this expectation, with a lower level of dispersion. With this answer, we can be very certain of the prediction.

The first implementation of an intermodal supply chain in Serbia was predicted for the beginning of 2017 by the answers in round I. Round II, however, suggests that the event will occur at the very end of 2016. However, since the difference between the answers is only slight and the dispersion level in the second round is lower, and in the consensus zone, we will say that an intermodal transportation system will be operational in Serbia at the very end of 2016.

When it comes to the question of a company having an intermodal transportation system, used for its own operations, something interesting occurred during the research. Namely, the dispersion level shifted from the level of consensus (0.996) in round I to a level outside of consensus (1.04) in round II. However, since the dispersion difference is only slight, and the answers are approximate to one another, we can use them to set a time framework for the occurrence of this event. Furthermore, since there was a consensus in round I, we will take that answer as final and say that the first company in Serbia will have its own intermodal transportation system in the final quarter of 2016.

International standards in the field of ICT are expected to be implemented at the beginning of the second half of 2017. Since the answers from rounds I and II are not in a dissonance from one another (3.63 and 3.5 respectively, and the dispersion in the second round is in the level of consensus, we will take the middle of 2017 as the final answer.

When it comes to the matter of the occurrence of competition in the railway sector in Serbia, there has not been a consensus in either of the rounds. In fact, the dispersion from round II is slightly higher than the one from the first round. On the other hand, both dispersion levels are only tolerably close to the value of consensus, and the answers are almost the same. Therefore, we can say that if the third round was undertaken, the answer would be close to the ones from the first two rounds. Also, the dispersion level would most probably be close to the two values. In conclusion, the third round will not be started for this question, and the answer from round I will be taken as final, since the dispersion was slightly lower in the first round. This means that competition in the railway sector in Serbia is expected to emerge in the second quarter of 2018.

Finally, the question of eco-innovations as a driver of development of “green” logistics is the last one, again, never reaching a consensus. The answer from round I indicates that this event should occur at the beginning of 2018, but with a high level of dispersion (2.02). The answer from round II, again, shows that the event will occur at the beginning of 2018, only with a lower level of dispersion (1.6). Neither of the two answers is within the tolerance, or the consensus zone. However, with the two answers indicating the same period of time and the dispersion level decreasing significantly in the second round, we will assume that if the third round was to be undertaken, the experts would have given the same answer, potentially only with a lower level of dispersion, or even within the level of consensus. Therefore, the third round will not be started at all, and the beginning of 2018 will be announced as the expected time when the companies in Serbia will start working on eco-innovations in order to support the creation of intermodal supply chains and “green” logistics.

7. CONCLUSION

In this research paper, we have inspected the times when certain events, crucial for the development of environmentally responsible logistics, are supposed to occur, by using the Delphi method and sending the questions to the teaching staff of the Faculty of Organizational Sciences in Belgrade, who have shown interest in the topic prior to the research, through their contribution to scientific work.

The factors included in the research, concerning environmentally responsible, or “green” logistics were scientific approach, “green” paradoxes of logistics operations, standardization and the legal system in Serbia, eco-innovations, intermodal transportation with all of its components and factors and eco-innovations. These factors were differentiated into 10 questions, sent together with additional information, to keep the experts on the right track, which has resulted in answers having a high level of consensus even in the first round of the Delphi research.

Finally, the answers show us that all of the examined factors will occur in less than 5 years from now, or, precisely, from 2016 to 2018. In fact, most of the examined factors, even 5 out of 10, are supposed to occur in 2016, according to the predictions. What can be expected in Serbia in 2016 is the implementation of environmental responsibility programs in the corporate sector, implementation of the laws, regulating some of the “green” logistics problems, exponential growth of E-commerce and the establishment of intermodal supply chains, within and among companies.

Furthermore, in 2017, we can expect the problem of “green” logistics to become a part of subjects taught in the technical faculties in Serbia, the occurrence of a hub-and-spoke structure and the implementation of international standards in this field.

Finally, in 2018, the railway sector in Serbia should become more competitive and partially privatized, in order to increase the quality of service. Furthermore, the companies in Serbia are expected to start working on eco-innovations, especially in the transportation and supply chain sector, in 2018, as well.

Since environmentally responsible logistics is still only given in a theoretical framework, rather than a practical innovation matter, there needs to be put more effort in its scientific development, prior to its use in practice. The matter still has a complex character. Therefore many more researches need to be undertaken before logistics operations would become completely “green”, minimizing the environmental damage to the lowest possible level. This scientific contribution should be followed and continued, in theory and practice, so that one day logistics will turn from “environmentally the least responsible field of business” to a completely “green” operation.

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ECO-INNOVATIONS AS A SOURCE OF COMPETITIVE ADVANTAGE IN ENTERPRISES

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Abstract: *The paper aims at assessing the impact of eco-innovations on the competitiveness of enterprises, and especially at answering the question which advantages resulting from ecological innovations businesses find decisive for their competitiveness. A review of mainstream literature on eco-innovation as well as on competitive advantages will be conducted followed by document-based research. The paper focuses on various and complex dependencies between the competitiveness of businesses and their eco-innovative activities. Resorting to numerous empirical studies, one may observe that an increase in the significance of ecological innovations in the process of building corporate competitiveness becomes noticeable. Enterprises undertake innovative actions in the field of sustainable growth, and especially ones related to environmental aspects, in this way increasing their market credibility and attractiveness. These results have important implications for business strategy decisions. Therefore, this paper contributes to existing literature on corporate sustainable development by achieving competitive advantages resulting from eco-innovative activities of enterprises. The presented benefits of competitive advantage resulting from eco-innovation activities of businesses may be used among others for a further study of the dependencies between the implementation of eco-innovations and increase in the competitiveness of businesses, as well as for the appropriate adjustment of business strategies to the changing conditions of the environment.*

Keywords: *eco-innovation, competitiveness, competitive advantage, sources of competitiveness, indicators, enterprises*

1. INTRODUCTION

Competition is a phenomenon present in many fields of everyday life: social, political, economic, cultural, etc. It is the foundation for the operation and development of market economy. Competition between enterprises is a special area of current interest of many economists, as businesses are generally considered the main source of real economy, and it is on their behaviours that the condition, directions, and pace of development of national economies and the standard of life of populations depends to a major extent. Thanks to the presence of competition, ever higher quality goods are delivered, and companies are forced to innovate and run reasonable pricing policies (Teece, 2010, p. 186). The capacity of an individual business for competition depends not only on how it achieves its basic economic goals (e.g. profits, profitability, and liquidity), but also on whether it considers a variety of political, legal, economic, and social influences as well as the impact of interest groups that represent them. Due to the growing environmental-oriented requirements on behalf of various stakeholders, whose number includes staff and investors, in their operation an increasing number of enterprises account also for questions related to environmental protection. These changes have made business perceive environmental protection as an important competitive factor, while executive boards and shareholders consider it a strategic managerial duty. Beyond doubt, the changes that take place in business macro- and micro-environment, the growing requirements expressed by customers, and increasingly strong restrictions concerning environmental protection enforce new methods of managing production and environment, which contributes to a more effective management of environmental resources (Bata, 2011, pp. 265-267). Positioning of businesses thanks to a more effective environmental protection and/or ecological products and services may bring a range of competitive advantages, including acquisition of new markets, cost reduction, legal safety, image enhancement, and efficient organisation (Shrivastava, 1995; Dangelico & Pontrandolfo, 2013).

A significant role in achieving a competitive advantage in businesses is ever more often played by the eco-innovative activities they undertake (OECD, 2009, p. 11). As any innovations, the ones in the area of ecology should first of all provide an added value for the clients, be more competitive, and contribute to the creation of profit for the innovators. Their main characteristic feature is their environmental aspect. The goal behind eco-innovation is reduction of the negative impacts on the environment, establishment of new markets opportunities, products, services and/or processes focused on environmental matters, and improvement of environmental impact (OECD, 2009, p. 11). Generally, ecological innovations are integrated with new environmentally-friendly products and services that aim at the improvement of the natural environment by saving energy and other resources, and reducing pollutants and waste (Urbaniec & Gerstlberger, 2011).

These grounds allow a claim that eco-innovations, being an answer to both environmental and socio-economic challenges, play a significant role in building the competitiveness of enterprises. The paper aims at assessing the impact of eco-innovations on the competitive advantages of enterprises, and especially at answering the question which advantages resulting from ecological innovations businesses find decisive for their competitiveness. Thus, the study focuses on various and complex dependencies between the competitiveness of businesses and their eco-innovative activities. To achieve this, the paper first presents the significant circumstances of enterprise competitiveness, and the multi-aspect character of ecological innovations.

2. THE ESSENCE AND SIGNIFICANCE OF ENTERPRISE COMPETITIVENESS

In general, the competitiveness is a feature that distinguishes entities operating within the field economy from the point of view of the results obtained, and the capacity for achieving them in future (Atkinson, 2013, p. 5). As views on the subject diverge, literature proposes an array of definitions of the notion, usually in reference to macroeconomics systems. Approaching the notion of competitiveness at enterprise level, the OECD defines competitiveness as ~~a~~ability of companies, industries, regions, nations, and supranational regions to generate, while being and remaining exposed to international competition, relatively high factor income and factor employment levels on a sustainable basis" (Hatzichronoglou, 1996, p. 20). This definition fully illustrates a view on competitiveness of businesses that depends mainly on the skills and ways of using the internal potential. The greater the competitiveness of an enterprise, the easier it can operate on the market. Moreover, a high degree of competitiveness is perceived in a better light by the potential investors and/or shareholders. That is why improving the competitiveness is of profound significance for businesses and influences their external perception and position in the market.

In the traditional economic approach, a competitive business is one whose economic activity leads to long-term increase of market value. The following are most frequently taken into account while assessing the changes in the competitiveness of businesses: analysis of changes in sales revenue, changes of financial results, changes of the level of investment outlay, changes of market share, etc. (Bressler, 2012). These parameters make it possible to assess the vector of competitiveness changes, while an increase in sales revenue is not always tantamount to an increase in goodwill (as the costs necessary to achieve the increase matter), nor does always a surge in investment outlay lead to a rise of goodwill (as investments may be failed, and companies have been known to overinvest, thus negatively affecting their liquidity).

Although many authors in economic sciences examine various aspects and circumstances of competitiveness, there is no consensus on the question of the definition (Atkinson, 2013, p. 2; Feurer & Chaharbagh, 1994, p. 49). Due to the complexity of the problem in literature, the definition proposed by Feurer and Chaharbagh (1994) seems most adequate. The authors claim that the competitiveness of an enterprise is a multi-dimensional trait, unique for the given enterprise, that results both from its internal properties and the skill of coping with external circumstances (Feurer & Chaharbagh, 1994, p. 58; Pulaj & Kume, 2014, p. 48-49). Moreover, it must be mentioned that the works of M.E. Porter – who claimed that competitiveness must primarily be perceived in the capacity to be innovative, to increase continuously the level of innovation and to the acquisition of an appropriate level of effectiveness in its result (Porter, 2008) – had a significant impact on the studies of competitiveness in economy. According to Porter, the foundation of the competitiveness is productivity – the efficiency in consumption of resources – and in the final appraisal, it is what decides about the competitiveness of businesses.

Thus, a competitive edge can be construed as a higher rank of a business in the sector, achievement of better results, and the skill of doing something better than the competitors. The factors that determine competitiveness of businesses known from literature cover a multitude of various approaches and classifications (Gupta, Guha & Krishnaswami, 2013), that can be synthetically divided into those directly dependent on the enterprises (internal, the potential of the enterprise) and those that are independent of them (external, resulting from the environment), (Birkinshaw, Hood & Young, 2005, pp. 228-233). The following can be counted among the basic sources of the competitiveness (Piercy, Kaleka & Katsikeas, 1998):

- technological sources (R & D, innovativeness)
- production-related sources (e.g. effect of the scale of production)
- distribution-related sources (developed distribution network, advanced logistics)
- marketing sources (efficiently implemented marketing activities)
- place in the market (trademark, patents, reputation),
- the unique quality of the company and its products (high level of differentiation)
- quality of management (managerial talents, closely knit organisation)

- know-how and information (the skill of aggregating and processing)
- time management (speed of reaction to changes in the environment).

The factors presented above depend to a great extent on the businesses themselves. Nevertheless, the competitiveness may also be influenced by circumstances that are independent of businesses, whose number includes, for example, the international economic climate, technological progress, fluctuations in supply and demand structure, and changes of principles of cooperation and competition in the market (Jeanjean, 2011). Moreover, an important role is played by the impact of the national policy on the creation and/or disappearance of the competitive edge by the development of a legal and institutional environment, and macroeconomic, structural and social policy, which is related to the participation of the given country in the sharing of the benefits stemming from international trade.

As far as current challenges, going beyond the economic conditions, are concerned, from business perspective, competitive advantage can be said to be increasingly often assessed on the grounds of a business‘s capacity for long-term sustainable development, where the scope of analysis goes beyond commercial issues, and covers not only an increase in the market share and profitability, but also environmental and social goals (Miron, Petcu & Sobolevschi. 2011). This means that the matrix of enterprise goals should also include the elements of environmental friendliness, e.g. cuts in the consumption of natural resources and pollution of the environment resulting from the production and managing by-products/waste. Thus, in the context of activities in support of the environment, the innovative activity, being the subject of the following chapter, plays a significant role in achieving a competitiveness.

3. MULTI-ASPECT DIMENSION OF ECO-INNOVATION

Much like in the case of innovation, literature and economic practice know many definitions of eco-innovation, which differ in their scope and degree of detail. Generally, they concern innovation that brings benefit to the environment. Ecological innovations were for the first time a subject of research already in the late 1970s. Strebel defined the so-called –economic innovations in environmental protection” as innovations that are related to the conscious implementation of environmental-oriented activities, and also to the environmentally friendly products and production processes to decrease or prevent environmental pollution, and thus achieved cost reduction (Strebel, 1979, p. 5). A more extensive definition of ecological innovations was formulated in the latter half of the 1990s and covers –all measures of relevant actors (firms, politicians, unions, associations, churches, private households) which; develop new ideas, behavior, products and processes, apply or introduce them and which contribute to a reduction of environmental burdens or to ecologically specified sustainability targets” (Rennings, 2000, p. 322).

According to the OECD, ecological innovations cover all the innovations that have a favourable impact on the environment, independent of whether the effect itself is the main purpose of the innovation or not (OECD, 2008, p. 8). Thus, eco-innovations are defined as –the creation of new or significantly improved, products (goods and services), processes, marketing methods, organisational structures and institutional arrangements which – with or without intent – lead to environmental improvements compared to relevant alternatives” (OECD, 2008, p. 19). Moreover, they are not limited only to innovations in products, processes, and marketing methods, but also include innovations in social and institutional structures. This definition is promoted mostly as part of the Environmental Technology Action Plan (ETAP), in whose view every investment made by a given organisation is bound to a choice (intended or not) between more and less environmentally friendly technologies. Therefore, an eco-innovation does not need to be a global novelty nor be a result of purposeful activity or strategy of an enterprise (Kemp & Pearson, 2007, p. 7). With the definition presented above in mind, one can claim that any innovation that contributes to environmental benefits as compared to significant alternative possibilities is an eco-innovation (e.g. environmental technologies, organisational innovations, product and service innovations, and green systemic innovations), (Kemp & Pearson, 2007, pp. 10–11).

In line with the OECD Innovation Strategy, eco-innovations are a significant element supporting the environmental-oriented, i.e. –green”, economy. A key element of the OECD Innovation Strategy, in the Green Growth Strategy, is accounting for the instruments that introduce price-related incentives, encouragement for businesses promoting greater involvement in –green activity”, and the financing of basic scientific research (OECD, 2010). At the level of the European Union, eco-innovations are perceived as innovations supporting the comprehensive objectives of the Lisbon Strategy supporting competitiveness and economic growth. Moreover, they play a specific role in the Europa 2020 document of the European Commission, defining the strategy of smart and sustainable economic growth. The document covers three mutually intertwined priorities (European Commission, 2010 a, p. 5):

- smart growth: developing an economy based on knowledge and innovation

- sustainable growth: promoting a more resource-efficient, greener and more competitive economy
- inclusive growth: fostering a high-employment economy delivering social and territorial cohesion.

With respect to the growing role of eco-innovations, especially in the context of Europa 2020 strategy, Eco-innovation Observatory (EIO) was developed at the level of the European Union in 2010 as a framework for analysing eco-innovation across the European Union. The EIO Methodological Report (EIO 2010) defined eco-innovation as “the introduction of any new or significantly improved product (good or service), process, organisational change or marketing solution that reduces the use of natural resources (including materials, energy, water, and land) and decreases the release of harmful substances across the life-cycle” (European Commission, 2010 b, p. 7.). The Eco-innovation Scoreboard (Eco-IS), a system of indicators that provided the first tool for assessment of eco-innovation, was developed as part of the project (European Commission, 2011, pp. 21–22). At the preliminary level, the results of EIO works were presented in the Eco-innovation Scoreboard 2010 through 13 indicators, a number that was expanded to 16 in the following years. The Eco-innovation Scoreboard is an index based on indicators in five areas (European Commission, 2013, p. 18): eco-innovation inputs, eco-innovation activities, eco-innovation outputs, environmental outcomes, and socio-economic outcomes (see Figure 1).

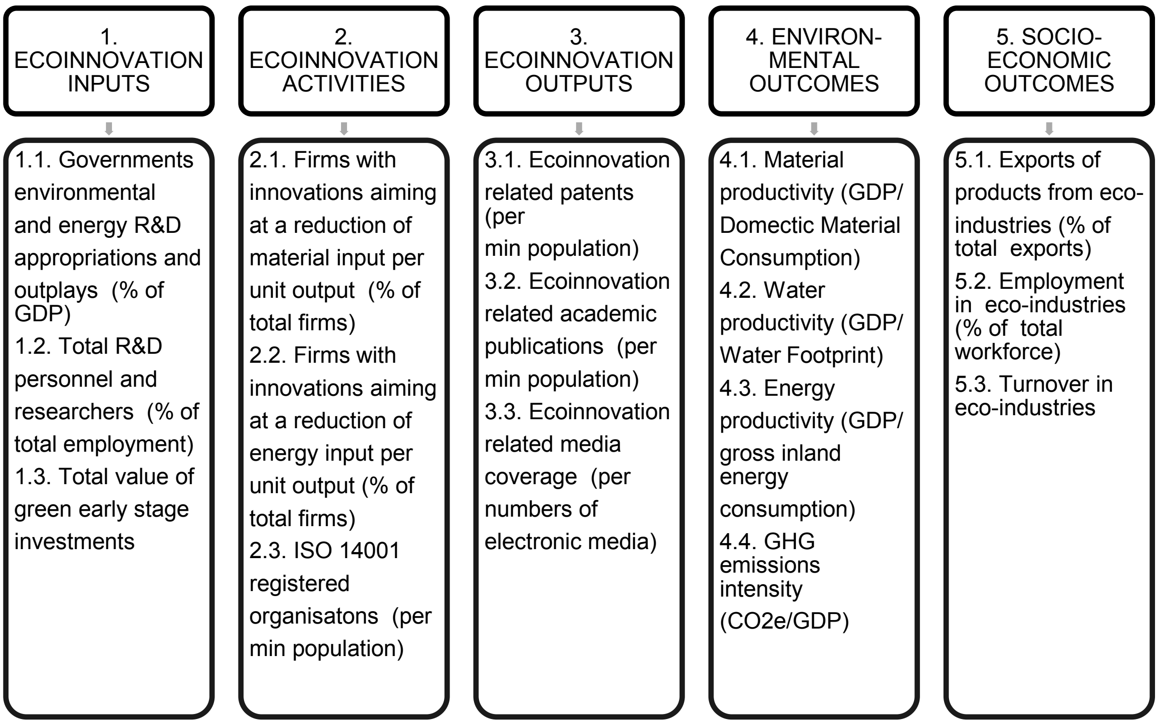

Figure 1: Structure and indicators of the Eco-innovation Scoreboard

It needs emphasising that only the first three groups of indicators concern eco-innovation directly, as the remaining two show the impact of introduced eco-innovations. Therefore, the Eco-IS score is calculated on the grounds of the previously mentioned 16 constituents indicators for all the EU states in reference to EU average, which allows the identification of strengths and weaknesses in ecological innovations in individual EU states.

