The circular economy: “the number one priority” for the European Green Deal

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The circular economy: “The number one priority” for the European Green Deal

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The articles of the participants of the International Conference “The circular economy: “the number one priority” for the European Green Deal”, organized on September 19-21, 2022 in Sremska Kamenica, Novi Sad (Republic of Serbia), are presented. The articles analyze problems, achievements and developments in the field of Circular Economy of the European Union.

The book will be an important work instrument for representatives of academia, researchers, and specialists in the field of Circular Economy (scientists, manufacturers, companies, agencies, etc.), graduate students, young professionals, public and private stakeholders, politicians and civil society.

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Sustainable and resilient energy development status (2021/2022) revealed by the pandemic, and a brief review of the U.S. Inflation Reduction Act of 16 August 2022

Invited Keynote paper.

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KEYWORDS – Sustainable energy, resilience, U.S. Inflation Reduction Act

ABSTRACT

This paper is the most recent among reviews of global energy sustainability (economic, environmental, and social pillars/impacts) framework by the author, updated to 2021/2; The full paper is based on references [1] and [2]. It was expanded by:

• Discussing key effects of the COVID-19 pandemic on sustainable energy development,

• Calling attention to the need for quantitative integration of steadfast resilience planning, analysis, and application with sustainable development.

• Very briefly introducing the US Inflation Reduction Act of 2022.

It briefly describes the recent estimates and forecasts of the energy resources, uses, and the dizzy and hence ruinous volatility of their prices (also in the absence of pandemics),

It updates the list of some currently main game-changing energy-related issues,

It introduces some of the planning and action status for countering the energy-related pandemic impacts that can seldom be easily foreseen or recognized early enough,

It recommends and briefly discusses some sustainable resilient paths to the future.

The U.S. Inflation Reduction Act of 2022 (IRA) is planned to reduce inflation by investing $369 billion in improvement of energy security and against climate change, and $64 billion in the Affordable Care Act (health) extension, while at the same time employing ways for generating $737 billion in new revenue. IRA is presented as the single proposed biggest climate investment in U.S. history [3].

REFERENCES

Green Deal. Novi Sad, Serbia, 19-21 September 2022, and available in the proceedings of this conference.


The full presentation can be seen at this link:
Examining Public Financial Flows for Environment in Bosnia and Herzegovina

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KEYWORDS – Bilateral funding, multilateral funding, developing aid, climate finance, public finance, sustainability finance

ABSTRACT

Reducing greenhouse gas emissions requires sufficient and stable funding. Securing adequate financing for the environment, climate change, and sustainable development has been challenging, especially in low- and middle-income economies. The study analyzed the environment-related funding flows for Bosnia and Herzegovina from 2015 to 2020. The results show that the country received US$545.6 million in environmental finance in the five years. More than 99% of this funding was spent on water, energy, waste, and environmental management. In contrast, biodiversity, resource management, chemical safety, and environmental noise altogether received less than 1% of total funding.

1 INTRODUCTION

Achieving the transition to keep the planet within a safe operating space will require enormous financial support [1–3]. To keep the global average temperature rise below one and a half degrees Celsius in line with the Paris Agreement, governments will need to radically bend the greenhouse gas (GHG) emissions curves [4, 5]. Global decarbonization is estimated to cost around US$130 trillion by 2050 [6]. By 2030, US$93 trillion would be required to support the development of low-emission and climate-resilient infrastructure globally [7]. Societal transition to a world where GHG emissions will decrease from current levels is impossible without sufficient financial support.

Environmental finance lacks a uniform definition. In this study, it is defined as finance that covers a broad array of interconnected sectors, including environment, climate change, and sustainability in general [8]. Environmental finance has been especially difficult for low(er)- and middle-income countries (LMICs) as they cannot necessarily prioritize investing in climate change action and environmental management [9]. Moreover, private investors are reluctant to invest in developing countries due to socio-economic, political, and security risks and diminishing investment returns [10]. The reluctance of private investors and the lack of domestic finance make LMICs heavily reliant on bilateral and multilateral funding for environmental finance.

Development partner institutions (DPIs) remain crucial for public environmental finance in LMICs [11, 12]. DPIs include development agencies, development finance institutions, multilateral development banks, the European Union (EU) and other development partners (e.g., Green Climate Fund and Global Environment Facility).
Their support is usually provided to avoid carbon lock-ins and achieve the Paris Agreement goals [13], even when financial support and pledges do not always come as planned [14].

Ensuring that publicly provided environmental finance is identified and utilized effectively will maximize its impact on the ground [3, 15, 16]. Without an agreed definition of environmental finance and many DPIs operating in LMICs [17–19], it is hard to track environmental finance and its utilization [20–23]. Having better insights into publicly sourced environmental finance flows and structure (i.e., quantifying flows, identifying actors and mapping actors’ strategic focus) helps LMICs better position themselves to take advantage of new funding streams and opportunities [22]. To this end, public funding flows mapping provides LMICs with aggregate quantification of funding streams and an awareness of how much finance is mobilized and when, who is funding what, and what is targeted [11, 20]. Understanding the broader context of environmental finance supports LMICs in their relations with DPIs. DPIs can gain information on country-level investments of all other active DPIs and better prioritize targeting and spending their environmental funds. Finally, public funding flows mapping and identification of DPIs are essential for evaluating the effectiveness of the funding flows at different scales [20, 22, 24].

Since the end of the Cold War, the Western Balkans region, which borders the EU, has seen a significant inflow of bilateral and multilateral development aid (including environmental finance). Bosnia and Herzegovina (BiH) is one of the region’s biggest recipients of foreign financial assistance [25, 26]. Like other LMICs, environmental finance in BiH and the region depends heavily on DPIs [27]. Still, it is challenging to understand if the financial disbursements have been sufficient to achieve the required domestic priorities and international pledges [21]. Since a comprehensive repository of DPIs and knowledge about which sectors are prioritized for funding is lacking, planning to transition to a sustainable, less carbon-intensive future is difficult.

This paper aims to analyze environmental public funding flows on a case example of BiH in the post-Paris Agreement period (2015–2020). Specifically, the study seeks to quantify public (i.e., bilateral and multilateral) environmental finance-related financing flows for BiH from 2015 to 2020.

2 METHODOLOGY

The analysis is based on the information from International Aid Transparency Initiative’s (IATI) Country Development Finance Data [28]. IATI data is an open data source constantly updated with contributions of over 1,300 organizations (i.e., governments, multilateral institutions, private sector, and civil society organizations). The study performed an analysis of funding flows by year, policy area, and by the funder. The research also included funder mapping and funding priorities.

The downloaded BiH-specific dataset was limited to funding flows from 2015 to 2020. The year 2021 was not included since this research focused on completed annual funding cycles. The study included unfinished projects that might have started before 2015. Eligible types of transactions were disbursement and incoming funds, and
all funding flows were shown in United States dollars (US$). The funding amounts examined were provided at face value and constant prices.