Moreover, it should be noted that national statistical offices (institutes) and/or appropriate ministries in EU states are involved in statistical research in innovation in line with the international programme of statistical studies in innovation (Commission Regulation (EC) No 1450/2004 of 13th August 2004 implementing Decision No 1608/2003/EC of the European Parliament and of the Council concerning the production and development of Community statistics on innovation), (European Commission, 2004). The studies are conducted according to methodological guidelines used in OECD countries and the EU, presented in a series of OECD manuals known as the Frascati Family Manuals (OECD, 2002).

Recapitulating, one must notice that despite the numerous and varied definitions present in literature, eco-innovation may be defined for the needs of this paper as innovations that lead to the improvement of the quality of natural environment and have been implemented to increase the environmental efficiency of an enterprise. This is justified by the fact that an ever greater number of businesses implement eco-innovative projects that contribute to the development of their brand among clients and to the improvement of the company‘s image. These and other advantages are decisive for the competitive superiority of eco-innovative businesses, and are the subject of the following chapter.

4. COMPETITIVE ADVANTAGES RESULTING FROM ECO-INNOVATIVE ACTIVITIES

Should we assume that ecological innovations are related to a complex pattern of determinants, the political, market, and social environment provides a particular system that is the grounds for defining the factors that have a bearing on ecological innovations. What must additionally be mentioned here are enterprise-specific factors. Due to a large number of relevant studies, attention in this chapter is turned to the significant factors that influence the competitiveness of businesses, as specified in – mostly English – literature.

The main constituents of competitiveness that belong to the so-called systemic (i.e. enterprise independent) determinants include environmental rules. In this context, the so-called Porter‘s hypothesis requires special attention. In its light, restrictive rules concerning environmental protection may increase efficiency and encourage introduction of innovations that help to improve the competitiveness of businesses. To quote: ―The new paradigm has brought environmental improvement and competitiveness together. It is important to use resources productively, whether those resources are natural and physical or human and capital. Environmental progress demands that companies innovate to raise resource productivity – and that is precisely what the new challenges of global competition demand" (Porter & van der Linde, 1995, p. 133). This hypothesis suggests that restrictive regulations on environmental protection help to identify and introduce ever more environmentally-friendly technologies, and improve the condition of the environment. The results of innovation make production processes and the products themselves more effective. The savings that can be achieved in this way are sufficient to compensate for the costs both related directly to observing the new rules and to introducing the innovations. Porter and van der Linde emphasise that appropriately designed legal regulations in this area may have a bearing on the direction of innovations among others through (Porter & van der Linde, 1995, p. 128):

- signalling of the current lack of efficiency in resource use and possibility of technological improvements to businesses
- raising the awareness of businesses and undertaking of remedial actions wherever legal regulations are aimed at providing information
- decreasing the uncertainty of net returns on investment
- motivation to implement innovation and achieve progress
- ensuring a level playing field, which is necessary in the context of limited compensations.

Besides the legal regulations concerning environmental protection, literature knows many other factors that also influence the shaping of corporate competitiveness. It is commonly assumed that innovations are a source of competitive advantage at the level of the enterprise. Zollo and Winter pointed out that innovations of varied value may lead to a lasting competitive edge (Zollo & Winter, 2002, pp. 339–351), while homogeneous innovations are developed rapidly and account only for a temporary competitiveness for innovators (Grave, 2009). To create a varied value, one needs to adjust the resources and potential of business, so as to make it difficult to copy or transfer. Similarly, the competitors‘ slow pace of reaction may provide innovators with a competitive advantage. On the other hand, building a competitiveness requires quick diffusion, which means that innovations should be quickly embraced by the clients. According to Shrivastava, the competitiveness may be developed along the supply chain, i.e. the use of raw materials, processes of production, and final effects of the production. At the input (e.g. raw materials) stage, the competitive edge may result from cost-effective use of materials and energy, which is reflected in cost reduction (Shrivastava, 1995, pp. 183–200; Bata, 2011, p. 267). Cost reduction as well as generation of savings are a significant stimulus for the development of ecological innovation. At the stage of production process of, application of environmentally friendly technologies contributes among others to environmentally-friendly and cleaner production by improving production efficiency and minimisation of waste and other pollutants. In turn, competitive advantage at the final stage of the process of production may result from better design of products and business models.

Moreover, Porter and van der Linde point to the improvement of revenue resulting from the advantage of being the first mover in the market (Porter & van der Linde, 1995, p. 127). The authors explained that environmental aspects may be perceived as potential competitive advantages. Especially companies leading in new markets may expect benefits from the title of being the first movers and improvement of the corporate image, which lets them charge higher prices for ecological products. For that reason, ecological innovations

may be used as a tool for a differentiating strategy, which helps to increase the market share (Peattie, 2001, pp. 187–199; Pulaj & Kume, 2014, p. 51), and therefore to obtain a competitive advantage.
Empirical studies provide grounds for the conclusion that obtaining a competitive advantage through ecological innovation is measured through various indicators. Depending on the context of the studies conducted, various types of indicators can be identified: ones that are enterprise-dependent (internal, e.g. costs) and ones that are not (external, e.g. market share).
The aggregated list of constituents of competitive advantage in businesses was presented by Wagner, who listed four basic types of benefits. They were operationalised with respect to the following (Wagner, 2009, pp. 296–297):

- market factors: regarding sales, new potential in the market, and market share
- image: related to the corporate image, and product and/or service brands that aim at differentiating the enterprise and its products from those offered by competition/competitors
- risk-related factors: related to financing options and terms of insurance
- efficiency-related factors: with impact on profitability, cost efficiency, and other financial indicators.

Therefore, it can be assumed that the four types of benefits stemming from the competitive advantage may lead to better results obtained by the enterprises in a longer term. Falling back on the presented classification of constituents of competitive advantage from the title of carrying out eco-innovative activities, other classifications of factors that influence the competitive advantage of businesses are also possible.

5. CONCLUSIONS

The competitiveness of an enterprise is a basic goal defining the strategy of its development. With the consumers increasingly aware of the need to protect the natural environment, businesses must be capable of meeting the requirements of the market. It is already generally known that businesses capable of offering their clients products that fulfil the aforementioned requirements become more competitive in the given market. The motivation motivating companies to undertake eco-innovative activities is an increasing sense of intensifying international environmental protection regulations, greater levels of ecological awareness among consumers, and expectation of earlier benefits which will let eco-innovators favour setting higher prices for their products (Valentine, 2010, pp. 284–298).

Ecological innovations play an important role not only in the process of minimising the negative impact of the company‘s operation on the environment but also contribute to increasing competitiveness. Resorting to numerous empirical studies, one may observe that an increase in the significance of ecological innovations in the process of building corporate competitiveness becomes noticeable. Enterprises undertake innovative actions in the field of sustainable growth, and especially ones related to environmental aspects, in this way increasing their market credibility and attractiveness. The presented benefits of competitive advantage resulting from eco-innovation activities of businesses may be used among others for a further study of the dependencies between the introduction of ecological innovations and increase in the competitiveness of businesses, and to the appropriate adjustment of business strategies to the changing conditions of the environment.

In summary, one may maintain that ecological innovations can be perceived as an instrument of a differentiating strategy serving the improvement of the competitive position of the enterprise. Enterprises perceive an array of environmental-oriented solutions as a significant stimulus to improve the competitiveness, because only thanks to those they are capable of standing up to the challenges of building the future, and react successfully to the dynamic developments in the market, scientific progress, ecological requirements, and social changes. For that reason, embarking on innovative solutions in such a manner that development of new products and/or methods of productions accounts not only for economic but also ecological and social goals is what remains the main challenge for businesses.

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CONSTRUCTED WETLANDS AS APPROPRIATE WAY OF WASTE WATER TREATMENT IN RURAL REGIONS

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Abstract: *Article discusses the possibilities of more frequent use of constructed wetlands for waste water treatment in Slovenia and Serbia. Situation about the use of drinking water and production of waste waters both in Slovenia and Serbia is briefly presented. Principles of functioning of constructed wetlands are briefly shown as well as their structure and types. At the end is also given information about cost for a typical individual constructed wetland object.*

Keywords*: Constructed wetlands, Waste water treatment, Environmental protection, Rural areas, Touristic destinations, Drinking water*

1. INTRODUCTION

Constructed wetlands present a very convenient mode for treatment of waste waters in areas with dispersed settlement. Therefore they are particularly applicable in rural regions as well as in areas with high density of touristic objects and are very efficient in treatment of sewage and agricultural waste waters. In the case of individual houses, groups of houses, villages, hotels, touristic camps, farms or similar objects where collection of waste waters and connection to central waste water treatment plant is not possible . In such occasions constructed wetlands are much more convenient and environment friendly solution as are septic tanks.
Constructed wetlands enable efficient secondary and tertiary part of waste water treatment. This is efficient way to prevent pollution of water and to protect underground waters and resources of drinking water.

2. SOURCES OF DRINKING WATER AND GENERAL DATA ABOUT MUNICIPAL WASTE WATERS IN SLOVENIA AND SERBIA

As has been already mentioned constructed wetlands present ideal solution for solving problems of waste water treatment in areas of dispersed settlement where the use centralized systems for treatment of waste waters is not able due to geographic or economic reasons. This is particularly important today as the use of drinking water is in continual increase. In Slovenia the use of drinking water according to the data from 2012 was 84,8 millions m^3/year which presents about 50% of the total quantity of water pumped in Slovenia. The total production of municipal waste waters was 200,9 millions m^3/year which presents 32,6% increase in comparison to the previous year (SORS, 2012). As much as 84,9 millions m^3 of waste waters (42,2%) remained untreated. According to the accessible data from 2005 the total quantity of municipal waste water was more than 360 millions m^3/year and less than 10% (5,6%) of these quantity was adequately treated. In Serbia only about 75% households in cities and 9% households in rural areas is connected to centralized sewage systems (Veljković, 2005).

Constructed wetland plants for waste water treatment seem very convenient for rural areas both in Slovenia and in Serbia, as in these regions waste waters are released in the environment and present potential danger for ground water pollution. Constructed wetlands present adequate solution also for villages which already have not adequate waste water treatment systems. This is important because of protection of drinking water resources as purified water from constructed wetlands can be used in agriculture. In such way can be reduced consumption of water from primary resources. Constructed wetlands can also help to meet legislative requirements which determine obligatory treatment of waste waters from individual houses until 2018. This can be also interesting solution for owners of individual houses as taxes for waste waters treatment in the case of constructed wetland use can be reduced as much as for 85%.

At this moment Slovenia in comparison to Serbia has on disposal enough qualitative sources of drinking water. Nevertheless, the fact the quality of drinking water is decreasing and that quantity of waste waters grows continually can be a matter of serious concern. According to the data for 2012 in Slovenia the average water use is 114 liters/day per person (41 m^3 /year per person) which is still much less than average use per person in Serbia 350 liters/day (400 liters/day in cities, 200 liters/day in rural regions). The quality of drinking water in Serbia seems at least very questionable - according to the data from 2007 results of drinking water analysis for various samples indicate on certain chemical pollution. In many samples have been obtained also positive results according to the microbiological test (possible bacterial pollution) (Trofej, 2014). The results of the survey of local and public water sources in Serbia are still more alarming as they show very bad quality for all of the 1.092 samples. In Slovenia except some individual houses the great majority of villages use water from public sources what is in Serbia not the case. However, the quality of drinking water must always be the matter of permanent concern.

Constructed wetlands are as mentioned particularly applicable on rural regions as they can solve the problem of waste water treatment as well as reduce the use of drinking water. In Serbia according to the data of Serbian statistical institute only 46% of households is connected to the centralized waste water treatment system. Thus many households have to search their own solution for the treatment of waste waters and this is also in Slovenia considerable problem as unsuitable treatment of waste water jeopardizes ground water.

3. PROJECTION AND DIMENSIONING OF CONSTRUCTED WETLANDS

In the course of projection and dimensioning of constructed wetland population equivalent (PU) is used as a unit. PU presents the degree of average water pollution caused by a person per day. It is expressed as BOD_5 (Biological oxygen demand – mg of oxygen used for oxidation of biologically degradable pollutants present in 1 liter of waste water, included are only those pollutants which are biochemically decomposed in the period of 5 days). 1 PU unit is equal to 60 g BOD_5 per person per day (Roš, 2001).

However, this pollution is not unique for all countries. By example, in Slovenia PU is according to the use of drinking water between 110 and 150 litres per day meanwhile in United States as much as 400 litres/day. In Serbia this quantity is 350 litres/day (Trofej, 2014). The quantity of used drinking water in particular country can be also indicator of environmental awareness of citizens.

The treatment of 1 PU requires the surface of 2-2,5 m^2 which depends also on meteorological conditions. Constructed wetlands operate during the entire year independently of weather conditions. As the majority of water treatment process is driven by micro-organisms and not by plants constructed wetlands are effective also during winter period. However, in winter different species of micro-organisms are present in the system. The purifying efficiency of wetland is in winter 15-20% lower because of vegetation break. This fact must be respected in the process of dimensioning of constructed wetland.

In Figure 1 is schematically shown constructed wetland for waste water treatment from individual house.

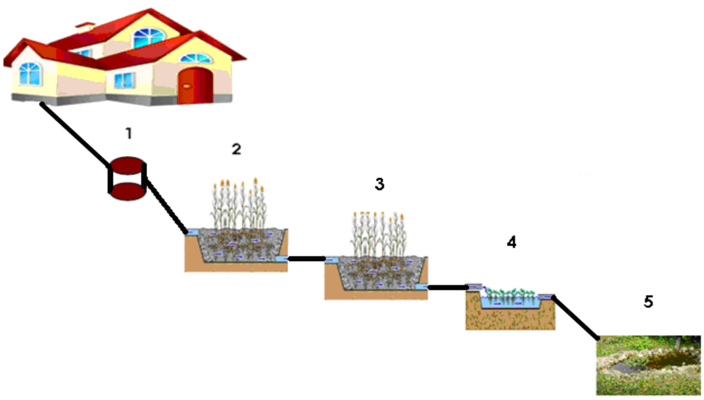


Figure 1: Principle of operation of waste water treatment by constructed wetland for individual house (1 – existing septic tank, 2-filtration bed-secondary pollution, 3-treatment bed, 4-polishing bed, 5-purified water – outflow (pool or environment).

4. MECHANISM OF WASTE WATER TREATMENT IN CONSTRUCTED WETLANDS

Mechanisms of waste water treatment are mutually connected and include:

- Sedimentation of suspended insoluble particles
- Filtration and chemical precipitation
- Chemical transformation
- Adsorption or ion exchange in surface of plants, substrate, sediments and waste plants

- Decomposition and transformation of pollutants and nutrients due to micro-organism or plant activities
- Natural decay of pathogens
- Biological reactions: photosynthesis, respiration, fermentation, nitrification, denitrification and microbiological removal of phosphorus.

Municipal waste waters need at the beginning mechanical purification. Septic tanks, Imhoff tanks, rough horizontal rock filters and anaerobic lagoon are used into this purpose. The basic composition of constructed wetland includes impermeable layer (foil) on which are positioned layers of sand and gravel (substrate). This presents adequate environment for plants. Various species of plants which like moist condition can be used as are common reed (phragmites communis), sedge (carex), water hyacinth (eichhornia crassipes), bulrush (typha latifolia) etc.

Important parameter for functioning of wetland is the time of waste water flow through gravel, substrate and roots of plants as there are located bacteria which take the main role in water treatment process. When the time is adequate the plants can use nitrogen and phosphorus for their growth and development. Therefore, in the case of too intensive growth the number of plants per area unit should be reduced by harvesting.

Lagoons are water treatment plants where processes of purification take place on natural way. They are constituted from various parts. In the first part sedimentation of rough particles takes place. The second lagoon is also called facultative anaerobic lagoon and there oxidation of organic substances by oxygen takes place. Oxygen enters in the water from air by diffusion or is provided by photosynthesis from algae. Bacteria and algae function in symbiosis as bacteria utilize oxygen and transform it into carbon dioxide meanwhile algae vice versa transform carbon dioxide into oxygen. According to the oxygen quantity contained lagoons can be divided into anaerobic and facultative anaerobic lagoons (Limnos, 2010).

Constructed wetlands for waste water treatment imitate self-purification ability of natural systems. They operate without any mechanical and electric equipment. Therefore, their construction, operation and maintenance are rather unsophisticated and cheap. The constructed wetland system consists of sequential pools which are isolated by foil and filled with substrate. Because of avoiding undesired gaseous emissions and dissemination of insects the subsurface flow of water is often used. The purification of water to the degree determined by adequate standards is reached due to natural physical and chemical processes and by function of microorganisms and wetland plants. The majority of purification process – 80% is performed by microorganisms and the additional 20% by plants. Those species of plants which like wet environment are mainly used as are common reed (phragmites communis), sedge (carex) water hyacinth (eichhornia crassipes), bulrush (typha latifolia) etc. Poisonous substances are partly decomposed during purification process or they are absorbed by plants. A certain part of noxious substances remain in the substrate from where they are periodically removed. Sludge resulted from the mechanical treatment of water is composted. Constructed wetland presents an appropriate environment for many animal species. In the case of additional pollution the constructed wetland can be simply upgraded.

4.1 Substrates used in constructed wetlands

Various kinds of sand are usually used as a substrate in constructed wetlands (according to the dimensions of particles, as is shown in Table 1):

Table 1: Composition of substrate used in constructed wetlands

Substrate type	**Dimensions of particles (mm)**	**Porosity (%)**	**Hydraulic conductivity ($m^3/m^2/d$)**
Sand (fine particles)	2	32	1
Sand (large particles)	8	35	5
Gravel (small particles)	16	38	7,5
Gravel (medium particles)	32	40	10
Gravel (large particles)	128	45	100

4.2 Preparation of municipal waste water for treatment in constructed wetland

Municipal waste waters require mechanical treatment before purification in constructed wetland. This can be performed by septic tank, Immhof tank, coarse horizontal gravel filter or anaerobic lagoon. Usually wetland contains foil at the bottom where substrate (gravel or sand) is located. This presents adequate environment for wetland plants.

The important parameter for operation of constructed wetland is the time of flow of water through medium – substrate and roots of plants as there are located bacteria which perform the majority of water purification process. When the flow of water is slow plants can use nitrogen and phosphorus for their growth and development. In the case of intensive plant growth they should be diluted, most often by harvesting.

4.3 Implementation of project in practice

In the course of projection of constructed wetland it is necessary to obtain the adequate information about:

- Number of citizens living in households connected to the wetland
- Quantity of used water
- Classification of users (households, agriculture, livestock, craft activities).

Constructed wetland can be used in different ways

- as individual objects in the case of dispersed settlement,
- in clusters for villages
- or some combination of both ways can be used.

In Figure 2 example of the project for a small village is shown. In the case shown in Figure 2 adequate infrastructure – the main (central) pipe – already exists but it is not yet used in practice. As can be seen from Figure 2 certain households can be directly connected to the main pipe meanwhile in the case of other households due to their distant location or other geographical conditions connection to the central system is not possible or reasonable. In these cases individual systems can be used. It should be emphasized that in the case of increase of inhabitants in the area and consequent increased degree of water pollution waste water treatment systems can be simply upgraded. This upgrading is possible due to modular type of construction. Upgrading can be performed in a very short period of time.

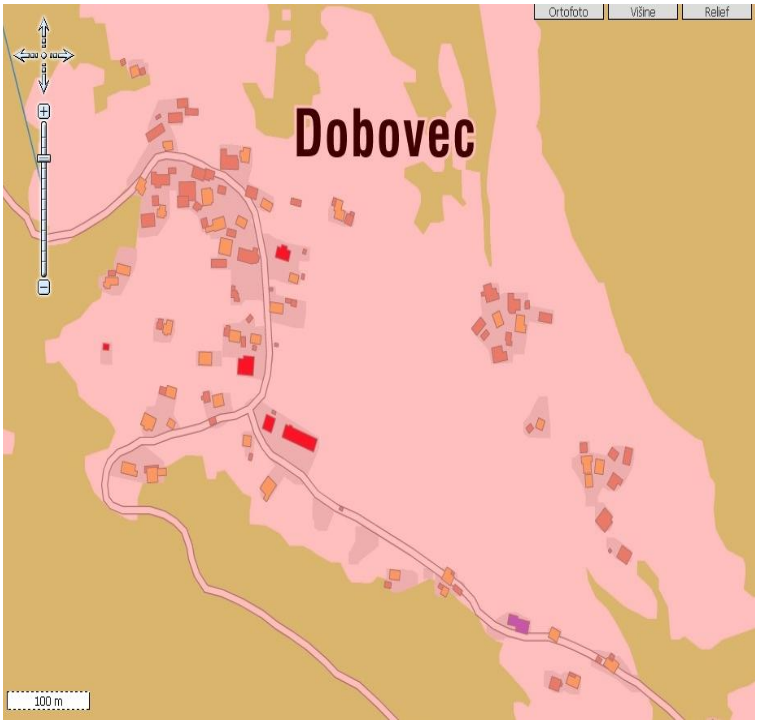


Figure 2: The example of connections to the constructed wetland for waste water treatment (village Dobovec in central Slovenia)

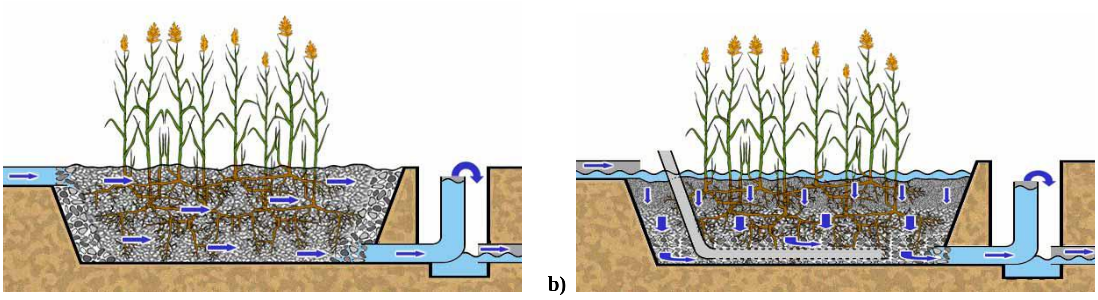
4.4 Types of constructed wetlands

Constructed wetlands can be basically classified in two groups:

- wetlands with surface flow of water (**f**ree **w**ater **s**urface, FWS)
- wetlands with subsurface flow of water (**s**ub**s**urface **f**low, SSF)

In the case of FWS water flows in the level of the ground or a bit lower, meanwhile in the case of SSF underground flow of water is used. SSF enable more efficient purification of organic pollutants and nitrogen and at the same time prevent the contact of people with the polluted water as well as dissemination of insects. On the other hand, SSF are less convenient from the economic view point as the construction of wetlands with the underground flow of water is more expensive. Besides this, it is also more difficult to control the process of water purification.

FWS are more often used for central systems as they are usually located outside villages where surface flow of water is less annoying meanwhile SSF are more appropriate for individual systems in the case of dislocated households where connection to central systems is not possible.



a) b)

Figure 3: Constructed wetland with surface flow of water – FWS (a) and constructed wetland with underground flow of water – SSF (b) (Limnos, 2010).

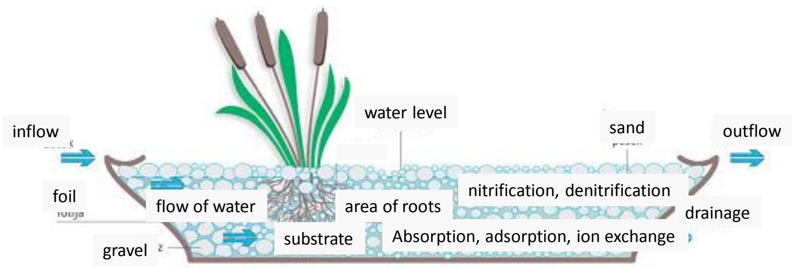


Figure 4: Cross-sectional drawing of constructed wetland (Vrhovšek & Vovk Korže, 2009)

According to the available data (April 2014) in Slovenia 130 constructed wetlands exist and the majority of them operate as individual objects.

4.5 Cost of construction

Cost of constructed wetland operating as an individual object with the capacity of 4 population units (PU): The investment costs for a typical constructed wetland for individual house is between 2.500 and 3.500 Euros (RČN, 2007).The difference in cost can be generated because of possible additional construction works which are sometimes necessary for connection between septic tank and constructed wetland. The average price for PU is 550 Euros. This price includes project outsourcing, material (substrates, plants) and monitoring. Monitoring is usually performed in the beginning of operation and later in three to nine-months periods for surveying of water purification efficiency. The price mentioned above does not include the cost of tank as existing septic tank can be used in the case that it is waterproof. When construction works are not outsourced the costs of construction can be lowered. However, adequate control of works is necessary – (quality of used materials, fluidity of wetland). The costs of investment are refunded to the investor in a certain period of time due to 90% lowering of taxation for water pollution.

5 CONCLUSION

Constructed wetlands present ideal solution for waste water treatment in areas where central waste water treatment systems do not exist – as are areas with dispersed settlement or dislocated objects. The appropriate treatment of waste water is particularly important for the objects which are located in the vicinity of water protection areas.

Constructed wetlands because of their capacity for purification of water efficiently contribute to environmental protection. They can be easily incorporated in the environment and do not present a disturbing factor neither to the people neither to the animals. The use of constructed wetlands efficient helps to reduce consumption of drinking water, waste waters can be efficiently purified and re-used.

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GREEN INNOVATION AS THE TRIGGER OF ENVIRONMENTAL RESPONSIBILITY

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Abstract: *This paper's purpose is to present how the green innovation process triggers environmental responsibility within the corporate sector in the world. Environmental responsibility is one of the key factors of sustainable development, which tends to preserve the environment and its resources for future generations, rather than exploiting them carelessly. Green innovations and environmental responsibility are accompanied by a phenomenon called corporate social responsibility, which improves the business model of companies, helping them face market needs, accordingly satisfying the conditions of sustainability. This process also affects the creation of green economy, as a global phenomenon. Furthermore, we shall present an example of how companies actually fulfill these tasks and keep the market leadership.*

Keywords*: green, innovation, corporate social responsibility, eco-innovation, green economy*

1. INTRODUCTION

The aim of our research is to show how green innovations affect the environment and how they can be a trigger of corporate social responsibility (CSR) within companies. Green innovations can be characterized as innovations in technology and business, which are environmentally friendly and suitable for sustainable development. They are essential in modern business and they ensure a better competitive position in the market.

There are numerous definitions for the notion "eco-innovation". One of the first, provided by Fussler and James (1996) defines eco-innovations as "new products and processes which provide customer and business value, but significantly decrease environmental impacts" (Schiederig, Tietze, Herstatt, 2011).

In a similar manner Kemp and Pearson define eco-innovation as "the production, assimilation or exploitation of a product, production process, service or management or business method that is novel to the organization (developing or adopting it) and which results, throughout its life cycle, in reduction of environmental risk, pollution and other negative impacts of resources use (including energy use) compared to relevant alternatives" (Schiederig, Tietze, Herstatt, 2011).

The Europe INNOVA panel concludes that "eco-innovation means the creation of novel and competitively priced goods, processes, systems, services, and procedures that can satisfy human needs and bring quality of life to all people with a life-cycle-wide minimal use of natural resources (material including energy carriers, and surface area) per unit output, and a minimal release of toxic substances" (Schiederig, Tietze, Herstatt, 2011).

Eco-innovation in companies leads to reduced costs, improved capacity to capture new growth opportunities and enhances their reputation among customers. (Schiederig, Tietze, Herstatt, 2011). In recent years, eco-industries have emerged as an important segment of the European economy. This sector has an estimated turnover of around €227 billion, corresponding to 2.2% of the European Union's GDP, and employs 3.4 million people directly. Eco-innovation is therefore a powerful instrument, combining reduced negative impact on the environment with a positive impact on the economy and society (EC Europa, 2014). This means that eco-innovations are not only beneficial for the environment, but also help businesses to improve their processes and the economies to move to a new, more sustainable level, thus improving the overall quality of life and preserving natural resources for the future generations, as well.

It is thus understood that to eco-innovate is to go beyond the adoption of environmental technologies. In developed countries this is characterized by the transition from investments in pollution control technologies to addressing cleaner production processes, recycling systems, and products (Kemp, 2008).

2. SUSTAINABLE DEVELOPMENT

Sustainable development is in short: environmental, economic and social well-being for today and tomorrow. It has been defined in many ways, but the most frequently quoted definition is from Our Common Future (*p.43*), also known as the Brundtland Report (WCED, 1987):

"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts:

- the concept of needs, in particular the essential needs of the world's poor, to which overriding priority should be given; and
- the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs."

All definitions of sustainable development require that we see the world as a system - a system that connects space; and a system that connects time (IISD, 2014).

It is about improving the standard of living by protecting human health, conserving the environment, using resources efficiently and advancing long-term economic competitiveness. It requires the integration of environmental, economic and social priorities into policies and programs and requires action at all levels - citizens, industry, and governments (EC, 2014).

3. BENEFITS OF CORPORATE SOCIAL RESPONSIBILITY

The idea of corporate social responsibility would have drawn a round of blank looks just a few years ago. But things are changing. Whether sparked by headline-grabbing protests against globalization and compounded by the attacks on America on September 11, we are waking up and wanting to know more about the major influence on our world. It's no longer just the radicals who are questioning the impact that business has on society (Financial Times, 2002).

CSR helps any business to be more competitive by supporting its efficiency; risk control is improved; stronger relationships with communities and an enhanced license to operate; better relations with investors and better access to funds; improved relations among employees; and improved reputation and branding.

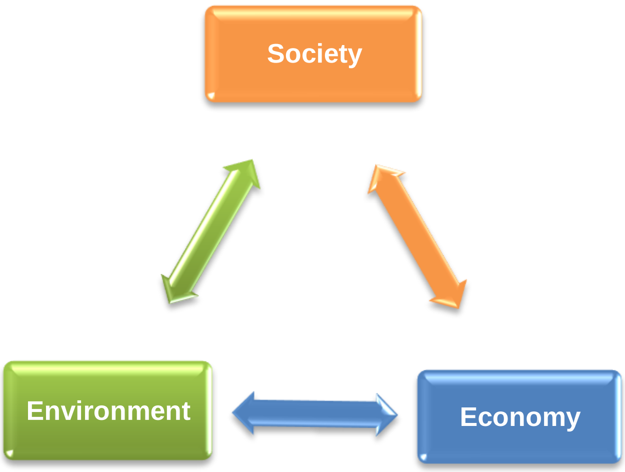

Figure 1: The interconnection of corporate social responsibility factors

Because of the uncertainty surrounding the nature of CSR activity, it is difficult to define CSR and to be certain about any such activity. It is therefore imperative to be able to identify such activity and we take the view that there are three basic principles which together comprise all CSR activity. These are: sustainability, accountability and transparency (Crowther and Aras, 2008).

4. ECO-INNOVATIONS AS A FACTOR OF GREEN ECONOMY

The European Environmental Agency (EEA) defines green economy as the increase in prosperity, with the preservation and sustainability of natural systems that surround us (O'Brien et al., 2012). In order to sustain natural systems, material resource spending needs to be reduced to a point where sustainable supply is met.

When compared with the current economy state, green economy has certain benefits. These benefits are mostly environmental, but also keep the operations at a functional and efficient level. A study, comparing the current and green economy in the European Union, follows (O'Brien et al., 2012).

Table 1: The comparison of current global economy and green economy in the EU

Aspect	Current global economy	Green global economy
Environment	One and a half planet is required to regenerate viable resources and absorb the CO_2 emissions at the global rate of resource exploitation.	Excavations and emissions are set within the planetary borders. For the European Union this requires the decrease in the level of overall exploitation of primary materials, land, water and energy.
Society	870 million people are chronically underweight, according to the data from 2012. 1.29 billion people live in extreme poverty (The World Bank, 2012). People in the industrialized countries spend up to 20 times more materials than the people in the least developed countries.	The available global resources should be distributed more adequately, on the global level. For the EU, this considers a significant decrease of overall resource consumption per capita.
Economy	The economic prosperity is mutually connected to the exploitation of resources.	The economic prosperity is detached from the primary resource consumption. For the EU, this considers the transformation of economy, in such a manner that helps increase the growth of the efficient consumption of resources, recycling, reuse and new business models.

The report of Eco-innovation Observatory (EIO) tells us in what way the eco-innovations will take part in the transition towards the green economy. Achieving efficiency alone will not be enough. The green economy will also have to find an alternative for the lack of moderation, which characterizes industrialized economies. Eco-innovations will most certainly play the key role in motivating and including all economy drivers to move towards the changes. This means that the green economy is only a framework for changes, and eco-innovations are the main instrument of igniting those (O'Brien et al., 2012).

Eco-innovation Observatory further identifies certain possibilities in cost decrease by implementing eco-innovations. A case study analysis in Germany has shown that a company can save around €200,000 per year simply by attaining material efficiency in the production sector. On average, these investments pay off after 13 months. However, when it comes to investing in eco-innovations, there is a gap in the quantity of investments and their results. In order to achieve better results with eco-innovations, some systematical changes need to be pushed, considering opening new markets, in parallel with upgrading the existing business models, so that they would be able to accept the current and the future global challenges (O'Brien et al., 2012).

Furthermore, while EIO is developing the new eco-innovation policy throughout the European Union, many companies see this as a new and growing field, but not many have felt the need for the systematic approach in public support of eco-innovations. The eco-innovations are still not considered to be a part of the strategy of social and economic transformation. As of now, the focus was on the research of the environment and employing technology with a financial support, without any further need to adapt the overall conditions of the economy to eco-innovations (O'Brien et al., 2012).

Many authors claim that the next "innovation wave" will actually be "the green wave", and that the concentration of innovative forces will be on the achievement of sustainability. The following decade will be the potential test for green economy, when it comes to using the synergy of social-economic and environmental goals. On the other hand, it is obvious that many innovations worked on as we speak actually have the completely opposite goal from sustainability, and not all radical innovations will be developing in this direction.

There are innovations and discoveries, such as new types of unconventional fuels, which are only realized for their economic advantages, not the goal of sustainability. With the increase in efficiency of drilling techniques, especially horizontally, the relative gas costs in North America have been reduced significantly in the past few years. In the USA, heating methods have turned from coal to gas consumption. In fact, more and more chemical production systems, fertilizer and plastic companies have started running on gas. According to reports, the benefits for the US economy due to this kind of material consumption were over $100 billion worth, in 2010 solely. This example shows that economic benefits are sometimes chosen rather than the social or environmental ones, and that there are different strategies, which can affect how companies run their business (O'Brien et al., 2012).

The strategy of the European Union, "EU 2020", promotes structural changes, with the focus on sustainability. In order to achieve these goals, the transition towards sustainable consumption of natural resources has to be in strong coordination with business practice and perceptions in the following five dimensions:

- Dynamics in the relative structure of production input costs
- Anticipated innovation trends
- Organizational criteria and principles
- Cooperation models
- Business models.

Dynamics in the relative structure of production input costs can lead to more efficient resource consumption and thus presents the most attractive choice for profitable innovations and investments, especially in the conditions of instability of material costs and expected price increase. In practice, this considers the decrease in material costs, through the eco-innovation process, reuse and recycling, and changes in material usage. Anticipated innovation trends expect the entrepreneurial advantages to be at a high level. Organizational criteria and principles consider a practice that shows how special management methods and structures are able to use the power of new eco-innovations for maximum efficiency and profit. Organizations that tend to expand the usage of eco-innovations help overcome the problems of coordination, which follow such changes. Cooperation models expect businesses and public organizations to be equally engaged in search for new partners for forming networks and coalitions among sectors and organizational value chains. The business models are supposed to help the organizations redefine their exported value and find new ways for delivering their services to the customers (O'Brien et al., 2012).

What directly affects a country's inability to ignite the development of eco-innovations is either the lack of funds (the economic factor), or the lack of will and strategy to deal with global problems (the social and environmental factors). In fact, some policies, such as unsustainable subventions, can directly affect the environmental impact. Furthermore, on a global level, the differences in solving this problem can be significant. Namely, while the US and Japan can directly work on solving these problems, the EU must coordinate between 27 different countries, thus including their needs and possibilities to worry about economic, social and environmental factors. There are many obstacles that have a direct influence on the strategy of a company. The lack of dedication to eco-innovations from the highest levels of management can be caused by different factors (O'Brien et al., 2012):

- Uncertainties about the future input prices (especially materials, but also other resources, such as carbon, or water)
- The lack of information from other departments concerning the profitability of production-integrated environmental technology, energy and materials, efficiency of changes and other innovation processes
- The lack of managerial capacities and capital, in order to start exploring the obstacles of eco-innovations
- The lack of orientation, concerning the long-term trends and key challenges.

5. ECO-INNOVATIONS FROM THE APPLE COMPANY

In recent years, many international companies have become concerned with the amount of carbon dioxide they produce in their business processes. Therefore, they have calculated the footprint of carbon dioxide generated in their facilities in order to innovate their processes so that the footprint is reduced to a minimum. In contrast, during their process of innovation, Apple has not only departed from the footprint of carbon dioxide in their facilities, or in production, but has considered the entire business process and their products' life cycles (Apple, 2014).