After filtering by period and transaction type, the analysis selected funding data from sectors relevant to the environment and climate change. The original dataset included 183 sectors from primary health care, human rights, culture, industrial development to biosphere protection. To choose relevant funding flows, the study filtered the dataset using OECD’s climate change mitigation and adaptation markers (also known as Rio Markers). Furthermore, the environmental sectors listed in the Environmental Approximation Strategy of BiH and the seven key policy areas of BiH’s Environmental Strategy and Action Plan of Bosnia and Herzegovina (BiH ESAP 2030+) were taken into consideration. The study identified IATI sectors by examining a list of Rio Markers by sector/sub-sector and matching those insights to policy areas of interest for BiH outlined in the country’s Environmental Approximation Strategy and BiH ESAP 2030+. The selection of sectors was broad, extending from renewable energy across river basins development to forestry services. However, this resulted from BiH’s environmental, climate change, and sustainable development sectors’ priorities. The final selection resulted in 42 sectors, shown in Table 1. Funding data were merged according to sectors and analyzed in an Excel spreadsheet using the pivot table option, data filter, and several simple Excel formulas. Even though specific sectors could be linked to more than one policy area, the decision was made not to do this because it could lead to double counting of funding flows per policy area. The analysis did not analyze cross-sectoral funding flows (i.e., those financing more than one sector) but only the funding within 42 sectors in seven key policy areas (see Table 1). The study followed project classification as per IATI’s rules.

Table 1: An overview of included IATI sectors with corresponding key policy areas

<table>
<thead>
<tr>
<th>Environment, climate, and sustainability policy areas</th>
<th>Corresponding IATI sector</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water (including sanitation)</td>
<td>- Water sector policy and administrative management</td>
</tr>
<tr>
<td></td>
<td>- Water resources conservation (including data collection)</td>
</tr>
<tr>
<td></td>
<td>- Water supply and sanitation - large systems</td>
</tr>
<tr>
<td></td>
<td>- Water supply - large systems</td>
</tr>
<tr>
<td></td>
<td>- Sanitation - large systems</td>
</tr>
<tr>
<td></td>
<td>- Basic drinking water supply and basic sanitation</td>
</tr>
<tr>
<td></td>
<td>- Basic drinking water supply</td>
</tr>
<tr>
<td></td>
<td>- Basic sanitation</td>
</tr>
<tr>
<td></td>
<td>- River basins development</td>
</tr>
<tr>
<td></td>
<td>- Education and training in water supply and sanitation</td>
</tr>
<tr>
<td></td>
<td>- Agricultural water resources</td>
</tr>
<tr>
<td></td>
<td>- Flood prevention/control</td>
</tr>
</tbody>
</table>
### Waste
- Waste management/disposal

### Biodiversity and nature conservation
- Biodiversity
- Biosphere protection

### Air quality, climate change and energy
- Power generation/renewable sources
- Hydro-electric power plants
- Geothermal energy
- Solar energy
- Biomass
- Energy policy and administrative management
- Energy sector policy, planning, and administration
- Energy education/training
- Energy conservation and demand-side efficiency
- Energy generation, renewable sources - multiple technologies
- Solar energy for centralized grids
- Wind energy

### Chemical safety and noise
- Chemicals

### Resource management (composed from subsectors: soil, mineral resources, forests, fisheries, and hunting)
- Forestry development
- Fuelwood/charcoal
- Forestry services
- Fishery development
- Mineral prospection and exploration
- Coal
- Ferrous metals
- Nonferrous metals
- Precious metals/materials
- Industrial minerals
- Fertilizer minerals

### Environmental management and policy
- Environmental policy and administrative management
- Environmental education/training
- Environmental research

### 3 RESULTS AND DISCUSSION

The total amount of disbursed DPI’s funding to BiH in 2015–2020 for environment-related finance was US$545.6 million (for more details, please see Figure 1). The funding flows level varied significantly from year to year. The lowest funding received was in 2017 (US$30.1 million or 5.5% of the total), while the highest was
US$206.2 million in 2020 (37.7% out of the total). On average, BiH received US$90 million annually between 2015 and 2020.

Figure 1: Total environment finance to BiH 2015–2020, in US$ million

The analysis showed that seven policy areas (see Figure 2), water (US$300.6 million) and air quality, climate and energy (US$182.3 million) attracted 88% of the total environmental funding (US$545.6 million). The waste sector followed the funding trend with US$42.7 million (7.8%) and environmental management with US$19.9 million (3.6%). The three policy areas accounted for 96% of the DPI environmental finance funding BiH received in the post-Paris Agreement era.

The three least funded policy areas were resource management, chemical safety and environmental noise, and biodiversity and nature conservation. They jointly acquired only US$96,078 or 0.02% of the total funding.

In general, underfunded sectors in BiH reflect the global trends. Funding flows into global biodiversity conservation are two to four times smaller than governmental expenditures into other sectors and some other environmentally harmful practices [29]. Therefore, BiH’s IATI dataset findings imply that adaptation-related investments are of lesser priority to DPIs (compared to mitigation-related investments). The low amount of funding received for biodiversity, chemical safety and environmental noise, and resource management is alarming because these policy areas are crucial in supporting BiH’s overall future transition to sustainability.
The market matureness in BiH (including the ability of the different governance levels to understand the benefits of investments in nature conservation and resource management) is still at an early stage. The general interest of policymakers (and thus policies and financial mechanisms) to support different underfunded sectors has yet to be developed and enforced. Moreover, investments into these sectors might not be seen as attractive to BiH authorities (compared to, for example, water management and energy efficiency), thus not being high on the country’s agenda of interest. Initiatives such as BiH ESAP 2030+ set a positive example by including the neglected noise management in environmental strategic planning, pioneering an initiative that requires visibility domestically and among the DPIs [30].

The analysis of the funding data demonstrated that large-scale infrastructure projects (e.g., wind turbines and wastewater purification facilities) attracted more funding than projects that are not infrastructure intensive (e.g., potentials of fast-growing plantation forests). The main reason behind this trend is that mitigation-related investments are more cost-effective since more considerable emission reductions can be generated per dollar invested [31]. On the contrary, the primary aim of climate adaptation activities is to avoid or curtail the adverse effects of climate change (e.g., via reforestation, soil and water conservation). This is problematic for investors (including DPIs) because the benefits of the adaptation projects are not always easily quantifiable in financial terms and remain primarily for society. In contrast, costs are potentially carried by the investor [32]. On the contrary, mitigation-orientated investments focus on sectoral and cross-sectoral interventions (e.g., phasing out fossil fuels in electricity generation), reducing and offsetting GHG emissions. Investing in these projects is more straightforward because their financial effectiveness and return
on investment potential are easily quantifiable compared to adaptation-focused projects [9, 31, 32].