Figure 2: Total carbon footprint created by Apple, in percentage

Apple has, therefore, engaged in a comprehensive life cycle analysis of their own operations, in order to determine where the emissions of greenhouse gases come from. What can be seen as a part of a business process in that matter are manufacturing, transportation, usage and recycling of products, in addition to monitoring the amount of the gases that arise within their business facilities.

If we consider the impact of all Apple operations on the environment, it can be concluded that most of the carbon dioxide footprint by as much as 61% comes from manufacturing, 5% from transportation, 30% from product usage, 2% from recycling and 2% from commercial buildings. Because of this way of observing the big picture of its ecological processes, this company can be categorized as environmentally very responsible.

The Apple Company is trying to reduce its negative environmental impact and to improve the environmental performance of its products. Therefore, in the production of these products, it uses fewer materials, ships the products in smaller packages, and designs them to be energy efficient and recyclable. What Apple saw as the potential benefits and process innovation is that with the faster growth than the market and the industry in general, products should be created as much more environmentally friendly, with the least negative consequences for the environment.

Although the profit of the company has increased in the past decade, emissions per dollar of revenue in 2008 have declined by 21.5%. In addition to this fact, Apple is the only company in the industry, of which the entire product line meets, and also exceeds the strict energy limit, set by the ENERGY STAR specification.

Creating smaller, thinner and more energy-efficient products does not only reduce carbon dioxide footprint, but it also means that products can be transported in smaller packages. The way Apple ensures high quality of these smaller product is by employing teams of experts from the fields of design and engineering, developing packages that are thinner and lighter, which, on the other hand, provide very good protection. Efficient packaging design reduces material consumption and waste, and has an impact on the reduction of emissions that occur during transportation (Apple, 2014).

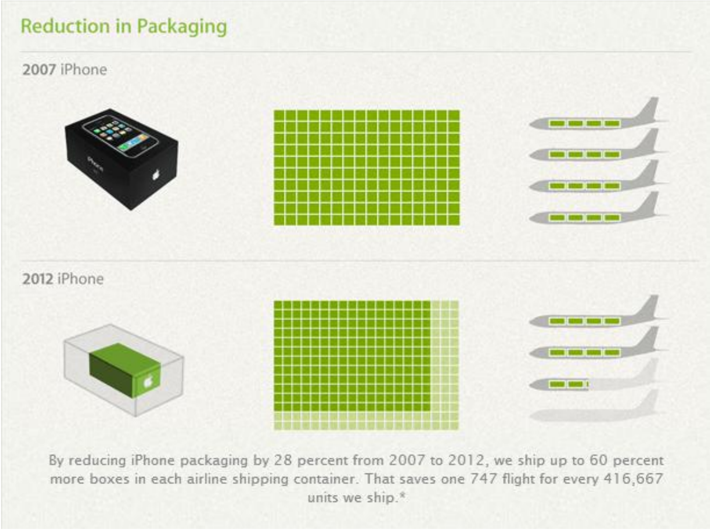

Figure 3: The decrease in iPhone packaging from 2007 to 2012

In the period from 2007 to 2012, iPhone packaging has been reduced by 28%, enabling the delivery of up to 60% more boxes in each container by air transportation systems. This implies the fact that for every 416,667 transported units of this product, a full Boeing 747 is “saved”. Furthermore, this causes lower carbon dioxide footprint, which means that in this way, the Apple Company has a double impact on the reduction of emissions, producing additional environmental contribution.

The Apple Company does not only monitor its own CO_2 emissions in order to minimize them, but by using the life cycle approach, it measures the footprint produced by its consumers, while using its products. Looking at this branch of industry, it is not recorded that any other company goes as far in measuring the carbon dioxide footprint. Apple has managed to reduce the emissions produced by its users, by designing hardware and operating system on its own, in such a manner that they work together to save energy and thus reduce the CO_2 emissions (Apple, 2014).

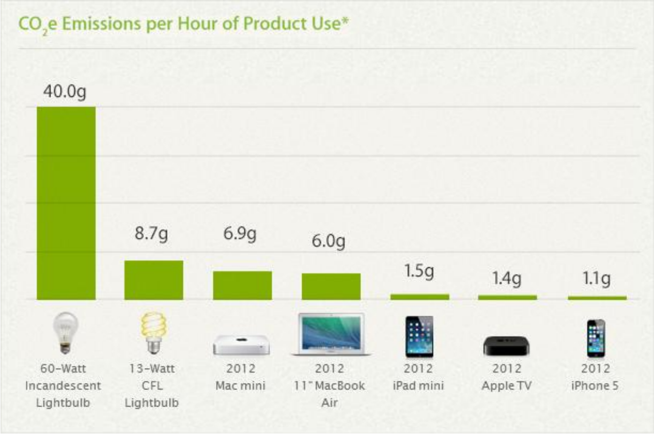

Figure 4: CO_2 emissions of Apple’s products, compared to emissions of light bulbs

Since 2008, Apple has managed to reduce the average fuel consumption of its products by 40%, demonstrating the fact that one of its goals is to create the most energy efficient devices. As a result of this procedure, it was found that the carbon dioxide emissions, resulting from the use of Apple's products have declined by 43% since 2008. Furthermore, not only do all of Apple’s products generate less CO_2 emissions than a regular 60-Watt or the frugal 13-Watt light bulb during their life cycle, but iPhone 5, from 2012, produces almost 40 times less carbon dioxide than a regular light bulb.

The Apple Company controls its own regulatory programs of collecting e-waste around the world, where all the waste is processed and recycled in the region where it is collected. This means that no waste is transported to other parts of the world for either disposal or recycling, which affects not creating new carbon dioxide emissions.

In addition to this, the company provides its own very strict procedures for recycling its products, which are based on health and safety laws. Furthermore, the company itself does not allow prison labor at any stage of the recycling process of its products. Another method that Apple prohibits is discarding hazardous electronic materials to landfills or incinerators, and currently operates with 153 partners worldwide, whose objects are tested and evaluated on an annual basis, considering the health and safety of workers, material tracking, social responsibility and ecological needs and requirements.

Other ways in which Apple has improved their business processes are recycling programs and responsible disposal, which are bound to the cities and university settlements in 95% of the countries in which the company sells its products, which has shifted more than 151.504 tons of equipment from landfills, since 1994. As of the countries that do not have disposal and recycling centers, Apple organizes the collection, transportation and environmentally responsible disposal and recycling of electronic products that are at the end of their life cycle.

A goal of the Apple Company in 2010 was to achieve the level of recycling of 70% of the worldwide level. To calculate this, they have used the product, the expected life of usage of which is seven years. The total weight that Apple had recycled each year was compared to the total weight of the product that the company had sold seven years earlier. Therefore, in 2010, it was necessary to recycle 70% of the weight sold in the 2003. The goal of 2010 has not only met, but also exceeded. The figure that the Apple Company has reached is far beyond their nearest competitors, Dell and HP, whose figures did not exceed even 20%. Once they have set and continued to maintain this level in the coming years, their expectations were that this trend would continue at least until the end of 2015 (Apple, 2014).

While most companies focus on reducing CO_2 emissions in their facilities, Apple believes that turning the lights off and recycling office waste do not have an impact on the environment that is strong enough. As previously disclosed, Apple has discovered that business objects generate only 2% of the total carbon dioxide emissions, and have therefore turned the focus to environmental responsibility in other activities of the business process and supply chain.

Although it focuses primarily on innovations and improvements in product design, Apple has not neglected the business objects, but has taken the necessary steps to ensure that their emissions around the world have been reduced to a minimum. One way to achieve this is with, so-called, clean energy. The term actually refers to renewable energy, which Apple uses in its facilities and data centers.

The company has constructed new objects and upgraded old ones, in order to be able to fully utilize this kind of energy. This is achieved by building solar panels and fuel cells, along the existing object. Furthermore, in order to achieve the balance among its energy needs, Apple tends to sign many long-term contracts with energy suppliers, at least to the maximum extent that is permitted by the law. In this way, the company has managed to convert 75% of its total energy needs of their office objects and data centers into renewable energy.

When it comes to data centers, all in the ownership of the Apple Company are powered by 100% renewable energy. Using solar panels and renewable energy sources has led to the fact that in 2012, total emissions have been reduced by as much as 93 million kilograms of carbon dioxide.

We found that the Apple Company is not only very innovative, in terms of products and processes, but also socially responsible. Another aspect that shows the social and environmental responsibility of the company is the transportation system of its employees.

In the fiscal 2012, more than 13,000 employees have participated in the "Commute Alternatives" program, which has increased the number of participants by 30% in several years. In this way, the employees were going to work by taking transit options that reduce traffic congestion and carbon dioxide, using only one vehicle for this entire process, instead of one or more transit lines per person.

In this way, 1,600 employees have used free transportation to work by taking buses or shuttles that run on biodiesel fuel and 50,000 arrivals to and departures from work by bicycles, which the company has provided for its employees to use, were recorded. The overall effect of the program in 2012 was the prevention of the occurrence of more than 102,500 kilograms of carbon dioxide emissions, by using the electronic charging stations for these vehicles (Apple, 2014).

6. CONCLUSION

As mentioned previously, eco-innovations present the new “wave” of innovations, which tends to not only increase the efficiency and effectiveness of the business process, but also to fulfill the goal of sustainability, carefully consuming natural resources and keeping the planet viable enough for future generations. As such, the eco-innovations do not only trigger environmental responsibility, but also pose a critical factor for maintaining sustainability, corporate social responsibility (CSR), green economy and other global development tendencies.

Sustainable development, as a matter affected by eco-innovations, concerns technological development in such a way that not only natural resources, but also health and well-being of people are saved. Furthermore, long-term competitiveness is achieved by the development of technology, especially when it is viable and, even better said, sustainable.

Corporate social responsibility is a clouded expression, not being able to precisely describe its activities. Be that as it may, as long as an activity of a company concerns three factors – economic, social and environmental – it is considered a CSR activity. This helps the company achieve some of its main goals, such as efficiency and effectiveness, improved risk management, better relationships with stakeholders and many more. Corporate social responsibility (CSR) is, as sustainable development and green economy, enhanced by the effect of eco-innovations.

Finally, green economy is a global tendency of preserving the planet and sustaining natural materials and creating a “playing field” for global sustainable development. Eco-innovations are its key running factor, since they are what triggers the economy to change in a sustainable manner. The green economy is based on three main factors, as CSR, economic, social and environmental. Generally speaking, having a green economy tomorrow means lower consumption of natural resources and their better distribution today.

Furthermore, we have shown how the Apple Company works on its green innovations and improves its processes, giving a good example to the rest of the corporate sector, thus creating conditions for global sustainable development. Thinking outside the box, as one of its main parameters, has led the company to decrease its own carbon footprint, not only by decreasing it in its facilities, but also by decreasing it throughout the life cycle of its products. Therefore today, Apple is one of the most environmentally responsible companies in the world.

In conclusion, the eco-innovations run the process of creating a sustainable economy and development, thus increasing the level of environmental responsibility, within a company and globally, as well.

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DEVELPOMENT IN RENEWABLE ENERGY PRODUCTION IN SERBIA WITH THE EMPHASIS ON BIOETHANOL

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Abstract: *Production and use of renewable energy sources has become an imperative for development around the world, including Serbia. The aim of this paper is to study the possibilities of production and use of renewable energy sources, especially bioethanol, as well as their place in the strategic objectives in the energy sector in Serbia. For this purpose, we will firstly frame the policies related to the production of renewable energy, and afterwards display the results of the cost-effectiveness of bioethanol production from the most important domestic biomass-based feedstock - corn. Our assumption is that, despite the existence of sufficient quantities of raw materials required for the production, knowledge, and the potential consumers of bioethanol in Serbia, its wider use will not be possible without the application of a systematic approach, especially without the development of adequate infrastructure in the production and use of energy resources.*

Keywords*: renewable energy, bioethanol, sustainable development, Serbia*

1. INTRODUCTION

Energy crisis and environmental pollution are two vital challenges the world is currently facing. Energy is a component of major significance for all sectors of modern economy and plays an essential role in improving the quality of life. The way energy is produced, supplied and consumed strongly affects the local and global environment and is, therefore, a key issue in sustainable development (Mojović et al., 2013). At the current rate of consumption, crude oil reserves, natural gas and liquid fuels are expected to last for between 60 and 120 years (British Petroleum Statistical Review, 2011).

Approximately 80% of world energy supplies rely on rapidly exhausting non-renewable fuel sources (e.g. coal, oil, natural gas) which are used to produce fuels, electricity, chemicals and other goods. Emission of greenhouse gases (GHGs) represents an additional challenge with fossil fuel consumption. Growing global energy needs and release of environmental pollutants from fossil fuels have finally directed the attention towards clean liquid fuel as a suitable alternative source of energy. Even though bioenergy from renewable resources currently already represents an alternative to fossil fuels, in order to meet the increasing need for renewable energy, new and abundant raw materials need to be considered. The alternative renewable energy sources, not only cut the dependence on oil trade and reduce the doubts caused by the fluctuations in oil prices, but also secure reductions in environmental pollution due to their high oxygen content (Huang et al., 2008; Boer et al., 2000).

In this context, the availability of renewable energy in its two main forms, wood and agro energy can offer cleaner energy services to meet basic energy requirements. Biofuels can be obtained from agricultural crops, crop residues and processing wastes from agroindustries, forests, etc. (Mekala et al., 2014). Interest in various agricultural crops such as cereals (maize, wheat, triticale, barley, rye, sugar cane, sweet sorghum, millet etc.) and some tubers (sugar beet, potato, Jerusalem artichoke, cassava, sweet potato etc.), as renewable and biodegradable feedstock for biofuel production are growing (Semenčenko V. et al., 2013). All petroleum-based fuels can be replaced by renewable fuels produced from biomass such as: bioethanol, biodisesel, biohydrogen etc. (Mojović et al., 2013).

Existing biofuel policies have been very costly; they produce slight reductions in fossil fuel use and increase, rather than decrease, in GHG emissions (Wuebbles and Jain, 2001). However, recent fluctuations and rise in international fossil fuel prices make biomass increasingly competitive as energy feedstock. Current renewable energy research around the globe should direct us toward reduced production costs, higher energy conversion efficiency and greater cost-effectiveness of biofuels (Mekala et al., 2014).

By implementation of the Kyoto Protocol, Serbia sends to international community and the EU a clear signal of readiness to implement the concept of sustainable development and monitor of global socio-economic trends, which will improve the investment climate and increase the confidence of potential foreign investors (Mojović et al., 2013).

2. DIFFERENT FORMS OF RENEWABLE ENERGY

There are many forms of renewable energy**.** Most of these renewable energies depend in one way or another on sunlight. Wind and hydroelectric power are the direct result of differential heating of the Earth's surface which leads to air moving about (wind) and precipitation forming as the air is lifted. Solar energy is the direct conversion of sunlight using panels or collectors.
Biomass energy is stored sunlight contained in plants. Organic matter holding bioenergy sources in side is known as biomass. We can utilize this biomass in many different ways, through something as simple as burning wood for heat, or as complex as growing genetically modified microbes to produce cellulosic ethanol (Adler et al., 2009). Since nearly entire bioenergy can be traced back to energy from sunlight, bioenergy has the key advantage of being a renewable energy source.
Other renewable energies that do not depend on sunlight are geothermal energy, which is a result of radioactive decay in the crust combined with the original heat of accreting the Earth, and tidal energy, which is a conversion of gravitational energy.

3. RENEWABLE ENERGY PRODUCTION IN EU

Heat and electricity production from biomass increased over the past 10–15 years by 2% and 9% per year, respectively, in the European Union between 1990 and 2000, and biofuel production increased about eight-fold in the same period. Today, the EU is the third producer of fuel-bioethanol in the world after the United States and Brazil; however its production is much lower than the first two (by a factor of about 10). Bioethanol production in EU was 4.97 billion liters in 2012, which is an 11% increase over 2011 (Mojović et al., 2013, Renewable Energy Magazine, 2013). However, although the amount of biofuels produced in the EU is growing; the quantities in general remain insufficient and low in comparison to the total volume of mineral-based transport fuel sold.
One of the significant regulations which impact the EU biofuels market is the European Directive 2009/28/EC on the promotion of renewable energy which aims at achieving a 20% share of energy from renewable sources by year 2020 in the EU's final consumption of energy and a 10% share of energy from renewable sources in each member state's transport energy consumption. In order to achieve that effect, EU members follow the Directive implementation with various political, fiscal and technical measures and incentives. Each EU Member State should adopt a National Renewable Energy Action Plan, setting out its national targets for the share of energy from renewable sources consumed in transport, electricity, heating and cooling in 2020 (European Biofuels Platform Technology, Gitiaux et al., 2012). More renewable energy will enable the EU to cut greenhouse emissions and make it less dependent on imported energy. Boosting the renewable energy industry will encourage technological innovation and employment in Europe.
On 27th of March 2013, the European Commission published its first Renewable Energy Progress Report under the framework of the 2009 Renewable Energy Directive. Since the adoption of this directive and the introduction of legally binding renewable energy targets, most Member States experienced significant growth in renewable energy consumption. Figures for the year 2010 indicate that the EU, as a whole, is on its trajectory towards the 2020 targets with a renewable energy share of 12.7%. Moreover, in 2010 the majority of Member States already reached their 2011/2012 interim targets set in the Directive. However, as the trajectory grows steeper towards the end, more efforts will still be needed from the Member States in order to reach the 2020 targets.
With regard to the EU biofuels and bioliquids sustainability criteria, Member States' implementation of the biofuels scheme is considered too slow.
In accordance with the reporting requirements set out in the 2009 Directive on Renewable Energy, every two years the European Commission publishes a Renewable Energy Progress Report. The report assesses Member States' progress in the promotion and use of renewable energy along the trajectory towards the 2020 renewable energy targets. The report also describes the overall renewable energy policy developments in each Member State and their compliance with the measures outlined in the Directive and the National Renewable Energy Action Plans. Moreover, in accordance with the Directive, it reports on the sustainability of biofuels and bioliquids consumed in the EU and the impacts of this consumption (European Comission, 2013).

4. BIOETHANOL

Bioethanol accounts for the majority of biofuel use worldwide (Margeot et al., 2009, Semenčenko et al., 2011). It is a liquid biofuel which can be produced from several different biomass feedstocks and conversion technologies. Nearly all bioethanol is produced by fermentation of corn glucose in the United States, or sugar cane sucrose in Brazil, but any country with a significant agronomy-based economy can use current technology for bioethanol fermentation (Balat and Balat, 2008). This biofuel is produced by fermentation of simple sugars present in biomass or the sugars obtained by prior chemical or enzymatic treatment of the

biomass. The bioethanol fermentation is performed by microorganisms, traditionally by yeasts (*Saccharomyces strains*) (Mojović et al., 2013).
Bioethanol has the potential to be a sustainable fuel, as well as a fuel oxygenate that can replace gasoline, in transport sector which is considered one of the largest energy consumers as well as environmental pollutant (Kim and Dale, 2004). According to the International Energy Agency statistics (2008), the transport sector accounts for about 60% of the world's total oil consumption. It is responsible for about one fifth of CO_2 emission on a global scale (Joint Research Centre, EU Commission, 2007).
The production of bioethanol has been increasing over the years, and has reached the level of 85 billion litres in 2013. According to the Global Renewable Fuels Alliance (GRFA), this level of the bioethanol production was predicted to reduce GHG emissions by 100 million tonnes in 2013 (Renewable Fuels Association - RFA, 2013). An increase in bioethanol production up to more than 125 billion litres until 2020 has been predicted assuming the production support by governmental policies and exemptions (Demirbas, 2013). The fact that the existing fossil fuel infrastructure, eventually with minor modification, can be used for bioethanol distribution and utilization puts this biofuel in front of other energy alternatives (IEA, 2008).
The economic and temporal constraints that crop feedstocks pose are the main downfalls in terms of the commercial viability of bioethanol production (Harun et al., 2014).Even though bioethanol production for decades mainly depended on energy crops containing starch and sugar (corn, sugar cane etc.), new technologies for converting lignocellulosic biomass into bioethanol are under development today.5 As an alternative to crop feedstocks, significant research efforts have been put into utilizing algal biomass as a feedstock for bioethanol production.
With the exception of sugar cane, corn provides the highest bioethanol yields compared to any other traditional feedstocks being used (US Grains Council, 2012). Alternative fuel - bioethanol is mostly produced from starchy parts of the maize grain leaving significant amounts of valuable by-products such as distillers' dried grains with solubles (DDGS), which can be used as a substitute for traditional feedstuff. Maize grain consists of approximately 70% of starch, which makes it a very suitable feedstock for the bioethanol production (Radosavljević et al. 2008). Renewability of maize and growing environmental pollution by oil products represent two principal reasons for maize becoming one of the major raw materials for the energy production (Radosavljević et al. 2009).
The rapid increase in biofuels production from traditional feedstocks during the last few decades has brought dramatic changes to food and agricultural systems especially in countries that are the biggest bioethanol producers (e.g. United States and Brazil).
Studies have found that, in general, with increased ethanol expansion, the prices of both the agricultural feedstock commodities and their competing crops increase with implications for land allocations, food prices, and the environment.(Elobeid and Hart, 2007, Elobeid et al., 2007).
Recent increases in biofuel production, particularly the dry grind corn-to-ethanol process, creates a sizable stockpile of its co-product in the form of dried distillers' grain with solubles (DDGS), which is made by blending distillers' wet grains (DWG) and syrup and drying the mix (Liu et al., 2012). A gallon (3.78 L) of bioethanol produced from corn kernels generates about 7.4 pounds (3.36 kg) DDGS (Pimentel 2003). During the production of bioethanol, starch is removed from the grain and converted to alcohol and carbon dioxide. As a result of starch removal, the concentration of the remaining nutrients in the grain increases approximately three-fold. The DDGS contains higher percentages of protein, fibre and lipid contents than those in corn (Liu et al., 2012).
Application of DDGS in livestock and poultry diets in concentrations greater than traditional could positively affect the economic viability of this biofuel production, but also stabilize the current imbalance in the food and animal feed market. However, DDGS feedstuff should not be treated as a perfect substitute for corn, because the complexity of ration formulation determined at the farm or feedlot level is driven by energy and protein and other nutrient requirements, as well as their relative costs in the ration (Semenčenko et al., 2013 a).

5. RENEWABLE ENERGY PRODUCTION IN SERBIA

Serbia and other Balkan countries interested in joining the EU, has accepted the obligation to follow EU policies and programs, including those that oblige them to introduce the production and use of fuels from renewable energy sources. Among renewable energy sources in Serbia, the most important are biofuels, especially bioethanol. Apart from natural resources, research and development within the National Innovation System of the Republic of Serbia are of great importance (Semenčenko D. et al., 2009). Starting from the first National Innovation Systems, energy has played an important role in stimulating the economic development. National innovation systems of today must, as well, demonstrate a significant level of innovation in research and application of new renewable energy sources (Semenčenko D., 2009). Better coordination between institutions and academic and private sector is a very important step in order to realize cost-effective bioethanol production in Serbia (Mojović et al., 2013). By implementation of the Kyoto Protocol, Serbia sends to the international community and the EU a clear signal of readiness to implement the concept of sustainable development and monitor of global socio-economic trends, which will improve the investment climate and increase the confidence of potential foreign investors.

With the ratification of the Agreement established by the Energy Community (Coordinating European Council - CEC, 2006), Serbia has, among other things, accepted the obligation to implement the Directive 2001/77/EC on the promotion of electricity produced from renewable energy sources and Directive 2003/30/EC on the promotion of the use biofuels and other fuels from renewable energy sources in the transport sector, to ensure the emergence of a certain quantity of biofuels on the market - 5.75 % of the total fuel used in traffic by the end of 2010. This directive is in accordance with the Kyoto protocol signed in 1997, with the aim to reduce emissions of gases that contribute to the greenhouse effect, which Serbia is a signatory. However, in 2009 European Commission has adopted a new Directive 2009/28/EC, which was established to promote the use of energy from renewable sources. This directive changes and consequently abolishes Directives 2001/77/EC and 2003/30/EC, by establishing a common framework for the promotion of energy from renewable sources. It sets obligatory national targets for the overall share of energy from renewable sources in gross final energy consumption, and for the share of renewable sources in transport: at least 20 % share of energy from renewable sources in gross final energy consumption in the Community and a 10% share of energy from renewable sources in energy consumption for transportation of each member country by the year 2020. In addition, sustainability criteria for biofuels and bioliquids have been established. Serbia has adopted the Directive and it is embedded in the Biomass Action Plan which was adopted in 2010.

6. BIOETHANOL PRODUCTION IN SERBIA

Today in Serbia, the bioethanol production is being conducted in seven plants, with total production capacity of 23,225 t per year. Raw materials predominantly used in these plants are molasses and cereals. In these plants, 96% vol. bioethanol is produced, and it is subsequently being used mainly for alcoholic beverages and medical and pharmaceutical purposes (Mojović et al., 2013). Bioethanol production in Serbia from fermented substrates amounted 8.69 million liters in 2011, which is only 30% of annual production capacity in Serbia. This indicates that the capacity utilization of bioethanol plants is rather small. The highest bioethanol production of 19.17 million liters was achieved in 2007 (Statistical Office of the Republic of Serbia, Biomass Action Plan for the Republic of Serbia 2010-2012). It is important to point out that despite current low level of industrial production of bioethanol, Serbia has main prerequisites to develop and improve this production since it possess a large feedstock potential, tradition and also educated human potential.

In Serbia, conventional energy crops such as starch-based raw materials are the most suitable and available agricultural raw material which can be used for industrial bioethanol production. However, a growing demand for the corn and wheat on global market are currently increasing their price and make these feedstocks less appropriate. For these reasons, possibilities of using cheaper substrates such as damaged crops and for example, triticale are being investigated (Pejin et al., 2009, 2012).

By applying the methodology used by the International Energy Agency – IEA, estimation of the amount of bioethanol that could be produced in Serbia in the future (from 2015 to 2030) was performed (Mojović et al OECD/IEA, 2010). The agency in its regional and global estimates of energy potentials used data recommended by FAO that assume global annual crop growth of about 1.3% and about the same global growth of agricultural biomass (waste). For Serbia, this analysis assumed slightly lower amount of crop growth of 0.9%. The estimation of first generation bioethanol production in Serbia based on available feedstocks taking advantage of surpluses of crops and use of marginal land showed there is a great potential for bioethanol production in Serbia of $1{,}188{,}030 \cdot 10^3$ lifters, i.e. 937,356 tons in 2015. Similar analysis has been performed to estimate the country potential for the production of second generation of bioethanol. The analysis was performed for two possible scenarios, the first for the possible utilization of 10% of the lignocellulosic biomass for the production of bioethanol and the second for the utilization of 25% of the biomass for the production of bioethanol. Results calculated for year 2015 were $258{,}385 \cdot 10^3$ lge (liter of gasoline equivalent), i.e. $645{,}962 \cdot 10^3$ lge, for these two scenarios, respectively.

Recently conducted studies revealed that Serbia will need to build new bioethanol plants in order to produce enough bioethanol for use as a fuel and thus follow the aims of the European Directive 2009/28/EC. Based on the given replacement of 20% of gasoline by bioethanol by year 2020 according to European directive 2009/28/EC, it has been reported (Dodić et al., 2009) that it will be needed to produce 233,000 t of bioethanol until 2026. If it is assumed that the needs of the ethanol industry and pharmacy stay the same (52,000 t), total demand for bioethanol would be 285,000 tons, which is 12 times the installed capacity in Serbia.

There is a great interest in the world today in the development, selection and cultivation of maize hybrids that can produce higher bioethanol yields. In that manner, maize hybrids with higher content of fermentable sugars are being developed. In the USA, two great companies "Pioneer" and "Monsanto" make efforts to identify and develop new corn hybrids, examine the impact of the environment on their growth, and the impact of corn varieties on the composition of useful by-products. Both companies have commercial corn varieties specifically cultivated for use in bioethanol production with obtained ethanol yield up to 4% higher than with conventional varieties (for the annual production of bioethanol of 150 million liters it means annual profit increase of 1-2 million US dollars). Further research in the world should result in modification of properties of starch and other complex carbohydrates by methods of genetic engineering (Mojović et al., 2013).

Furthermore, significant efforts have been made at the Maize Research Institute, Zemun Polje, Serbia, in order to determine the suitability of local maize hybrids for bioethanol production. The calculation of average potential costs of bioethanol production from corn grain in Serbia performed on some of these hybrids is shown in Table 1.

Table 1: Average potential costs of bioethanol production from corn grain in Serbia calculated for 2012 prices, for most widely used local maize hybrids (Source: Semenčenko V, 2013)

Cost component	Average price, € l^{-1}
Feedstock costs	0.132
By-product credits	
DDGS	0.042
Carbon dioxide	0.001
Net feedstock costs	0.089
Cash operating expenses	
Electricity	0.011
Fuels	0.041
Waste management	0.001
Water	0.0007
Enzymes	0.008
Yeast	0.001
Chemicals	0.007
Denaturant	0.01
Maintenance	0.012
Labor	0.011
Administrative costs	0.008
Others	0.0009
Total	0.1116
Total cash & net feedstock costs	0.2006
Ethanol yield per hectare, l	3888.67
Ethanol production costs per hectare, €	778.69
Net income per liter, €	0.3094
Net income per hectare, €	1204.53

From the data presented in Table 1 it can be concluded that the average net income per liter of bioethanol produced from maize grain 0.3094 €, and the net income per hectare of 1204.53 €. The table shows the fact that the price of bioethanol fermentation by-product – dried distillers' grains with solubles (DDGS) amounts 0.042 € l^{-1} ethanol, which means that based on the total revenue from the sale of one liter of this fuel represents about 14%.

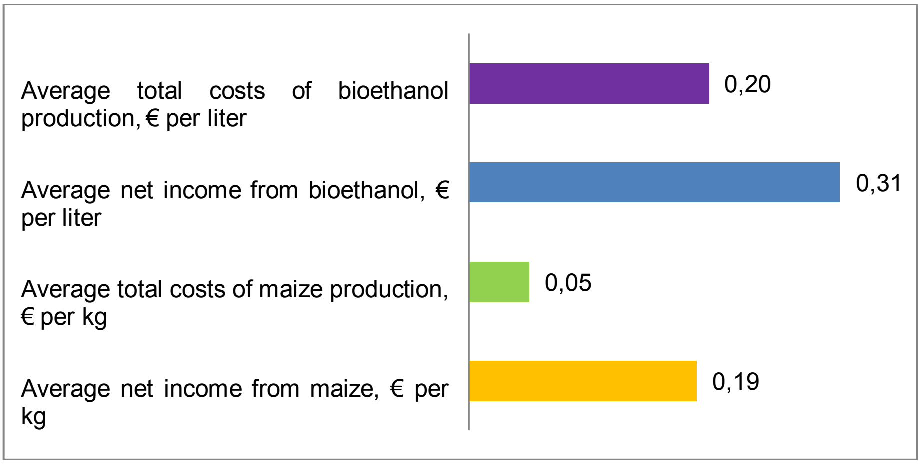

Figure 1: Average net income and costs of maize and bioethanol production in Serbia, calculated for prices from 2012 for most widely used local maize hybrids (Source: Semenčenko V, 2013)

From Figure 1 it can be concluded that by selling one liter of bioethanol higher profit can be achieved than by selling one kilo of maize grain. However, profitability per hectare of commercial maize grain sold is higher. This can be explained by the fact that for the production of one liter of ethanol was requires, on the average, 2.5 kg of maize grain.

In real terms it cannot be expected that all maize grain, intended primarily for human and animal nutrition will be used for the production of biofuels. The obtained results indicate that the production of a certain quantity of bioethanol from corn grain could be cost-effective, and it is necessary to design the production process in a way to find appropriate measures between the food industry and the alternative fuels production. Taking into account the fact that Serbia is a signatory of the Kyoto Protocol (1997), which refers to the reduction of greenhouse gas emissions and that the Biomass Action Plan (2010) established sustainability criteria for biofuels and bioliquids, the start of production of at least and the minimum amount of bioethanol would be a significant step towards achieving these goals (Semenčenko V, 2013).

7. CONCLUSION

Bioethanol production in Serbia is now at a very low level, even lower than the production scale at the very end of the twentieth century, and it is not sufficient enough to fulfil the country's ethanol needs for beverages, medical and pharmaceutical purposes. This is the main reason why in Serbia, there is still not an organized production and utilization of bioethanol or other biofuels for gasoline and diesel substitution. Recently conducted studies revealed that Serbia will need to build new bioethanol plants in order to produce enough bioethanol for use as a fuel and thus follow the aims of the European Directive 2009/28/EC. The obtained results, furthermore, indicate that the production of a certain quantity of bioethanol from corn grain could be cost-effective, and it is necessary to design the production process in a way to find appropriate measures between the food industry and the alternative fuels production. The revenues from corn bioethanol co-product – DDGS sold for animal feed could reach 14% of total income. In Serbia, it is necessary to introduce new strategies for the bioethanol production - large capacity plants that apart from bioethanol also include the production of animal feed and carbon dioxide; or introduce a network of small plants for the production of bioethanol within the petroleum industry.

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SMART METER AND CONSUMERS

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Abstract: This work is focused on a specific segment of devices that facilitate a smart use of energy and relations with consumers. Throughout this document a Cost-Benefit analysis will be showcased. The aim of this work is to combine and explain key information about the technology being implemented; Cost-Benefit analysis for consumers, benefit from the smart meter implementation in households and four utility prototypes that influence the overall business case for smart meters.

Keywords: smart meter, advanced metering infrastructure, energy efficiency, consumer, energy management

1. INTRODUCTION

Energy and its sustainable use has become the top priority for both developing and developed countries. With the upcoming growth of both population and energy consumption, being able to be more efficient and effective with the allocation of this resource is a challenge that the world and its leaders are embracing. In spite of efforts, the impacts of an unbalanced use of natural resources have led the world to a critical situation where the environment and society are under an unhealthy and dangerous burden. The development of technologies and the engagement of energy users towards a more conscious use of the energy they consume is critical, as well as, the development of the market to allow these innovative solutions to be both reliable and affordable, to ensure that their potential is achieved and their expected benefits delivered.

2. THE CONCEPT OF SMART METER

The concept of smart meter can be defined in general terms as (Obenchain, Thurber, Quenn, et al. 2011) electronic measurements devices, installed by the utilities at the consumer facilities to allow communication of the consumption of energy (gas, electricity, water). These devices have been used by utilities to deliver accurate billing information, for a part of their customers. At first the devices were mainly used by industrial consumers given the higher consumption and the need of specific consumption data, to allow the right and best quality service to be delivered, and also to provide specific and detailed billing data. The evolution of the market and consumer needs facilitated a decreased price of the technology, and increased need of information by all consumers, leading to the migration of these systems from the industrial sector to all customer classes. From the consumer side smart meters can be defined as (SEDC, 2012), communication and control systems, which have the ability to directly empower the consumers to understand, control, produce and earn from energy. Through this definition the consumer becomes an equal partner in the energy value chain.

A broad view of smart metering, published by the European Commission (EC, 2010) states that an intelligent metering system or “smart meter” consists of an electronic device used to measure the consumption of energy, delivering more information than a conventional meter, and that can transmit data through a communication network. In this perspective, the key feature of a smart meter is the possibility of bidirectional communication between the consumer and the supplier/operator; the system should also promote the dissemination of services that improve energy efficiency within the home. On a market perspective, shifting from old and static meters to smart active devices is a matter of increased importance for competition in energy markets.

A considerable array of definitions for what smart meter and smart metering is, are available in the literature and in industry reports. From the definitions stated above (Obenchain, et al. 2011; SEDC, 2012; EC, 2010) it is possible to build a comparison table to highlight different focus of different authors (*table 1*).

Table 1 Smart meter definition comparison (Obenchain, et al. 2011; SEDC, 2012; Martin, 2011)

Smart meter definition comparison			
Author	Obenchain *et al*, 2011	SEDC, 2012	Martin, 2011
Key concept	Electronic devices, providing billing information to allow better management by the companies and utilities.	Electronic devices, that allows consumers to manage and benefit from a better control of their energy expenditure.	Intelligent meters, that provide more and better information, allowing energy efficiency to be improved, while increasing competitiveness of the energy market.
Focus on	Utility benefits from smart meters, and management of resources	Consumer benefits from smart meter, as well as, utilities.	Consumer, utilities and the market benefit from the roll-out of smart meter technologies.

The general structure of the smart meter (*figure 1*) consists on a hardware combination of the meter and the platforms needed to gather the information, and the necessary software and communication layer that transmits and processes data, and enables the system to communicate consumption data for accurate billing, controlling and monitoring purposes.

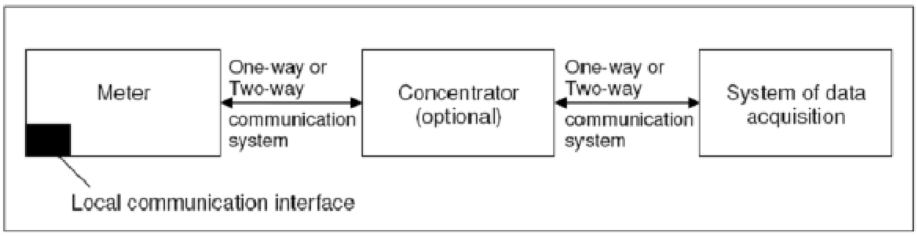

Figure 1 The general structure of a smart meter (source: Martin, 2011)

The general system architecture as demonstrated in *figure 1* represents the possibility of “one-way” or “two-way” communications between the different layers of the structure.
The evolution of the systems technology from “one-way” communications to “two-way” communications is linked with the shifting from the Advanced Meter Reading (AMR) systems (one-way communication) to the Advanced Metering Infrastructure (AMI) (two-way communication). The main differences between these two systems, AMI and AMR, are (Obenchain, et al. 2011):

AMI: Consists on the combination of the electronic meters with two way communication technology, for information, monitoring and controlling energy use;

AMR: Utilized one-way communications to collect meter data only.