The analysis identified the following institutions as funders investing in BiH in the period 2015–2020 (in alphabetical order): European Bank for Reconstruction and Development (EBRD), European Commission, Food and Agriculture Organization of the United Nations (UN), German Federal Ministry for Economic Cooperation and Development (BMZ), Government of BiH, Green Climate Fund, Greenways, Italian Agency for Cooperation and Development (AICS), Government of the Netherlands, Slovak Aid, Spanish Ministry of Foreign Affairs and Cooperation, Swedish International Development Cooperation Agency (Sida), Swiss Agency for Development and Cooperation, UN Development Programme, UN Environment Programme, United States Agency for International Development (USAID), and World Bank.

The World Bank was the biggest provider of funding with US$188 million (34% of total funding), BMZ was in second place with US$155 million (28% of total financing), followed by the European Commission, with US$71.4 million (12.8% of total funding), and Sida with US$53.2 million (9.7% of total funding). These four funders accounted for US$465.3 million, or 85% of total financing (see Figure 3). The Government of BiH (including all administrative levels of state, entity, and district) ranked sixth, providing US$23.7 million. Nevertheless, this amount was not taken to further analysis because the Government of BiH is not a DPI, and the amount is co-financing for different projects.

![Figure 3: Funding distribution per funder for BiH’s environment, climate, and sustainability, 2015–2020, in US$ million](image-url)
4 CONCLUSION

A better understanding of environmental public funding flows provides multiple benefits to both funders and recipients of funding. Consolidated knowledge about funding landscape, flows and priorities can point to underfunded areas, help mobilize more funds and facilitate the development of necessary financial structures for receiving and distributing funding more efficiently and equitably.

The analysis showed that the water policy area received slightly over 50% of all funding. Air quality, climate change, and energy; waste; and environmental management policy areas received almost all remaining funds. The policy areas of biodiversity, chemical safety and environmental noise, and resource management obtained a minuscule funding share. The analysis further showed that the funders prioritized several particular sectors, whereas others were utterly neglected, and this situation might remain in the future. BiH could benefit from diversifying in environmental finance from funder and recipient perspectives.

BiH has considerable development needs (environmental sector included) and will require external support for environmental, climate, and sustainability projects to reach the Paris Agreement targets for 2030 and 2050. Decreasing air pollution, establishing a functional circular economy, and strengthening overall environmental management is no easy task. In addition to being expensive, it is a technically demanding undertaking and requires a lot of qualified human resources to support the effort. Consequently, it will not be easy for BiH to achieve these goals without international support, not because it is not capable of undertaking this task but because the transition to sustainability is systemic rather than incremental.

ADDITIONAL INFORMATION


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Energy security and sustainable development

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KEYWORDS - Energy security; energy stability; Sustainable Development

ABSTRACT
Sustained and stable energy development, with the availability of adequate types and quantities of energy sources, represents the basic setting for reaching and maintaining the desired level of energy security. The above represents an extremely complex phenomenon and as such is subject to evaluation, assessment and criticism by professionals and the general public. In addition, by its essence, sustainable and safe development is largely opposed to the traditional way of determining the directions and goals of development, which meant exclusively economically driven development. Conventional economic science was the only one that could predict, define and describe past, present and future development. In doing so, it was guided exclusively by traditional economic indicators, without considering the impact that development had on other aspects of society and the environment.

1. INTRODUCTION
Economic development was entirely based, first of all, on the depletion of natural resources, which are located in the observed country or in another location, which means that economic development inevitably led (and leads) to the degradation of the quality of the environment in all parts of the world, whereby the exploitation of a country's natural resources does not necessarily mean the economic development of that same country. The above complicates even more the issue of conceiving sustainable and safe development as a global concept that will be able to be implemented on the entire planet.

With the development of humanity, the need for energy resources is constantly growing. Without the consumption of energy, the development of society, as known to mankind, would not be possible. With the increase in the number of inhabitants and with the increase in energy consumption, the need for the exploitation of energy resources also grows. The issue of the ability to provide sufficient energy resources ceases to be technical and economic, and becomes a complex financial, social, political and security issue. Each country strives to provide sufficient resources for its needs and thus achieve its own development. On the other hand, countries that have energy resources have different development models, and become important factors on the geopolitical scene, or become and remain areas that have been exposed to unrest, political turmoil and war conflicts for decades.

Energy resources are unevenly distributed, especially crude oil and natural gas, on which all human activities are based. The use of coal is associated with high environmental pollution, renewable energy sources have not significantly contributed to the increase of energy security. The use of nuclear energy is a special issue that opens up a whole range of challenges and is not allowed in most countries in the world.
With the advancement of technology and the increase in consumption, the threats to the energy sector and the energy supply as a whole have increased. Technical problems, long distances, price fluctuations, specificities of energy sources (high flammability and explosiveness), possibility of accidents, increased intensity of transport - all of the above greatly complicates the issue of energy security, which is becoming a global geopolitical phenomenon. With the transition to the 21st century, new threats to energy security are emerging: cyber attacks, uncontrolled use of drones and terrorism.

Total energy consumption in the world is the subject of extremely complex monitoring and control, which has multiple goals. First of all, monitoring the total consumption of energy in the world is necessary in order to see the general situation in this area, to notice differences between individual regions, as well as to see trends and predict the future. Monitoring energy production and consumption requires extremely complex measurements, so more precise data can only be obtained after several years.

Organized precise measurements of energy consumption in the world have existed since 1965. After this base year, energy consumption in the world is characterized by three periods. In the mentioned base year, that is, in the first period (from 1965 to 1980), the world's energy consumption amounted to slightly less than 5 TW. Of the stated amount of energy, the largest amounts were provided by the exploitation of traditional sources (oil and coal), and in almost equal proportions. Twice as much energy was obtained from gas, and the least amount of energy was obtained from the exploitation of water energy. Even then, one percent of energy was obtained from the operation of nuclear power plants. After only ten years, at the beginning of the second period, energy consumption from oil doubled and reached its maximum in 1980. Energy consumption from coal is also growing, but it is somewhat slower and more even. The consumption of energy from natural gas is steadily increasing, which can be explained by the increase in the number of the population and environmental requirements. The huge increase in energy consumption from oil can be explained solely by the increase in the volume of traffic. In the mentioned period (from 1980 to 1990), energy consumption from water sources remains at the same level, and energy consumption from nuclear sources increases slightly, but not significantly in the observed period.

The third period begins in 1990 and is characterized by the beginning of a stable and even further growth of energy consumption from all the mentioned traditional sources. Energy consumption from oil and gas continues to grow steadily, while coal consumption stabilizes to some extent and even decreases by the end of the observed period. The consumption of hydro and nuclear energy remains at the level reached in 1990 and there are no significant changes until 2000, that is, until the end of the second observed period. At the beginning of the new millennium, moving into the third distinct period, the consumption of energy from oil and gas continues to grow at the same pace, with the fact that the consumption of energy from coal, after a decade of stabilization, starts to grow again. At the end of the third observed period, i.e. 2005, the total consumption of energy in the world amounts to less than 15 TW, which is three times more than the consumption recorded 40 years earlier.