The evolution of the communication system and its impacts on the smart meters capabilities are represented on the diagram below (*figure 2*), including the evolution of functionalities and the stakeholder benefits as a result of these evolutions.

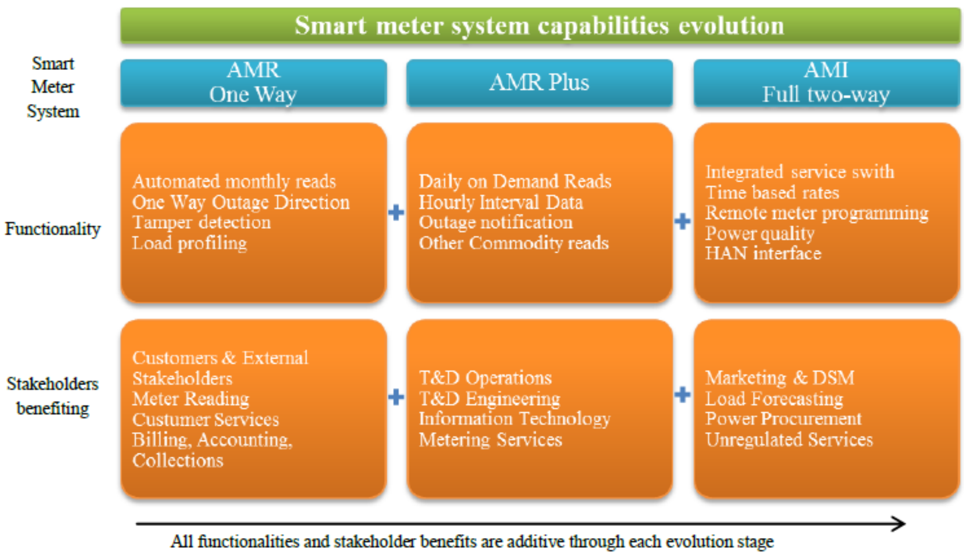

Figure 2 Smart meter system capabilities evolution (adapted from: Obenchain, et al. 2011).

Smart meters represent the new generation of meters, with the ability to replace existing electro-mechanical meters while offering a range of benefits for both the individual consumer and the energy system in general.

3. SMART METER AND CONSUMERS

Imagine a typical modern day Southern European family of four, husband and wife and a couple of grown up college kids living together. They go about their daily lives to work and university sharing their two cars and when necessary visiting the gas station to refill. In this world the system is such that they don't actually pay for gas at the gas station but simply fill the tank as necessary and receive a bill every month or two, once they have already forgotten who and with which car visited the gas station and how many times they have poured how much fuel into their vehicles. Let's also assume that their cars don't have a speedometer or a gas gauge, therefore they have absolutely no feedback in order to manage their fuel expenses. This is how we spend electricity and account for its usage in the world of today.

The widespread installation and utilization of AMI, and Smart Meters as its essential part, by homes and businesses will transform the way we purchase, spend, account for and manage our electricity consumption and needs. In preparations for widespread distribution of smart meters utility companies in Europe, North America, Australia and parts of Asia have during the past decade carried out numerous feedback and pricing pilot trails with their customers to assess the potential impact of smart meters and other AMI components on improving energy savings, increased energy efficiency, changes to customer behavior, their potential monetary savings in bills and reduction of greenhouse gas emissions. This section will provide an overview of cost benefit analysis of smart meter application, followed by a summary of selected feedback pilots carried out and their results[1].

3.1. Cost-Benefit analysis for the customer

Despite the rapid growth in the home energy management, and the significant energy management opportunity that is possible with the combination of smart meters and smart home energy management devices, concerns whether the costs outweigh the benefits of smart meters are a persistent concern among all stakeholders in the smart meter roll-out initiatives.

Smart meters provide an opportunity for two-way digital communications between the utility and the customer and establish a platform for customer energy management and demand response via both information feedback and rate programs. They are a tool for improving utility operational functions such as outage detection and management, remote meter reading, and remote customer (dis)connections. Furthermore, smart meters allow smart charging of plug-in electric vehicles as well as integration of distributed generation resources (Ehrhardt-Martinez, Donnelly, & Laitner, 2010).

Benefits from smart meters can be driven by changes in consumers' expected consumption behavior. Two potential sources of change in average consumption behavior may arise (DECC, 2010):

- a reduction in overall energy consumption/demand as a result of better information on costs and use of energy which drives behavioral change, and
- a shift of energy demand from peak times to off-peak times.

Smart meters provide benefits for utilities, customers and society as a whole (Faruqui, Mitarotonda, Wood, et al. 2011):

<u>Operational</u> – Allow the utility to deliver more reliable service, remote connection, better outage detection and recovery to its customer base at lower overall cost.

<u>Customer</u> – Arise from engagement in energy management driven by information and/or price signals, which leads to electricity usage reduction or load shifting and the opportunity to lower bills and mitigate cost increases.

<u>Societal</u> - Arise from demand response and direct load control, enabling reduction of peak purchases, thereby applying downward pressure on energy prices in spot markets, offsetting the need for new generation and transmission and distribution capacity, and potentially lowering carbon emission.

[1] (Ehrhardt-Martinez, et al. 2010; DECC, 2010; Faruqui, et al. 2011; Griffiths, 2012; Johnson, 2010; EComm, 2011)

A very elaborate cost benefit analysis of smart meters was carried out by The Edison Foundation, Institute for Electric Efficiency in their 2011 publication, *"The Costs and Benefits of Smart Meters for Residential Customers"* (Faruqui, et al. 2011).

Firstly the analysis defines profiles for four utility prototypes that influence the overall business case for smart meters, including the electricity generation mix, the renewable energy portfolio, the regulatory environment, emphasis on efficiency and conservation, and other factors.

- Pioneer: A utility that previously invested in automated metering with very high energy prices and that purchases power from a variety of generation sources;
- Committed: A utility with relatively high energy prices, primarily natural gas-fired generation, and a mandate to aggressively pursue renewable generation;
- Exploratory: A utility with relatively low-cost generation available, high population density, and highest demand in winter months;
- Cautious: A utility with low population density, high annual demand growth, and coal, nuclear, and natural gas dominant in its generation portfolio.

To continue, the authors define consumer adoption patterns and assume they will align with their energy worldviews. We developed energy management participation plans to correspond with four dominant customer segments, described below.

- Basic: For consumers who do not wish to engage at all;
- Comfort: For those with large load homes with air conditioning, pool pumps, smart appliances, minimal interest in energy engagement, and limited concern about their bills;
- Saver: For those primarily motivated by the opportunity to save money on their bills or mitigate potential bill increases;
- Green: For those motivated by environmental concerns and willing to be more engaged.

Out of the four consumer types, the authors of the study assume that each can have five different engagement pathways in terms of their usage patterns of smart meters:

- Passive: Unengaged households that benefit indirectly from operational improvements due to smart meters and incrementally if they coincidentally defer usage on demand response event days;
- Active: Engaged households that make conscious and manual adjustments to their electricity use based on energy information and price signals from peak rate plans (either no risk peak-time rebate (PTR) or heat wave critical peak pricing (CPP)) obtained via a web portal, a display, or other communications methods (e.g., email, text, or phone);
- Set and forget: Engaged households that use automation to adjust their electricity use via technologies such as programmable communicating thermostats (PCT) or home energy management systems (HEMS) based on energy information and price signals from peak rate plans (either no risk PTR or heat wave CPP);
- Utility automation: Households that allow the utility or a third party to directly control their central air conditioning via a signal sent to their smart thermostat or to a switch on their air conditioner. Customers retain the ability to override;
- Energy partners: Highly interested and engaged households that have electric vehicles and home energy management systems to automatically control electricity usage. The time of use rate applies to the entire household on a daily basis, not just on event days.

The model assumes that customers will choose an engagement path in line with their preferences in terms of price and in accordance with the appliances they use at home but also their sustainability sensibilities and willingness to take action.

Costs and benefits, as presented in *table 2 below,* are calculated based on investments in technology and the benefits arising as of their utilization.

Table 2 Costs and benefits (adapted from Faruqui, et al. 2011)

Costs and Benefits		
Costs	**Operational Benefits**	**Customer Benefits**
AMI	Avoided metering	Avoided generation and capacity
Enabling technology	Avoided outage	Avoided transmission and distribution
	Remote connection and disconnection of service	Avoided energy
		Avoided GHG emissions
		Avoided Gasoline

Even with conservative assumptions regarding consumer engagement in technology, programs, and rate plans, the results of the analysis show positive net benefits are possible for all four utility types. The model assumes a service territory of one million households. According to the study findings, the total costs of investing in AMI and associated technologies for home energy management varies across the four utility prototypes based on the utility and customer characteristics from a low of $198 million for the Pioneer utility to a high of $272 million for the Committed utility. The benefits also vary across the four utility prototypes based on both utility and customer characteristics.

- The operational savings vary from a low of $77 million for the Pioneer utility (who has already deployed AMR) to a high of $208 million for the Cautious utility;
- The consumer-driven savings vary from a low of $100 million for the Cautious utility to a high of $150 million for the Pioneer utility;
- The net benefits vary from a low of $21 million for the *Committed* utility to a high of $64 million for the Exploratory utility.

Although the net benefits are positive for each utility in this analysis, signifying that investments in smart meters make economic sense, customer-driven benefits could be much greater with more investment in and focus on customer education and engagement.

Furthermore if we consider an analogy to recycling, which took some time to get a substantial amount of people on board with the effort, we can assume that customers will migrate from passive engagement in energy management to much more active strategies. A potential area for further study is how to accelerate this process so that a broad array of customers are ready, willing, and able to engage in energy management soon after smart meters are deployed. Given the high satisfaction ratings of feedback pilot participants where education is a key component, the combination of program choice based on personal preferences (with comprehensive consumer education) could yield financial and societal benefits.

4. CONCLUSION

Smart metering is a way to reduce energy consumption, which is otherwise projected to keep growing across the Europe over the next two decades. Smart meters have the proven ability to enable significant changes to the current scenario regarding energy consumption (Johnson, 2007). Their purpose is to improve efficiency, not just at the household level, but utility-wide. For energy providers, smart meters promise to slash uncertainties in electricity consumption data and billing, eliminate the cost of manual meter readings and alert utilities to problems and outages more quickly and effectively.

The development of smart metering and the evolution on has the potential to change the energy industry and the interactions between consumers and distributors of electricity. Providing more and better quality information, these devices set the basis for realistic demand side programs and initiatives, focused on reducing unnecessary consumption, and shifting flexible load outside of peak hours. Reducing the peaks on demand will be possible through dynamic pricing, feedback and strong consumer engagement.

Smart energy systems deployment will positively impact safety and the overall service quality achieved, whilst providing distributors and network operator with essential information to enable demand side initiatives and programs to be implemented with success. Realizing the potential benefits linked to smart meter systems and their dissemination will depend on the success of consumer engagement initiatives and how the available information is organized and used to create more value for the energy market, for the society and for the environment.

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SUSTAINABLE DEVELOPMENT INDICATORS OF THE REPUBLIC OF SERBIA

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Abstract: *This study is based on a survey of possible ways and adopted methods and techniques for achieving adequate model of sustainable development in Republic of Serbia. For that reason, sustainable development is seen first at the global level, giving an example of good practice of European Union. Then, it provides an overview of state strategies and legal framework for sustainable development of the Republic of Serbia. The aim of this study is the assessment of the state of sustainable development of the Republic of Serbia.*

***Keywords**: Sustainable Development, Strategy, Indicators of Sustainable Development, Goals, European Integration, Climate Changes, Global Pollution*

1. INTRODUCTION: ABOUT SUSTAINABLE DEVELEOPMENT

The rapid technological advancements and industrialization have resulted in an increased level of negligence and insensitive behavior, leading to the destruction of environmental balance (Cetin & Nisanci, 2010). Human civilization has never been closer to ecological collapse: one third of humanity lives in poverty, and another 2 billion people are projected to join the human race over the next 40 years (Worldwatch Institute, 2012). The implication of this ecological situation is obvious: to be sustainable, human beings must live within nature's carrying capacity; and they must measure where they are now and how far they can go. In 1992, governments at the Rio Earth Summit made a historic commitment to sustainable development - an economic system that promotes the health of both people and ecosystems. Otherwise, “sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (WCED, 1987). In addition, it is important to notice that since sustainability is a multidimensional concept, economic, social and environmental aspects must be considered and integrated, too (e.g. WCED, 1987; Piątek, 2007; Sanchez, 2008; Pawlowski, 2009; Pawlowski, 2010; Tuziak, 2010).

2. EU SUSTAINABLE DEVELOPMENT STRATEGY

Sustainable Development Strategy has its origins back in Agenda 21, which is a key document for achieving Sustainable Development. Agenda 21 was adopted at the Earth Summit in Rio de Janeiro in 1992. Agenda 21 called all countries to develop a strategy for Sustainable Development, with the involvement of all stakeholders (Eurostat, 1998).

As originally stated in Chapter 40 of Agenda 21, the role and importance of statistical indicators for monitoring progress towards Sustainable Development have been identified as key items for the management strategy of the European Union.

Sustainable Development Strategy of the European Union, launched by the European Council in Gothenburg in 2001, and renewed in June 2006 contains goals for continuous improving the quality for present and future generations. Eurostat, the statistical office of the European Union, every two years publishes the monitoring report that supports the European Commission's report on the progress of implementation strategies. Objectively, the report provides a statistical picture of progress on the EU set of Sustainable Development Indicators. Through indicators, the quantitative rules are consistently applied; as well as the time direction, through certain symbols. In order to provide approximate assessment whether Europe is moving in the right direction, given the goals and objectives set out in the Strategy.

Sustainable Development Strategy is based on four distinct pillars: economic, environmental, social and international, which should mutually reinforce one another. Economic, social and environmental effects of all policies should be examined in a coordinated manner and should be taken into consideration when these policies are drafted and adopted. The EU also needs to assume international obligations in terms of Sustainable Development, and its various aspects, including peace, security and freedom, should promote outside the EU (Eurostat, 1998).

The strategy is based on the following guiding principles: the promotion and protection of fundamental rights; solidarity within and between generations; guarantee of an open society, the participation of citizens, businesses and the involvement of social partners; policy coherence and policy management integration; use of the best available knowledge, the precautionary principle and the "polluter pays" principle.

3. EUROPEAN UNION'S GOALS OF SUISTAINABLE DEVELOPMENT STRATEGY

The first, long-term goal of the strategy is limitation of the climate change and its effects to perform the obligations under the Kyoto Protocol, and taking the action to prevent the increase of global medium temperature above 2 degrees Celsius, above the level that was before the industrial era. The EU should pressure major industrialized countries to meet their obligations under the Kyoto Protocol and it should seek to provide an appropriate international framework for the period "after the Kyoto". It must implement measures and adaptations and testing ways of expanding greenhouse gas emissions; trading system to other sectors and other greenhouse gases (The Renewed EU Sustainable Development Strategy, 2006).

Limiting the negative traffic effects and reduction of regional disparities, is another long-term goal, for which is necessary to break the link between economic growth and development of transport So that the development of transport could be more environmentally friendly and suitable for health. Among other measures, the strategy envisages charging infrastructure, promotion of road transport and vehicles that produce less pollution and use less energy.

To promote more sustainable modes of production and consumption, the relationship between economic growth and environmental degradation should be terminated and also the attention should be on the tolerance of the ecosystems. With this goal, the EU, among others, should also promote Green Public Procurement; it should define the goals of environmental protection and social performance of products in collaboration with stakeholders; it should expand the distribution of eco-innovation and environmental technologies and produce relevant information on the labeling of products and services.

Also, the EU goals include the greater responsibility in natural resources management. Therefore, over-exploitation of resources should be avoided; the efficiency of use of natural resources should be improved; the value of services provided by the ecosystem should be recognized and further loss of biodiversity should be ceased.

In particular, the EU must make an effort in the fields of agriculture, fisheries, forestry; it should define and implement the priority actions for the protection of biodiversity.

Another Strategy goal is limiting the major threat to the public health. Food safety and quality must be ensured through the food chain. Threat to public health and the environment from chemicals should be removed by 2020 year, and research of the connection between health and pollutants must be developed.
In order to fight against the social exclusion and poverty and to mitigate the effects of the aging society, the EU needs to support the so-called "active ageing", which implies the inclusion of older people in different kinds of activities, whether it is voluntarily or not. Also, the effort should be made for assuring the sustainability of the pension system and social protection; integration of legal migrants and improvement of family situations (especially when it comes to children), and to promote the equality of sexes.

4. NATIONAL SUSTAINABLE DEVELOPMENT STRATEGY OF THE REPUBLIC OF SERBIA

National Sustainable Development Strategy of the Republic of Serbia defines Sustainable Development as long-term, continuous, comprehensive and synergetic process that affects all aspects of life (economic, social, environmental and institutional) on all levels (National Strategy for Sustainable Development of Serbia, 2008).

The goal is to achieve balance between three key factors, i.e. three Sustainable Development pillars: Sustainable Economic Development, Economy and Technology; Sustainable Development of Society based on social equality and Environmental Protection with the rational use of natural resources. At the same time, the Strategy aims to bring together these three pillars as one whole, which will be supported by suitable institutions.

Strategy settlements are in line with European integration: EU Sustainable Development Strategy (adopted in 2001, and restored 2006) and the Lisbon Strategy (adopted by the Council of Europe in March 2000). The strategy is aligned with the Millennium Development Goals (UN) and the Millennium Development Goals in the Republic of Serbia, the Government of the Republic of Serbia adopted in 2006. The strategy is based on the reform goals identified in the strategic documents adopted by the Government. The strategy is fully in line with the principles and goals set out in the National Strategy of Serbia for Serbia and Montenegro's approaching to the European Union (adopted by the Government in June 2005) and Poverty Reduction Strategy (adopted by the Government in 2003), as well as strategies to regulate the economic development and environmental protection programs of the Republic of Serbia. It should also be noted that the Strategy is aligned with the entire set of strategies in almost all areas of economy, development, education, energy, in order to facilitate its application in various segments.

Indicators are very important for the successful evaluation of measures and activities for implementation of the Strategy. The choice of indicators reflects the connection with key instruments. In order to be internationally comparable, the selected indicators are aligned with new revised UN List of Sustainable Development Indicators, which also includes the indicators for the Millennium Development Goals. The indicators compliance is primarily reflected at the highest level, while some regional differences are recognized in the Indicators of the second, and especially of the third level. All indicators are gender-supported and they cover all aspects of Sustainable Development: economic, social and environmental (environmental indicators). Classification of indicators of Sustainable Development in Serbia is shown in the following tables (Milanovic, 2010).

Table 1: Poverty

I Level	II Level	III Level
1. Poverty	2. Lack of Income	3. Percentage of population below the national poverty line.
		4. Ratio of the average earnings of women and men.
	5. Inequality	6. GINI Coefficient
		7. HDI - Human Development Index
		8. Index of regional disparities in human development
	9. Help for the Poor	10. Population covered by State Help and Support programs
	11. Living Conditions	12. Percentage of constructed social housings regarding the total number of constructed dwellings

Table 2: Managing

I Level	II Level	III Level
1. Managing	2. Corruption	3. CPI - Corruption Perception Index
		4. Level of Citizen's General Trust
	5. Crime	6. Number of recorded violent crimes per 100,000 population
	7.Efficiency of the State Administration	8. Degree of computer automation in the state administration

Table 3: Public Health

I Level	II Level	III Level
1. Health	2. Mortality	3. Mortality rate of children under 5 years
		4. Life expectancy in good health
		5. Years of living with a disability / incapacity
	6. Provision of Health Care	7. Percentage of population with access to primary health care
		8. Percentage of women using some of the type of contraception.
	9. Health Status and Risks	10. Prevalence of smoking among children from 13 to 15 years
		11. Prevalence of smoking among adults aged 20 years
		12. Number of suicides

Table 4: Education

I Level	II Level	III Level
1. Education	2. Second Level Education	3. Percentage of population with a university degree
	4. Literacy	5. Adult literacy rate
	6. Level of population education	7. Rate of enrollment in primary and secondary education

Table 5: Population - Demographic Indicators

I Level	II Level	III Level
1.Population	2. Population	3. Percentage of population with a university degree
		4. Fertility rate
		5. Dependency ratio of elderly population
		6. Indicators of internal migration
	7. Tourism	8. Density in major tourist regions and destinations

Table 6: Economic Indicators

I Level	II Level	III Level
1. Economics development	2. Macroeconomic performance	3. GDP *per capita*
		4. Percentage share of investment in GDP
		5. Internal and External debt
		6. Trends in the retail price index
	7. Employment	8. Unemployment
		9. Employment rate
		10. Employment rate for women
		11. Unemployment rate for young people under 28 years
		12. Unemployment by region
	13. Information and Communication Technology	14. Number of active Internet users per 1000 population
		15. Number of Mobile phone subscribers per 100 inhabitants
	16. Research and Development	17. Expenditures for Research and Development as a percentage of GDP

Table 7: Global Economic Partnership

I Level	II Level	III Level
1. Global Partnership	2. Trade	3. Trade Deficit
	4. External Funding	5. ODA as a percentage of GDP

Table 8: Production and Consumption

I Level	II Level	III Level
1. Production and	2. Balancing Current Production and Consumption	3. Ratio of Current Production and Consumption
	4. Energy Use	5. Energy Consumption *per capita*
		6. Energy Intensity (energy per unit of GDP)

Consumption		7. Share of Renewable energy in total energy consumption
	8. Waste generation and management	9. Generation of waste
		10. Generation of hazardous waste
		11. Amount of waste that is subjected to the treatment
	12. Transport	13. Energy Intensity of Transport

Table 9: Natural Disaster

I Level	II Level	III Level
1. Natural Disaster	2. Sensitivity to Natural Disaster	3. Number of victims of Natural and Technological disasters
		4. Percentage of population living in natural risky areas

Table 10: Climate Change

I Level	II Level	III Level
1. Atmosphere	2. Climate Change	3. Emission of CO2 *per capita*
		4. Emission of Greenhouse gases
	5. Ozone Layer	6. Consumption of substances damageable for Ozone Layer
	7. Air Quality	8. Ambient concentration of pollutant urban areas

Table 11: Natural Resources

I Level	II Level	III Level
1. Natural resources	2. Land Use and Status	3. Change of the land use
		4. Land Degradation
	5. Desertification	6. Land degraded by drought
	7. Agriculture	8. Share of permanent crops in the structure of arable land
		9. Use of mineral fertilizers
		10. Use of pesticides
	11. Forest	12. Share of forest land total land
	13. Fishing	14. Annual catch five most common species of fish
	15. Water Amount	16. Annual amount exhausted quantity of grounded water and surface water, as part of an absolute and total of renewable water
		17. Water consumption by sectors
	18. Water Quality	19. Presence of fecal bacteria in drinking water
		20. Biochemical Oxygen demand in streams
		21. Percentage of waste water being treated
	22. Ecosystems	23. Share of protected areas regarding the total area of land
		24. Areas under the selected key ecosystems
		25. Index endangered species
	26. Types	27. Change in status of threatened species
		28. Share of endangered species in the total number of species.

5. CONCLUSION

Advanced climate changes, global population growth, changing market disinclination lifestyle, a global growth industry, and almost the lack of natural resources (water, food, oil) are just some of many problems that exist or will occur in the near future due to non-compliance with the laws of nature and its process (Strategy for Sustainable Development of Serbia, 2008). With that, human society is increasingly moving away from the environment, which provides the basis for life and survival.

In order to enable future generations to live in prosperity we have to turn to Sustainable Development. Sustainable Development is a multidimensional phenomenon that integrates several aspects of every individual's life (economic, social, and environmental), with emphasis on their mutual influence. Sustainable Development Indicators are qualitative indicators that evaluate the situation and change those aspects.

The introduction of the concepts of Sustainable Development over the past two decades became a turning point in our societies. Current policy should not mainly focus on their short-term impact, but they have to look for the long term one, and be more in tune with each other. Considering the complexity of the concept of Sustainable Development: taking into consideration of what counts for the benefit of both present and future generations; well-appointed official statistics that lead to impartiality and diversity available to provide expert statistical tools for both generations; and especially, statistical indicators necessary for adequate assessment and implementation of current policies are some of the basic and the key matters that need to be directed so that the concept of Sustainable Development could give positive effects, both today and tomorrow.

Since the concept of Sustainable Development has become increasingly present in our country, through the National Strategy for Sustainable Development, its indicators were first identified and currently are developing measurement models for those indicators that are not in the statistical system of the Republic of Serbia. The analysis of sustainability indicators, both the EU and the Republic of Serbia, will enable not only understanding the differences, but also the steps and actions necessary to take, in order to overcome those dissimilarities and according to the Republic of Serbia's strategy of joining the European Union. Comparing the indicators the Republic of Serbia and the European Union, it could be said that they are substantially oriented in the same topics and the same structure. However, it is noticeable that the EU, being much larger entity than the Republic of Serbia and whose institutions and laws are more developed, has certain indicators globally oriented, which in Serbia, a developing country, are not possible and measurable.

In Serbia, the indicators of sustainability are positioned on a lower level (in comparison to the level of the EU) because the awareness of Sustainable Development is not very high, and therefore it is necessary to begin from collecting the less complex indicators data, which doesn't require a certain institutional level and the ability to access data and financial resources, since in Serbia it is still not possible obtain. This is precisely the path that Serbia should take and it lies in strengthening the economic stability of the country, increasing the awareness of Sustainable Development, the adoption of laws that enable the framework for progress and application of indicators and general activities towards sustainability in the future time (National Strategy for Sustainable Development of Serbia, 2008). Indicators of sustainability can be useful for different types of communities and in different ways. Above all, they may indicate negative trends of certain aspects of human life, in order to preventively access to these areas before they should turn into a problem, in the future time.

For those communities that already have certain economic, social and environmental problems, indicators can show the way to a better progress. At the global level, indicators can initiate a joint discussion of people with different attitudes and coming from different surroundings, and during that process it can help to create a common vision towards Sustainable Development.

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RESEARCH ON THE SUBJECT OF STUDENTS AWARENESS AND KNOWLEDGE ABOUT GREEN IT

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Abstract: *The aim of this work is to show whether and to what extent the young generation is familiar with the concept of Green IT based on the survey which has been conducted. Furthermore, the goal is to inform primarily the students, and then the others as well, on how ICT can reduce the harmful impact on the environment and contribute sustainable development through various forms of informing. The introductory part shows how the use of ICT, and all its equipment individually, creates a detrimental impact on our environment. In addition, the concept of Green IT is outlined in more detail as well as the reasons why it needs to be implemented. As this approach shows its advantages, the following concepts are introduced: cloud computing, grid computing, virtualization technologies, utility computing, client server and peer-to-peer networking. A research has been conducted, where data has been collected by means of a survey, on whether and to what extent the students are familiar with the concept of Green IT. The research encompasses 82 freshman students from the Vocational College of Technology in Arandjelovac who attended the lectures from 'The Essentials of Information and Communication Technologies'. Young generations are overwhelmingly uninformed and don't possess awareness of this issue, the consequential emissions of harmful gases and harmful effects of ICT in general.*

Keywords: *Green IT, cloud computing, sustainable development, environmental, ICT*

1. INTRODUCTION

Thomas Friedman, in his well-known book ―Hot, Flat, and Crowded” came to the following conclusion: ―The convergence of global warming, global flattening, and global crowding is driving those five big problems – energy supply and demand, petro dictatorship, climate change, energy poverty, and biodiversity loss – well past their tipping points into new realms we've never seen before.” Considering just how widespread ICT is and the fact that people can‘t imagine day to day life without it, it shouldn‘t come as a surprise to learn that it contributes a great deal to those five problems. People, in general, are not very aware of these problems and what they can mean, not only to us, but also to future generations. It is for their benefit that we should think about environmental sustainability, that is, about ―development that meets the needs and aspirations of the present without compromising the ability of future generations to meet their own needs” (Development., 1987).

2. DETRIMENTAL EFFECT OF ICT USE ON OUR ENVIRONMENT

Today we rely on the Internet to find whatever we need, for example, library catalogs and databases, digital libraries, institutional repositories, e-books, e-journals, and so on. Access to this information is provided by an IR system. Such an extensive use of IR systems, which uses ICT (Information and Communication Technologies) at every stage of its creation and management, has an adverse effect on environment. Whenever ICT equipment is created or destroyed, it creates harmful gases, called GHG (greenhouse gases, a term used to measure environmental impact of a product or service). In running the ICT we use energy, and that also generates a substantial amount of GHG. In other words, as we are, in our daily life, becoming more and more reliant on IR systems for accessing and using digital information in a variety of forms, we are creating more environmental damages because of the increased use of ICT and energy. Because of that, it can be argued that we need to find a way to develop IR systems and services that are environmentally sustainable. As environmental sustainability has become a major area of concern for various national and international bodies, many different measures are being proposed for reducing the impact of industries and businesses on environment. One of those measures is the appropriate use of ICT which can reduce the overall GHG emissions of businesses.

The environmental impact of ICT can be significantly reduced by employing Green IT and cloud computing (Chowdhury., 2012). It has become a competition between computer hardware and software manufacturing firms to use environmentally sustainable energy efficient technologies in their products and services. Also, many companies and organizations are trying to make their businesses environment friendly, sustainable and cost effective by implementing green sustainable technologies (Lamb., 2009). Environmental sustainability is becoming imperative in data centers. Data centers are used by business facilities which contain ICT infrastructure platform (ICTP), cooling and power delivery equipments, servers and storage devices to store and process digital data and information (Lefurgy et al., 2007). Financial services, media, high-tech, universities, government institutions, and many others use and operate them to aid business processes, information management and communication functions (Daim., 2009). Data centers form the base of a large number of different services offered via the Internet including e-commerce, Web-hosting, social networking, and a variety of more general services such as software as a service (SAAS), platform as a service (PAAS), Internet as a service (IAAS), grid and cloud computing (Loper & Parr, 2007).

Many world known organizations like Green Grid, Energy Star, Green Data Center Alliance and many others are trying to develop green IT frameworks which are meant to reduce the emission of green house gases through maximum usage of already installed resources and devices in data center industry (Uddin & Rahman, 2012). However, not only do individual users but also systems and services that make extensive use of ICT have to change so that the target of reducing the GHG emissions of the overall business, industry and government could be met. The increasing use of ICT in its current form is not environmentally sustainable, as is proved by the research. The same research estimates that ICT‘s own sector footprint currently stands at 2% of global emissions and it will almost double by 2020 (Chowdhury G., 2012). In the same report it is suggested that appropriate use of the Green IT is a solution and that it can reduce ‗annual manmade global emissions by 15% by 2020 and deliver energy efficiency savings to global businesses of over EUR 500 billion" (Group., 2008) (Chowdhury G., 2012). ‗Gartner emphasizes that ICT industry is responsible for about 2% of global CO2 emissions which is almost equivalent to the aviation industry. An EPA report to U.S congress in 2007 emphasizes that current energy consumption in data centers is leading to an annual increase in the emission of CO2 (green house gases) from 42.8 million metric tons (MMTCO2) in 2007 to 67.9 MMTCO2 in 2011" (Uddin & Rahman., 2012).

From the mid-2000s onward, the amount of energy that is used by the applications available on the Internet has become a concern because of the rise of greenhouse gas (GHG) emissions; due to those concerns power-saving architectures and protocols have been seriously considered (Gupta & Singh., 2003). Since 2009, ICTs take amazing 4% of the world wide electricity consumption, and this number is expected to double within the next few years (Leisching & Pickavet., 2009). Zhang et al. have submitted a complete review on energy-efficiency plans in different parts of the telecommunication networks (Zhang at el., 2010). Energy-management is for the most part established on turning off, or putting in low power (sleep) mode, the components that are not in use such as line cards, network interfaces, router, and switch ports. There are also plans and projects for energy-efficient ICTs which require special power-saving hardware and architectures (Mouftah & Kantarci., 2012).

In the report from 2009 it is said that IT equipment contributes to global GHG emissions in the following percents: PCs and monitors contribute 40%, servers and their cooling equipment 23%, fixed line telecommunication equipments 15%, mobile telecommunications equipment 9%, local area and office network devices 7%, and printers 6% (Leisching & Pickavet., 2009). Keeping these numbers in mind, we can conclude that significant amount of energy could be saved in PCs and monitors by moving the IT services to distant servers. In this area, cloud computing could reasonably provide a solution for the green IT purposes. However, there is a negative side to the migration of services to distant servers in remote data centers. It will have two main impacts on global energy consumption and in direct correlation to the GHG emissions: (i) there will be an increase in the usage of data center servers, and (ii) moving the resources over the Internet will overload the Internet backbone traffic which will lead to an increase in power consumption of routing and switching equipments. Therefore, as Baliga et al. have stated," energy-efficiency in cloud computing needs to maintain a balance between processing, storage, and transport energy" (Mouftah & Kantarci., 2013). As well, the Berkeley study concludes that laptops and desktop comprise approximately half of the Internet‘s total power consumption (Chowdhury G., 2012).

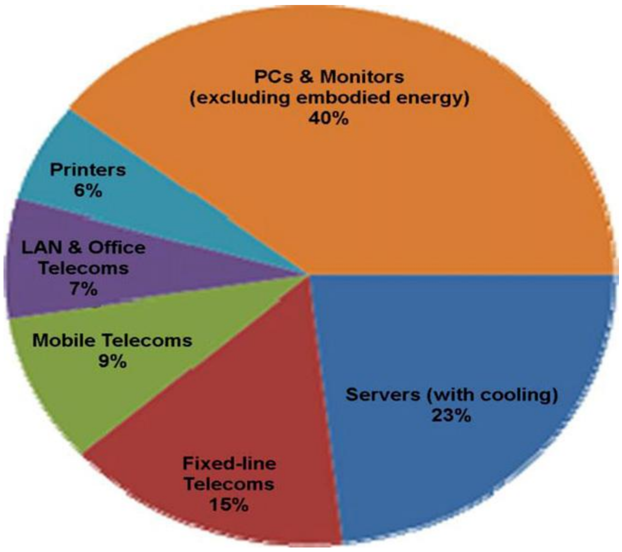

Figure 1: Estimated ICT CO2 emissions

In this picture we can see CO2 emissions for each ICT category. Based on this we can conclude that carbon emissions and energy consumption will only grow from year to year. The SMART 2020 study shows us that CO2 emissions from ICT are increasing at a rate of 6% per year and with such a growth rate they could represent 12% of worldwide emissions by 2020 (Kumar & Mieritz., 2007). It is becoming clear to the people all over the world that the humanity will have to pay dearly for the irresponsible behavior of the enterprises that have done the great damage to the environment. As we have already stated, information and communication systems account for 2–2.5% of the global carbon emissions, but it must be understood that if indirect energy use was to be included, then the number would rise to 14% of the total global carbon emissions (ITU-T, 2007). The problem becomes even greater if we take into consideration the e-waste made by massive usage of the IT equipment. About 500 million PCs were discarded between 1994 and 2003. That many PCs contain approximately 2872,000 t of plastics, 718,000 t of lead, 1363 t of cadmium and 287 t of mercury. The environmental problems that are connected to the IT are without doubt one of the most pressing concerns not only for the IT society, but for the general public as well. To date, the largest number of the environmental regulations and measures of control are being focused on the IT equipment manufactures. Every day environmental problems are more closely connected to the unsustainable trends in consummation than to the human population and technology. In particular, for the IT system, system‘s overall environmental impact largely depends on the system owner‘s decision concerning design. As Kohler and Erdmann concluded (Köhler & Erdmann, 2004), there are three levels of environmental impact: the environmental impact which is a result of the hardware‘s full lifecycle, the shifting of other connected non-IT processes, and the change in people‘s daily life and economy. A good system design results in lower environmental risks and impacts and improves corporate social responsibility (Zhang et al., 2011).

3. WHAT GREEN IT REPRESENTS AND WHY IT SHOULD BE IMPLEMENTED

Green IT refers to the initiatives and programs that directly or indirectly address environmental sustainability (Jenkin et al., 2011). Its objective is to lessen the overall environmental impact of ICT by applying various measures some of which are taking environment-friendly approaches to the production and use of ICT equipment and facilities and optimizing the use of those equipments and network infrastructure so that the energy consumption at every stage would be reduced (Chowdhury G., 2012). If we observe only the direct environmental impact of IT system, then we could define Green IT as ‗the study and practice of designing, manufacturing, using, and disposing of computers, servers, and associated subsystems— such as monitors, printers, storage devices, and networking and communications systems—efficiently and effectively with minimal or no impact on the environment.“ (Murugesan., 2008)

Green IT or Green Computing helps us create more environment friendly and cost effective use of power and production technology. Green IT is a term that covers many different concepts like virtualization, cloud computing outsourcing, recycling, procurement and power management, etc. The main goal of Green IT is to achieve higher energy efficiency in the use of IT devices and to increase the utilization of already installed devices in data centers. On the other hand, organizations need to deliver new IT Services in short time while keeping in mind high reliability, performance and availability requirements as important issues in supporting the business processes. IT must have a clearly defined Green IT strategy or framework which is in tune with business strategy and goals in order to realize and achieve both of these objectives at the same time. IT needs to translate IT Strategy to IT operational processes efficiently and clearly in order to assure effective business IT alignment in the most secure way (Uddin & Rahman., 2012).

4. TECHNOLOGIES WHICH ENABLE THE IMPLEMENTATION OF GREEN IT

Recent years, maybe even decades, have been marked by astonishing advances in information technology (IT). Their sole purpose is to achieve high performance data processing, data storage, and high speed wired/wireless communications on the Internet. Distributed systems, each aiming at a specific target, have become possible solutions, because of the limitations of local resources and power-efficiency concerns. For example," IBM‘s *autonomic computing* aims at building self-configuring, self-healing, self-optimizing, and self-protecting distributed computer systems for complex and unpredictable computing environments". As another example, *grid computing* comprises a" group of computers located at physically distant locations and sharing computing and storage resources to accomplish a specific task on an on-demand basis". There are also client–server and peer-to-peer networking. Client-server networking is a ―distributed system consisting of a high performance server and lower performance clients", while peer-to-peer networking defines a" distributed system consisting of peers that share hardware resources such as storage, processing power, and network link capacity". Similar to the distributed computing services, *utility computing* is another business model that ―delivers the computing resources among several computers based on an on-demand basis and bills the computing facilities such as in electricity and Internet billing" (Mouftah & Kantarci.,2013). The idea of distributed systems has in the end evolved to the *cloud computing* concept which offers almost infinite computing resources on-demand as well as the dynamic provisioning, release, and billing of computing facilities. On top of that, the expenses of service providers who use cloud computing are reduced (Armbrust, et al., 2009). As a matter of fact, as stated by Zhang et al., cloud computing is just a new business model that merges several distributed system concepts. (Zhang et al., 2010) According to the definition of the National Institute of Standards Technology (NIST), which is the one most often referred to in literature, cloud computing denotes ―a shared pool of resources available to the users, which can dynamically be provisioned and released without interacting with the service provider" (Mouftah & Kantarci., 2013).