The reasons for the increased consumption are numerous and complex, and the main ones are considered to be: the increase in the number of inhabitants, the
improvement of the needs of industry and traffic, inadequate consumption and poor indicators of energy efficiency. Regardless of the reasons, such a large consumption of energy, in addition to depleting the world's energy resources, has also led to significant environmental consequences. All of the above imposes the need for a strategic reorientation in the field of energy management at all levels, while taking into account the fact that energy consumption is extremely uneven in certain parts of the world.

It was the uneven distribution of fossil fuel reserves that led and continues to lead to major geopolitical changes, crises and armed conflicts on the world stage, whereby energy security definitely becomes one of the development priorities of all countries. The sensitivity of each country to the lack of energy (for any reason) is at a high level, with an increasing trend. The modern exposure of energy systems to new threats (cyber attacks) has led to the fact that energy security is one of the most complex problems faced by states, governments, regions and the world as a whole. The highest energy consumption was recorded in the USA, Canada, Norway and Saudi Arabia, which can be largely explained by the high level of technological development and living standards, as well as the intensity of traffic. Slightly lower values were recorded in Russia, Scandinavia and Australia. Compared to the first group of countries, European countries, Japan, South Africa and Argentina consume twice as much energy. They are followed by the countries of Eastern Europe. Even lower energy consumption was recorded in Brazil, and the lowest in the countries of Africa and the Far East.

Since the very beginning of technological development, energy from oil has been used the most, because a third of the world's energy needs are provided in this way. Somewhat less energy is obtained from the exploitation of coal, with a slight stagnation noted, which can be explained by the specifics of the technological process and the expansion of traffic, which cannot use coal as an energy source. About one-fifth of the world's energy needs are obtained through the exploitation of gas. The remaining amounts of energy are provided in proportionally the same amounts from biomass energy, nuclear energy and water flow energy. Exploitation of nuclear energy is limited to countries where such production is permitted. The least amount of energy is obtained from alternative sources. The world average value is shown, but it should be noted that it is significantly higher in certain countries and regions.

Taking into account the energy dependence of developed countries and the uneven distribution of energy resources, the production and distribution of energy has become a problem of special international political and economic importance over time. Energy in all its forms has become the subject of international trade, numerous disputes, conditions and military conflicts. Acknowledging the fact that the needs for energy on the planet are constantly growing, energy will occupy an increasingly important place in global economic and political changes. With the development of awareness and responsibility of individuals, countries and humanity as a whole, and with the aim of reacting to an increasing number of environmental problems, the concept of sustainable development was defined at the end of the twentieth century, which deals with the development of possibilities for solving them. The problem of providing sufficient amounts of energy represents one of the basic challenges of the concept of sustainable development. The concept of
sustainable development clearly breaks the trend of uncontrolled energy consumption and implicitly imposes the need for changes in this sphere.

The sustainable development of the planet implies, among other things, the gradual implementation of certain measures that drastically change the current approach to energy production and consumption, because they involve the development of new technologies, the application of new energy sources, the elaboration and implementation of comprehensive savings measures, the preparation and implementation of numerous legal lists, and all with with the aim of raising the level of energy efficiency, i.e. gradually stopping the trend of uncontrolled energy consumption, which inevitably leads to the rapid and total depletion of existing energy resources. The mentioned measures have a binding character for all countries that accept the concept of sustainable development and ratify numerous international agreements and protocols that regulate this area. The global nature of the energy problem, the need for economic development on the one hand, and the need to preserve energy resources and reduce pollution on the other, led to the requirement to define a special mechanism for achieving energy security and stability, which are imperative in planning processes at all levels, from companies, through regions, countries, to the international community as a whole.

2 ENERGY SECURITY AND SOCIETY DEVELOPMENT

2.1 Energy sustainability

Sustainable energy development, as a theory, concept and idea, represents a comprehensive framework for the development of humanity in the future, that is, an attempt to plan future development based on past experiences, on the one hand, and goals that are set for a specific or indefinite period of time. The basic subsystems of sustainable energy development are economic, ecological and social. The concept of sustainable energy development implies the need to see it and understand its complex and multidisciplinary, multidimensional and heterogeneous structure, which makes it one of the most complex, if not the most complex concept of social, economic, civilizational and any other development since the beginning of the world. Every human activity can be viewed from various points of view and evaluated on several grounds, but sustainable energy development as a starting point and the basic criterion of privacy imposes the need that the observed activity, event or material asset in no phase of its implementation, creation or consumption has a harmful effect on human environment. Sustainable development in the broadest sense represents the need to encourage and allow the performance of only those activities that do not leave harmful consequences for the quality of life of future generations.

Taking into account the different nature of human activities, the variety of energy resources, their exploitation and consumption, and taking into account the current and future contrasts in the degree of economic, social, cultural and institutional development, it is necessary to study certain aspects of sustainable development as separate phenomena, but also to consider their connection with all other sustainability parameters. Sustainable energy development represents a modern accepted concept of development that arose as a result of the fact that the development of civilization has
exhausted natural resources to such an extent that it has become unsustainable, and has called into question the perspectives of development and survival of future generations. Awareness of the need to preserve and restore natural resources has existed since ancient times, as evidenced by written monuments and oral traditions. In the early periods of development, people were much more aware of their own dependence on nature and treated it with appreciation and a certain amount of respect. With the increase in the population, geographical discoveries, the exploitation of colonies and the industrial revolution, man's interest in preserving the connection with nature suddenly ends, and its resources are constantly and without compensation depleted in the last two centuries.

Only after the Second World War, and especially after the first major environmental disasters that occurred in the energy sector (first in the transportation of oil by tankers), did citizens become aware of existing and future environmental problems. The concept of sustainable development was officially used for the first time as a possible development model in 1987 at the 42nd session of the UN General Assembly, in the report of the Commission for Environment and Development entitled "Our Common Future".

The commission was established at the 38th session of the General Assembly in 1983. The report is popularly called the Brundtland Report, after Gro Harlem Brundtland, Prime Minister of Norway, who chaired the historic session. The most frequently cited definition of sustainable development is the one given in the Brundtland Report: development should meet the needs of the present generation without compromising the ability of future generations to meet their own needs.

If development is defined as increasing well-being, then sustainable development means not reducing well-being over time. Energy production and consumption are recognized as one of the basic problems for which an adequate solution needs to be found. Namely, the Brundtland report proposed the concept of sustainable development, defining it as meeting current needs without compromising the ability of future generations to meet their own needs. Nevertheless, the exploitation of energy sources continues at an unabated pace, so it is highly questionable whether future generations will have enough energy resources available for their needs.

According to this concept, the distribution of energy resources that impoverishes future generations and aims to enrich the current generation is unfair and cannot be considered sustainable. The principle of sustainability emphasizes the existence of the freedom to use resources that future generations will be deprived of as long as their living conditions remain the same as those of current residents. In other words, preventing resources from being used by future generations represents a deviation from sustainability criteria if the living conditions of future generations deteriorate in this way compared to the previous ones.

Although there are different understandings of the meaning of sustainable energy development, the problem becomes more complicated when it is necessary to formulate a model for development and international relations. The normative content of economically sustainable development is defined in the requirements to preserve the natural conditions and environment for the normal life of the future generation. The following can be listed as implicit requirements of the concept of energy sustainability:
• Conservation of energy resources; Aspiration towards elasticity in the energy sector and/or stability of their characteristics (their ability to recover when exposed to shocks);
• Stability of the world energy market;
• Ending monopolies in the field of energy;
• Preventing energy poverty and
• Improving energy stability and security.

The complication of economic, energy and environmental issues, which are primarily a consequence of the rapid development of the industrially developed countries of the West, has influenced the acceptance of the understanding that the traditional economy cannot solve these issues adequately. If the volume of economic production increases, (as a result of the increase in energy and raw materials consumption, but also the increase in the number of inhabitants), it will necessarily use natural resources and ecological services to a greater extent.

2.2 Dimensions of energy stability

In order to more easily accept energy stability as part of development, it is first of all necessary to determine what is desirable from the aspect of stability and what should be strived for, in order to direct development activities in that direction. Defining the concept and essence of energy stability is a particularly big challenge because the list of acceptable and/or unacceptable activities or phenomena can never be final. Energy stability, especially in the most developed countries, which are leaders in this field, has taken on such broad aspects of observation that it is safe to say that energy stability can be sought in any phenomenon and activity that takes place in the sphere of obtaining, transmitting and consuming energy. Energy sustainability, unlike many qualitative measures, has a specific temporal, spatial, political, economic and civilizational dimension.

It is difficult to say that the mentioned dimensions of energy stability are once determined and unchangeable. The coming time will inevitably bring numerous new requirements, but it is still necessary to determine the specifics of these dimensions more precisely. The time dimension of energy stability implies respect for the time factor, which is extremely important in energy, which includes several ways of observing phenomena in the sphere of energy, which can be characterized as stable or unstable. First of all, the observation, study and appropriate evaluation of events from the near and distant past are carried out, in order to establish their consequences on the current situation and draw very useful lessons. The monitoring and control of all current phenomena is directly related to the past and most directly relates to the future. By the nature of things, energy stability implies performing adequate activities in the present and assuming how they will affect the energy situation in the future, because it includes what is most important - the prevention and timely prevention of all safety-unacceptable phenomena and activities.

The spatial dimension is based on the generally accepted fact that energy stability can and must be observed in every space. Each individual can and should find energetically sustainable and acceptable ways of behaving and acting in their
immediate environment and initiate their wishes and demands accordingly. At the level of settlements, areas, states, regions, etc. energy stability is observed, found and presented. Of particular importance is the understanding that energy stability must be viewed primarily from a global point of view.

The political dimension has especially gained importance and weight since 1990, and to a significant extent numerous changes on the political scene, misunderstandings and conflicts are connected with the growing uncertainty in the sphere of energy security of countries and regions. All the most developed countries of the world assess energy stability, both in their own country and in the region. In this sense, a special intensification of political interference in the determination of energy stability and all that it implies in the near and distant future is to be expected.

The economic dimension of energy stability is of particular importance, given that successful economic development and economic stability are of immediate importance for each individual and the country as a whole, and it is closely related to the possibilities for meeting energy needs. Bearing in mind the fact that the cost of energy is embedded in the price of every good and service, and that energy prices are often variable and subject to the influence of complex geopolitical changes, the question of the economic dimension in the sphere of energy security is particularly complex. The civilizational dimension of sustainability represents a sort of summary of all of the above and includes much more, so it is particularly difficult to define and almost impossible to limit, and at this point energy stability must be viewed integrally with the sustainable development of all other activities. Modern man has the right to live in an adequate living environment, which includes water, air, soil, flora and fauna. However, most importantly, a person's environment includes other people and their mutual relationships. It is relatively easy to determine physical and chemical parameters and establish what is energetically stable and what is not, and based on that to work out further procedures, especially when it comes to a certain energy technology or resource.

Facing numerous problems, misunderstandings, wars and intolerance, strongly influenced the development of the consciousness of a modern man who wants to lead life in a maximum quality way. A civilized man should not base his existence on the disappearance and destruction of his environment in order to satisfy his own, usually short-term and limited goals. Nevertheless, the modern world largely puts the mentioned dimension of development in the background and bases its priorities above all on its own needs, with energy security at the very top of the priority list.

2.3 The concept of global energy stability

The world community, as a whole, represents a special challenge in every respect. Differences in the level of economic development, political system, culture, religion and customs between individual countries and regions have caused different understanding of energy stability. Therefore, in order to study the aforementioned issue, it is inevitable to briefly review the historical development in certain parts of the world, given that events in the past have directly influenced the current level of development of environmental awareness, and therefore the understanding of energy sustainability.
Thanks to the achieved high level of economic development, the developed education system and the achieved level of responsibility and political maturity of the society, citizens - consumers openly express their demands, demand that they be answered and can opt for energy-friendly technologies, products or services. Legal regulation in the field of energy is developed and functional, stable business and trade arrangements for the supply of energy are the focus of political activities, so it can be said that the system in developed countries almost fully supports the concept of stable energy development. The countries of the European Union, the Scandinavian countries, the USA, Canada and Japan are absolutely leading in terms of emphasizing the importance of energy stability in all areas of life and work. On the other hand, there are a certain number of countries at an intermediate level of economic development, which are concentrated in Southern and Eastern Europe, which lag behind in terms of energy stability. The history of the development of these countries favored the development of a stable energy system until 1990, but after that, in the process of transition, a completely stable economic and political environment did not emerge, so energy stability was greatly disturbed.

Stable energy development represents a kind of desire and need to harmonize the energy development of mankind in accordance with the possibilities - energy resources in nature. Regardless of the comprehensiveness of the problem and the diverse situation in the world today and in the future, several basic concepts of the concept of stable energy development have been defined:

- The concept of non-decreasing energy wealth implies the preservation of both natural and acquired overall natural energy wealth;
- The concept of non-decreasing natural energy wealth derives from the previous one, and implies that natural energy wealth is kept constant, viewed as a whole and per capita, which should be considered especially when taking into account the constant growth of the population and
- The concept of elasticity, which would explain the reduction in the amount of individual energetic natural wealth, which is necessary and inevitable, and arises as a logical consequence of the increase in the number of inhabitants and their demands.

It should be emphasized that the mentioned concepts were gendered over time after the adoption of Agenda 21 at the UN conference in Rio de Janeiro in 1992. A little earlier, the basic assumptions about sustainable energy development were also developed, because the energy crisis was to a large extent the initiator of a change in the approach and way of exploiting nature by man. At the very beginning, there was an assumption or a requirement to fully preserve the energy wealth in the given current state. Consequently, it meant the cessation of further exploitation of energy resources and their complete conservation. In certain countries and in certain cases, the idea of completely stopping the exploitation of energy resources has been implemented, but only sporadic occurrences and negligible capacities are involved. Given the rapid increase in the number of inhabitants and the growing need for energy, the concept of undiminished natural and acquired wealth has been abandoned.