Grid computing comes closest to the cloud computing because it offers a distributed, powerful and cheap computing platform over the Internet. The difference is that cloud computing offers a homogeneous pool of resources to the users while the ones that grid computing offers are more heterogeneous. Also, cloud computing may be better than grid computing because of its high reliability assurance from the service providers (Kondo et al., 2009). For instance," Amazon-EC2 assures 99.995% reliability, which leads to 27 min or less downtime per year" (Mouftah & Kantarci., 2013).

IT infrastructure is growing almost daily, so we can consider cloud computing as a natural extension of virtualization technologies. These technologies enable scalable management of virtual machines over a number of physically connected systems. That is why cloud computing which is based on virtualization can offer practical and applicable approach to green IT/clouds. These are the clouds which emphasize the construction and development of scalable, energy efficient network software applications (NetApp) through improved utilization of the primary resources. The key precondition for upgraded security services as an integrated component of the infrastructure management strategy is emphasized by boosting the sharing of hardware and data in a multi tenant cloud architecture/environment and through this the former is achieved. Not only is the virtualization technology at the forefront in the sphere of industry but it‘s also grown into paramount technology in building a green IT infrastructure.

Since modern computing is prone to lead to high energy consumption it creates technical issues as well as environmental challenges. Due to the growth of the sizes of IT infrastructure, it has become an imperative to come up with efficient green IT solutions in order to minimize its effect on our environment. Cloud computing provides a natural extension of virtualization which enables scalable management of virtual machines dwelling on distributed hosts, thus permitting maximal usage of the concealed resources and supplanting the traditional ‗one server, one application‟ model with a multi-tenant architecture/model of cloud services (Li, et al., 2011). The carbon footprint of ICT can be reduced in different ways, as is shown by Green IT/IS research. Some of those ways are the following: (1) by developing more sophisticated software and business systems that can help in the reduction of GHG emissions of businesses, (2) by developing new and improved technologies for manufacturing ICT equipments and infrastructure, and (3) by sharing computing and ICT infrastructure and thereby optimizing the use of computing and network resources and also reducing energy consumption of ICT (Chowdhury G., 2012).

5. DISCUSSION AND RESULTS

With regard to the cognitions which have been reached on the basis of former research, and bearing in mind people‘s feeble awareness on the topic of environmental conservation and the facts which imply this, a research on Green IT has been conducted. In conformity with the already mentioned, this research also starts from the presumption that the majority of the respondents aren‘t acquainted with the term. On the basis of the results of the survey which has been conducted on the Vocational College of Technology in Arandjelovac, and where 82 freshmen students of vocational studies who attended the lectures on ‗The Essentials of Information and Communications Technology‘, in autumn semester of the school year 2013/14 were surveyed, the following conclusions have been reached:

- Out of 31 surveyed students on the study program Information Technology, out of which 23 are members of the male and 8 of the female sex, 30 (96,7742 %) have never heard of the concept of Green IT, while only 1 (3,2258%) student is familiar with this term.

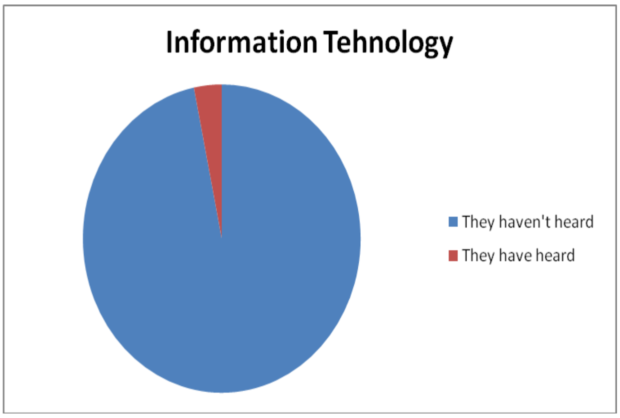

Figure 2: Percentage of students' familiarity with the concept of Green IT

- Out of 23 surveyed students on the study program Management in Tourism and Hospitality Industry, out of which 7 are members of the male and 16 of the female sex, 20 (86,9565%) have never heard of the concept of Green IT, while only 3 (13,0435 %) students are familiar with this term.

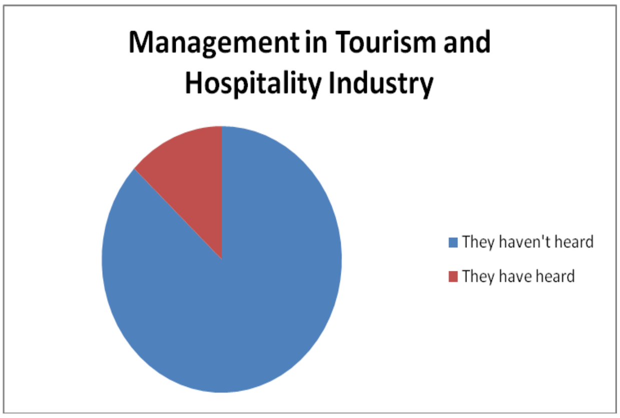

Figure 3: Percentage of students' familiarity with concept of Green IT

- Out of 6 surveyed students on the study program Technology and Engineering, out of which 3 are members of the male and 3 of the female sex, no one has heard of this term.

- Out of the 22 surveyed students on the study program Environment Conservation, out of which 8 members are of the male and 14 of the female sex, 20 (90,9091%) have never heard of the concept of Green IT, while only 2 (9,0909%) are familiar with this term.

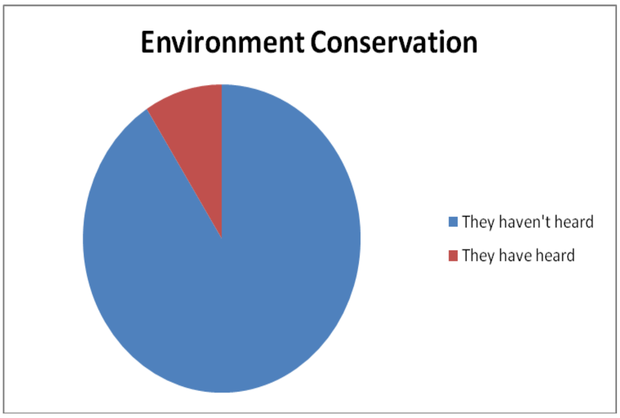

Figure 4: Percentage of students' familiarity with the concept of Green IT

6. CONCLUSION

Given its rapid development and progress, ICT has become part of our everyday life and is an integral part of many activities. Although ICT is very useful, emission of harmful gasses threatens to contaminate the environment. Green IT produces minimal greenhouse gas emission and can contribute significantly to the achievement of sustainable development, and play a key role in the aforementioned. The goal of Green IT is to directly or indirectly reduce the impact of ICT on the environment, that is, the ecological and economic costs by adopting a series of measures. Therefore, it is especially important that people are familiar with this concept. According to the results of this study we can notice that younger generation, which to a large extent uses ICT for various purposes, has a poor understanding of these relevant concepts. Consequently, it is necessary to inform and create awareness that through the use of ICT they should think and adhere to the measures that have been proposed in order to protect the environment and reach sustainable development.

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CLIMATE CHANGE TREATMENT IN NATIONAL SECURITY DOCUMENTS

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Abstract: *Climate change is a threat multiplier. It is hard even to list all concrete security threats generated from climate changes. Perception of this factor as a threat is relatively new. Natural disasters are one of logically expected implications of climate change. One of the missions of the defense forces in many countries is dedicated to supporting the civil authorities and population in a case of natural or man-made disasters. While traditional missions of defense forces are well presented in strategic documents and well evaluated towards implementation, the question arise how much defense forces are prepared, equipped and trained for conducting a mission of supporting society in a case of disasters. We started with investigating a placement of this mission in a strategic documents related to national security and defense. In dealing with climate change security implications, lessons learned from the similar cases in the past could be of help.*

Keywords*: Climate change, Disasters, Security, Military, Strategy*

1. INTRODUCTION

People around the globe become more and more aware of possible impacts of climate change on their life. There are many aspects of considering climate change impact on our civilization. Marshall (2012); and Pain (2013), offer some interesting analyses of a climate change possible impact on some common everyday issues. Alexander (2013), considered an real disaster event which occurred few years ago (Iceland volcano eruption in 2010), and noted some impressive facts about consequences on everyday life and particularly on air traffic.

Climate change issue arises, during last few decades, as a security threat worth of consideration and mentioning in a national security documents. It also earns growing attention. Tanner and others (2009), registered changes in priorities among security threats, and found that higher priority has been given to the climate change. In a long-term perspective for security, some nations see climate change as one of the most important factors, like in Finnish Prime Minister's Office Publications (2012).

In order to recognize climate change as a threat in a comprehensive way, there is a room for research in different scientific fields. First, what are causes and effects of climate change? Climate change may be a consequence of some natural phenomena, as well as the consequence of the mankind activities (global warming). Climate change made by the nature may be a consequence of orbital changes of the planet, Sun activities, a change of Earth's magnetic field, meteor impact, or gigantic volcano eruption, to mention some of the well known causes. Climate change affects almost all fields of human life and society, and negative aspects of that influence make that we perceive climate change as a threat.

Climate change is a threat multiplier in many aspects. Climate change may be a cause for generating problems in many other fields: agriculture, transportation, health, energy, technology, economy, social issues, migrations, and consequently, politics and security domain. Climate change may appear gradually (as it is considered for global warming), or in a short time with enormous changes. Climate has complex and global dynamics, and scientific climate models are still far from enough reliable tools for good, comprehensive and long-range forecasting.

Human civilization experienced various kinds of natural disasters. In last decade we had a series of severe mega-storms with devastating effects in the USA, volcano eruption in Iceland that heavily blocked air transportation in Europe (Budd and others, 2011), tsunami in Indian Ocean, earthquake with tsunami in Japan, wildfires in Australia, Mediterranean countries but in Russia as well, heavy earthquakes in Haiti and in Asia, long drought in Africa, devastating floods, and so on. One should not separate such disastrous events from climate change perceived narrowly just as global temperature grow. Common sense may suppose that body's volume enlarges proportionally with grow of temperature. In the case of our planet, that means that Earth's tectonic plates will make some motion which could be a trigger for earthquakes, tsunamis, volcano eruptions, etc.

2. DEFENSE FORCES MISSIONS AND CLIMATE CHANGE

In any nation state, defense forces are considered as highly organized, structured, robust, respective, trained and equipped social entity that are very appropriate for meeting different types of security challenges including natural or man-made disasters. In general, it is a kind of a last resort capacity of one society for dealing with various large-scale security challenges.

The purpose of the defense forces (tasks, duties, responsibilities) is usually given in strategic documents related to the national security and defense. Number and type of declared missions varies depending on country. However, there are three general types of missions for the military that could be found in strategic documents of different countries:

- Defend the country, nation and national interests (traditional tasks of armed forces).
- Contribute to the global peace (by participating in peace missions abroad).
- Support the civil authorities in a case of natural or man-made disasters.

The first mission is the most traditional task and every military organization is very familiar with that. Personnel strength, size of organizational structures, quality of equipment, military training and strategic and doctrinal documents, are mainly determined and oriented towards preparation for use of military forces for the purposes of the first mission: defending the country.

The second mission becomes very actually during the last few decades: many troop-contributing countries, many missions, many different places, increased mission duration, etc. Peace supporting is relatively new mission (comparing with the first mission) for the military. It is a lot different from the first mission. It demands new capabilities from military organization and particularly from the military man and woman as individuals. Fortunately, peace missions are in their essence of international character. Wide portfolio of specific training and operating procedures has been developed during decades in many countries. International military cooperation developed and sustained during the peace missions, evolve progressively on many other activities before (training, and preparation) and after mission (lessons learned, training improvement, etc).

For the first and the second mission, it could be said that modern military organizations are well prepared, trained, equipped and more or less familiar with. However, it couldn’t be said for the third mission. The military organizations usually are not exclusively dedicated to the preparation of capabilities for natural or man-made disasters. However, the third mission is in a very close relation with negative consequences of climate change.

While traditional missions of defense forces are well presented in strategic documents and well evaluated towards implementation, the question arise how much defense forces are prepared, equipped and trained for conducting a mission of supporting society in a case of disasters (third mission). We start with investigating a placement of this mission (“third mission” in a further text) in a strategic documents related to national security and defense for a number of countries.

De France and Witney (2013), gave comparative qualitative analyses of security strategic documents for a European Union countries. This analysis generate ranking list of national security documents against criteria of comprehensiveness and currency. We used theirs results to pay more attention on those strategic documents that are estimated as very good, in order to recognize successful approaches and use them as a model in a future work.

In national strategic documents of various countries, the mission of defense forces related to challenges caused by (but not exclusively) climate change, appears in next forms:

- Support to civil authorities in countering security threats (Serbia).
- Defend the Homeland and Provide Support to Civil Authorities; and Conduct Humanitarian, Disaster Relief, and Other Operations (USA).
- Supporting civil emergency organizations in times of crises (UK).
- Protect nation and territory from major crises resulting from natural, health, technological, industrial or accidental risks (France).
- Supporting civilian bodies (Czech Republic).
- Contribute to countering natural and industrial disasters, mitigating their consequences, managing humanitarian crises and, if necessary, and participating in the support of civilian authorities (Hungary).

- Contribution to the National Security in Peacetime includes: protection and support to the population in case of natural disasters, industrial accidents and ecological crises; providing humanitarian relief; support to migration control; search and rescue activities; support when necessary to other government organizations and local authorities to prevent and overcome the consequences of natural disasters, industrial accidents, ecological crises and epidemics (Bulgaria).
- Assistance in the case of natural catastrophes and disasters of exceptional magnitude (Austria).
- Support other authorities on the basis of their requests for executive assistance, or in accordance with jointly implemented contingency plans (Finland).
- Assisting the civil authorities in response to major emergencies, natural disasters and in the maintenance of essential services (Ireland).

3. CLIMATE, WEATHER AND MILITRAY OPERATIONS

One of direct implications of climate change is change of weather conditions. Temperature, rain, snow, wind, in all theirs aspects and combinations, are factors that have tremendous impact on living and working conditions and all other activities of human society including international and internal conflicts and warfare. Weather conditions may have direct and indirect influence on national security and on engagement of national army. Potential influences of severe weather conditions on planning and conducting military operations could be numerous. To mention some of the most famous events from historical evidence where weather conditions made crucial impact:

- Debacle of the Spanish Armada at the end of 16.century. Spanish Navy, during expeditionary operations against Kingdom of England in 1588, had been faced with very strong North Atlantic storm that destroyed the Spanish fleet. It was introduction in the historical change of the strategic balance on the Atlantic between Spain and England.
- Influence of severe Russian winter on military operation in French-Russian war in 1812, and again on military operations during the World War II, particularly in 1941 and 1942.
- Weather conditions influenced a delay of the D-Day in operations Overlord in World War II (Allied invasion of Normandy, France). Landing operation was planned to start on the beginning of June, 1944, but it was threatened by strong wind, high seas and clouds. Initially planned D-Day was shifted to June 6, 1944. Weather forecast by military meteorologists suggested that day as it was expected to be slightly gentle weather and sea conditions. Otherwise, whole operation would have been delayed for at least one month.

Climate change makes impact on all sides in potential conflict, but also it changes the “theatre of operation”. Climate change may generate much worst weather conditions then mankind ever experienced in its history. That may place new challenges to the military organizations and on planning and executing of military operations. Some consequences of climate change could be indirect reasons for triggering situations for any of those three missions. In cases of first and second mission, climate change may:

- Induce tremendous increase of the need for some vital resources (energy, water, food, etc).
- Dramatically reduce availability of the currently available natural resources.
- Open new problems (new transportation routes across the Arctic Ocean; border issues on sea; under-sea resources exploitation; etc).
- Large-scale migration.

4. ALL MISSIONS SIMULTANEOUSLY – ONE HISTORICAL EXAMPLE

Looking back in history, it could be found some good examples of use of military forces for support civil population in some dramatic natural disasters. There are many examples where national armed forces are used to help civil population and authorities in fighting with floods, earthquakes, wildfires, high snowdrifts, etc. It is clear that respective logistical resources and well organized and disciplined military units are of great help in emergency situations caused by natural disasters.

However, natural disasters may arise in any time. They may appear in a peacetime, but also during some war. So, the military forces may be affected to perform two or even all three pointed missions at the same time. This may seem as logical exercise of scholar strategists, but it actually happened in not so far past. During the World War II, in March 1944, there was volcano eruption (Vesuvius, Naples region) in south Italy, just in period of famous Monte Casino battle.

Telling the story in a modern vocabulary, US and UK military forces performed the first mission (defending the country and national interests), which was somehow extended towards the second mission (wide international coalition that included: democratic states, common interest partners and resistance movements, conducted peace enforcement operations outside of national borders). Suddenly, in the middle of military operations, volcano eruption generated the need for performing the third mission. Comprehensive description of that situation with very good conclusions and recommendations was presented by Chester and others (2007). Frontline between Allied and German forces was few hundred kilometers on the north from Vesuvius, and final battle of Monte Casino started on 15 March 1944. Southern part of Italy, including Vesuvius region, was under Allied forces administration. The volcano eruption started in the middle of afternoon on 18 March 1944, and became a threat for around 600,000 people who leaved at that time in the Vesuvius area.

The responses of the USA and UK military forces were timely and comprehensive to that natural disaster. They took over complete responsibility for volcano emergency response: started with situational awareness; used military meteorology capacities to predict wind direction and intensity (because of volcano ash); call for cooperation local population and some local scientists for volcano behavior; engaged military engineering equipment (bulldozers, trucks) for sustaining transportation routes functional; helped in rescue and evacuation on hot spots; and prepare contingency plan for large-scale evacuation of civil population mostly by sea, for the case of worst-case scenario.

5. CONCLUSION

Long-term vision of the national and international security, incorporate the climate change issues and theirs complex implications as one of the most important factors. At the moment, climate change security consequences (mainly in the form of natural disasters) are recognized in many strategic documents related to national security and defense. Defense forces are seen normatively as a supporter of civilian authorities in coping with disasters, and not as a chief executive body.

Order of magnitude of needed resources, skills, information, etc, for comprehensive respond to possible disasters caused directly or indirectly by climate change, could be so huge that no single organization could cope with it, at least not so effectively and efficiently as it could be in coordination and cooperation with other organizations of the national states, but also with others at the international level. In that sense and in this context, future research could be related towards investigating concepts known in the field as: The whole of government approach; International military cooperation; Smart defence; Civil-military cooperation; etc.

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