After that, recognizing the shortcomings of the concept of non-decreasing natural and acquired wealth, the concept of non-decreasing wealth was developed,
which takes into account the number of inhabitants on the planet. Namely, the concept defined in this way implicitly believes that every inhabitant of the planet must have a certain amount of energy wealth. The concept conceived in this way tried to eliminate the problem that arises in the case of the place of birth of the inhabitants, that is, it recognizes the fact that all natural resources belong to everyone, regardless of the place of birth or place of life. Regardless of certain civilizational progress, the concept defined in this way could not be sustainable for a long time, primarily due to the absolutely uneven distribution of energy wealth on the planet and the absence of the intention to introduce any changes in that field.

Currently, the concept of elasticity is considered the most acceptable, which recognizes the basic shortcomings of two previously developed and abandoned concepts of sustainable energy development. The concept was defined with respect for the inevitability that characterizes the global situation on the planet, and above all the increase in the number of inhabitants and the need for a superior quality of life that the inhabitants do not want to give up. In such a situation, there is a need to review the existing way of energy management, both at the global and local level. Implementation of minor or major changes in the traditional way of thinking, doing business and dealing with energy at all levels is inevitable. In a word, the concept of stable energy development, ie its basic principle from which all others are derived, is based on the principle of intergenerational justice, which means meeting the energy needs of current generations without jeopardizing the ability to meet the energy needs of future generations. In other words, the current generation has an obligation to leave to its successors at least the same energy situation as it found itself.

The basic concept of stable energy development can be derived on the basis of various criteria, but they can generally be reduced to the following:

- the principle of preserving existing non-renewable energy resources, whereby, depending on the type, quantity and quality of available resources, as well as the needs and possibilities in the specific area, considers the most acceptable way of conservation of existing resources, that is, permanent reduction of the intensity of their exploitation;
- the principle of exploitation of renewable energy resources, which to a certain extent replaces the use of non-renewable resources, and enables the use of energy in areas that are insufficiently rich in traditional energy resources, i.e. in hard-to-reach areas;
- the principle of energy efficiency, which implies efficient and economical handling of energy in all phases of its existence, from energy accumulated in resources, through efficient production, distribution and consumption, to the promotion and support of the production of goods that consume less energy than the same or similar goods on me;
- the principle of intergenerational justice, whereby all energy development plans incorporate an energy management rule that will enable future generations to meet their own energy needs;
- the principle of harmony between economic development and energy consumption, which determines the mentioned development, as a particularly
sensitive principle, the realization of which is fraught with a large number of problems, because it imposes the need to change the traditional way of thinking. Namely, economic growth was seen as the only measure of the progress of each country and only indicators of economic growth were authoritative and available for determining the situation in a particular country and its position in the international community. The need for sustainable energy development imposes the acceptance of a new principle, according to which it is necessary to consciously stop economic growth if it leads to excessive depletion of primarily energy and all other resources;

- the principle of paying for damages caused by excessive and inadequate use of energy resources, which opens the possibility for all countries of the world and all economic entities to understand the importance of adequate energy management, and to assume the obligations arising from it and bear responsibility if they do not fulfill the assumed obligations;

- the principle of measurability, is derived from the need for sustainable strategic management, which is only possible if during the process of planning, implementation and evaluation one operates exclusively with goals and data that are strictly and exactly measurable. Arbitrary and general definitions, plans and goals are not able to provide a true picture and enable adequate application of all available sustainable energy management tools and

- the principle of promotion and education, which imposes the need for continuous promotion of sustainable energy management. Exclusively thorough education that begins at the earliest age enables the creation of conditions for long-term responsible handling of energy and for the acquisition of benefits in the future, which is not limited.

The stated basic principles of energy stability indicate the basic framework needed for planning and implementing sustainable energy management and represent a specific framework within which energy management can be implemented. Energy stability and long-term energy sustainability are made possible exclusively by observing the aforementioned basic principles.

3 CONCLUSION

Energetics are one of the basic drivers and prerequisites for the development of humanity. Energy security, as well as all other measures and goals of the energy policy as a whole, should be aligned with the concept of sustainable development. Sustainable development represents a comprehensive concept of development that was adopted with the aim of preserving the planet's resources to the extent that will meet the needs of current generations without jeopardizing the ability of future generations to meet those same needs. When it comes to energy sources, the concept of sustainable development is particularly complex, comprehensive, multidimensional, multidisciplinary and opens up possibilities for different models of its application in practice. Studying the concept of sustainable and safe energy development implies consideration of a whole series of problems, mechanisms, solutions and critical attitudes. Currently, there is no single concept of sustainable and safe energy
development that can be universally applied in all areas of human activity around the
world, so it is necessary to study it in certain sectors that are of special interest for a
certain spectrum of problems.

Since the emergence of modern man, and especially with the progressive
development of human activities, there has been a need to provide and consume a
certain type and amount of energy. Every activity is connected with the consumption
of energy, which is generated, transmitted, transformed and consumed according to
clearly defined laws and ultimately results in the transfer of a certain value to the
finished product or other effect of human work. Energy production and consumption
represent a special problem of the modern world for several reasons. First of all, with
the increase in the population, the need to provide sufficient amounts of energy also
grows proportionally. Considering the nature of population growth and the
impossibility of stopping the said growth trend, the problem of providing energy for
all human needs becomes constant and global.

Energy needs are very different in certain parts of the world. Since the beginning
of the industrial revolution (the end of the 18th century), countries that are at the highest
level of development have recorded the highest consumption of energy. The
consumption of large amounts of energy brought these countries a significant economic
advantage, but also created a constant need for more energy, and the aforementioned
countries face the constant challenge of providing sufficient amounts of energy for the
functioning of all elements of society. On the other hand, in countries at a lower level
of development, energy consumption ranges in a wide spectrum, from minimal to
medium significant, but from a global point of view it cannot be considered secondary.
Energy security is essentially the ability of a certain country to provide enough energy
for its own consumption. Therefore, energy production and consumption are two key
indicators of energy security. Energy consumption in the world can be defined and
monitored on several bases, with the most acceptable being energy consumption in the
total amount over time, in certain regions, as energy consumption from certain sources.

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Electric power system as a critical infrastructure for the Green Deal transition

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KEYWORDS - Electric power, transition, grid, green economy.

ABSTRACT
The development of the green economy in the second half of the 20th century is one of the key instruments for achieving sustainable development, for the protection and preservation of natural resources. For today's phase of human development, we can thank the current, and from that comes the electricity system is the most influential. Without electricity, almost everything would have stopped. You couldn't cook lunch, your food in the fridge would break down. Traditionally, the industry has focused on increasing productivity that will provide growing capital and a greater workforce, thereby enabling economic growth. The industrial revolution that led to the pollution of the economy led to the necessity of new production methods that are most often defined as resource-effective and socially applicable in various segments of the green economy. The green economy cannot be considered a substitute for sustainable development, but as a way of achieving such development at the national, regional and global levels.

1 INTRODUCTION

Electrical networks, as an important phenomenon of the utilitarian part of modern civilization, by its physical structure, way of functioning, spatial distribution and human relationship to it, fall into the category of large technical systems. A comprehensive mathematical model of the behaviour of a large electrical grid cannot be achieved due to today's imperfections, lack of capacity, and often the slowness of the computer machinery at our disposal. For the primary power grid as a system to function in the first place, it must "live" in a multi-subsystem symbiosis. These are subsystems for automatic protection against faults and interference, for measuring electrical and non-electric sizes, for automatic regulation of voltage and frequency, for data transmission and processing, and ultimately a working man with his intellectual and physical potential.

Therefore, for the design of the power grid, it is necessary to pay attention to a number of factors without which such a system could not function. From the production of electricity itself, through its transformation, transmission and construction of portable systems, to connecting to other power systems and powering the final lawnmower with this kind of energy.

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1 This designation is without prejudice to positions on status, and is in line with UNSC 1244 and the ICJ Opinion on the Kosovo declaration of independence.
Green economy development in the second half of the 20th century is one of the key instruments for achieving sustainable development, for the protection and preservation of natural resources, to ensure the economic evaluation of the ecosystem of services and goods, to reduce poverty, to create opportunities for job creation and for decent work and to start the world in the direction of development with reduced levels of carbon dioxide emissions.

The green economy is one in which income and employment growth is generated by investments that reduce carbon emissions and/or increase ecosystem efficiency and biodiversity. Overall, on the other hand, the Western Balkan countries are poor and small, but with enormous potential for green economic application, sustainable development and environmental entrepreneurship. In this context, the aim of the work is to point out the possible directions of establishing a balance between social and economic development and environmental protection, and thus to emphasise the importance of building a long-term sustainable economy whose concept is based on economic development in line with environmental grounds, and for this purpose the method of case study will be used.

2. ELECTRICITY SYSTEM

The energy system consists of production, transmission, distribution and consumption of electricity. The basic task of the electricity system is reliable and quality electricity supply. This includes the production, transmission, distribution and consumption of electricity. When electricity is produced at power plants, it is handed over to consumers. Settlements, cities, cuts and the entire state are intertwined with power lines. The power system is the largest, most influential, most necessary, most prevalent of all technical systems. So it's the most expensive technical system. It's the biggest because it permeates entire countries and continents. The largest power system is UCTE, which electrically connects 24 European countries with a total population of about 500 million. (UENSCO, 2011)

For today's phase of human development, we can thank the current, and from that comes the electricity system is the most influential. Without electricity, almost everything would have stopped. You couldn't cook lunch, your food in the fridge would break down, your lights would go out, mobile communications would stop, you couldn't talk on your mobile phone, connect to the Internet, watch TV. After a while, the water would run out because the water in the water pumps is powered by electric pumps. Many other benefits provided by electricity would cease. That's why electricity is most expensive when it's gone. (Radivojevic, 2018: 52)

The most prevalent is the power system, which comes from its size. The only system that could be compared to the power system is the Internet, but the power system is more widespread than it is because there are places where electricity is available and the internet is gone. To connect to the Internet, you must have electrical infrastructure in most cases.
2.1. Power system as critical infrastructure

Critical infrastructure facilities are vital facilities for each state, so protecting their safety is of paramount importance. Primarily telecommunication facilities, electricity generation and transmission facilities, storage and transport of oil, gas and other derivatives, water supply, traffic, facilities of vital state institutions, etc. Protecting critical infrastructure facilities is a complex system of security equipment, people and procedures that must be respected in order to keep security at an appropriate level.

The first line of security of critical infrastructure facilities is perimeter protection, and is protected by a combination of anti-burglary systems and video surveillance with intelligent video analytics. IR "beam" detectors, or sensor fiber optic cables, divide the entire perimeter into a number of sectors, behind which fixed cameras are installed for sector monitoring of the perimeter. Their work is accompanied by a moving camera, which in case of a breach of the building's security monitors the continued behaviour of a potential attacker. Video analytics in this case plays an important role in reducing the number of false alarms.

By monitoring the movement of people and production processes on critical infrastructure facilities, we control compliance with procedures, whereas in the event of a fire or other critical situation, we use the video surveillance system to verify alarms obtained from other systems, and to evacuate people as efficiently as possible. Large-scale evacuations are time-consuming and the situation can quickly become dangerous if panic occurs. Clear announcements help keep coordinated evacuations fully under control.

During rotation, generators generate electricity with a voltage of up to 25,000 volts. However, after production in the generator, electricity passes through the transformer located in the power plant, which changes its voltage from the lower voltage at the transformer inlet to a voltage of up to 1,500,000 V at the output of the transformer because the higher the transmission voltages, the more efficient the transmission of electricity.

Cables and power transfer cables are made of copper or aluminum because they are materials that have little electrical resistance. The reason is that greater electrical resistance causes more heating of conductors, and because of the resistance of the power line or its conversion into thermal energy, a certain amount of electricity is lost. High-voltage power lines carry electricity to large, high-voltage transformer stations where it is transformed from the highest to the slightly lower voltage and then leads to transformative stations located near industry and households. These substations are called distribution (distribution) transformer stations and in them electricity is still converted into even lower voltage, into medium voltage. (Mitrovic, 2020: 125)

3. DEVELOPMENT AND IMPORTANCE OF GREEN INDUSTRY

Traditionally, the industry has focused on increasing productivity that will provide growing capital and a greater workforce, thereby enabling economic growth. The Industrial Revolution began in the mid-17th century in Britain. It started when the
machines started replacing manual labor. Fossil fuels have replaced wind, water and wood as energy sources, and human activities on Earth have changed the natural greenhouse. The Industrial Revolution marked a major milestone in Earth's ecology and human relationship to the environment. It dramatically changed every aspect of human life and lifestyle, as well as the impact of the industrial revolution on the world environment only began to register in the early 1960s. Over time, the burning of fossil fuels such as coal and oil increased the concentration of atmospheric carbon dioxide (CO2). This is because the process of burning coal or oil combines carbon with oxygen in the air to create CO2. (UNESCO, 2011)

Also, to a lesser extent, soil clearing for agriculture, industry and other human activities has increased the concentration of greenhouse gases. There are four main points of impact of industrialisation, which are air, water, soil and habitat pollution (Folk, 2018). The biggest problem is air pollution caused by smoke and emissions from the burning of fossil fuels. Although a series of regulations on various toxins found in industrial pollution, from asbestos and dioxins to lead and chromium, industries remain among the worst air pollution generators in the world. Water pollution is also a problem in these areas, especially in regions where factories are built next to water sources. Toxins can come in different forms - solid, liquid or gaseous, and can all contaminate local water supplies. Even landfills can excrete toxins. (UNEP, 2013: 36)

Soil pollution is another problem that goes hand in hand with industrialization. Lead is the most common form of land contamination, but other heavy metals and toxic chemicals can also penetrate land and contaminate any crops growing on the ground. Finally, industrialization led to the dramatic destruction of habitats. Forests are cut for wood, and ecosystems are destroyed to create pathways, mines and gravel pits. The destruction of these habitats disrupts local ecosystems and leads to the extinction of plant and animal species if the species are not able to move or adapt to their new environment.

However, CO2 is not only a greenhouse gas that generates high levels of pollution, but also nitrogen oxide (N2O) and methane (CH4) emissions, which are also growing rapidly through agricultural, energy and industrial sources. Like CO2, their concentrations are also rising sharply. Although progress appears to have been made in global emissions, atmospheric concentrations continue to rise. But CO2 stays in the atmosphere for the longest of all greenhouse gases. It takes about ten years for methane emissions (CH4) to leave the atmosphere and about a century for nitrogen oxides (N2O) (Union of Concerned Scientists, 2017), which would mean that the emissions we release today from our cars and power plants determine the environment that generations will have. CO2 levels were fairly stable at 270-285ppm (parts per million) until the 18th century, and since the industrial revolution, global concentrations have risen rapidly. (Bačković, 2017: 69)

3.1. Development of green industry

The green economy, as a low-carbon, resource-efficient and socially inclusive economy, is increasingly being embraced as a key driver in the fight against climate change, poverty, pollution, health and any key goal of improving life. Unfortunately, today no country in the world can be a role model for achieving decent human
development within the capacity of the Earth. During the 18th century, as the industry evolved, there was a lot of speculation from meteorologists who warned of rising temperatures, but because the changes were small and under-explored, no one could point to them with certainty. (Manic, 2020: 214)

Over the last 20 years, economic growth has helped pull nearly a billion people out of extreme poverty, but unfortunately growth has come at the expense of the environment. Thus, over time, concepts such as green growth and green economy were introduced, which will represent the development of a new era, where the economy is sustainable and built in accordance with the country's capacities. In 2009, during the economic crisis, which was a "wake-up call", a conference was held in Copenhagen where 34 OECD member states signed the so-called "Declaration on Green Growth" (OECD, 2009).

Also, green growth will be relevant and overcome the current crisis, addressing pressing challenges, including fighting climate change and degrading the environment, improving energy security and creating new drivers of economic growth. The crisis must not be used as an excuse to delay key decisions for the future of our planet.

### 3.2. Protection of critical infrastructure

Modern electricity system is a very complex technical whole, unique in terms of size and importance for people's lives. Given the physical characteristics of electricity and the typical high speed of electrical processes, control of the operation of such a facility is a complex task from an organizational and technical perspective. Therefore, devices designed for automation and protection of energy equipment appear almost at the same time as the energy industry. Today's Protection, Automation and Control System (PACS – Protection, Automation and Control System) is a complex set of interconnected information systems that cover all areas of operation of power facilities. The rapid development of computer and communication technologies has changed the system of protection and automation of electricity components. In addition, new control functions integrated into modern protection and automation systems change the principles of building electricity supply network facilities.

Improving the quality of control is one of the main tasks of future development of electricity and the transition to Smart Grid systems. Control systems therefore play a key role in the production, transport and distribution of electricity.

Today, PACS systems are highly integrated and use digital communication technologies based on open international standards, such as IEC 60870, IEC 61850 and IEC 61970. Integration of separate subsystems has improved the capabilities of the protection and control systems, making them more intelligent and efficient to use. In addition, common standards have significantly reduced integration costs and provided a higher degree of reliability for functionality.

The high level of openness and integration of power systems, combined with the penetration of ITs and internet technologies in everyday life, has raised new challenges for the electricity sector. Modern automated protection and control systems for power facilities are integrated distributed computer systems that communicate through open protocols. In such systems, cybersecurity is a low priority, as electricity control systems are constructed as isolated solutions. However, for modern control systems, which are
globally integrated and connected to corporate services, the risks to cybersecurity are very high.

4. GREEN ECONOMY AS VISION OF DEVELOPMENT

International Labor Organization ILO, Global Sustainability Panel, Green Growth Leaders, Global Green Growth Institute GGGI), Green Economy Coalition (GEC), consulting organizations, universities and sections of the business community itself. More recently, the green economy stands out as a generally accepted concept, mindset and business model. The concept is quite complex and made up of various initiatives and as such, it occurs at all political, management and entrepreneurial levels and includes research and development of new technologies, new policies and directions of thinking, the creation of completely new paradigms, lifestyles and habits. Green economy is a concept with principles embedded in the economic, social and environmental domain. Overall, the green economy is niving on the following five principles: (UNESCO, 2011)

1. Welfare – a green economy must lead to true, sustainable and common well-being, which transcends mere monetary wealth, prioritising human development, happiness, health, education and community;
2. Justice – the green economy places emphasis on equity, equality, community cohesion, social justice and the upholding of human rights – in particular the true margin of alkaline and vulnerable groups;
3. Planetary boundary - the green economy recognizes that mankind's entire progress depends on a healthy natural world. It defends the functions and limits of nature, protects biodiversity, soil, water, air and other components of the ecosystem;
4. Efficiency and sufficientness – green economy is low-carbon, diversified and circular. It recognizes that our only economic challenge is the need to create prosperity within planetary boundaries and to align economic incentives with the true costs to society;
5. Good governance – the green economy builds institutions that combine dynamic democratic responsibility, relevant metrics, sound science and local knowledge. Civil society benefits from public participation, social dialogue, informed consent, transparency and accountability.

4.1. The concept of green economy

The concept of a green economy is linked to several different economic theories, concepts, practical approaches and assessment tools that can be integrated into a single holistic framework, as shown in figure 1. Based on explicit explanations of all concepts and their multiple intertwining, the framework is imposed as a kind of "heuristics of the green economy. The concept of a green economy is rarely linked to ideas such as "low-carbon growth" or "green growth" where, in the context of the green economy, the notion of growth implies not only growth in economic output but also refers to "sustainable economic progress". (Radivojevic, 2018: 85)
Green growth, as an important component of sustainable development, is about making growth more resource efficient, cleaner and more resilient without slowing down. Overall, green growth policies involve introducing environmental factors in economic decision-making by introducing resource efficiency considerations, transforming energy systems, evaluating natural capital in economic calculation, and determining the cost of environmental effects. In addition to increasing ecosystem resilience and strengthening the quality of the environment and ensuring the sustainability of agricultural and food systems, green growth policies carry with them a wider range of economic benefits such as: (Radivojevic, 2018: 90)

1. improved performance of production processes and new improved products;
2. innovation and structural changes in the economy, which would be accompanied by the emergence of new industries, products, services and new business opportunities globally, as well as overcoming technological blockade, especially in relation to infrastructure;
3. fiscal consolidation, for example, by reviewing the composition and efficiency of public spending and increasing revenues through pollution pricing,
4. investor confidence through greater predictability and stability of the way governments deal with the main issues of environmental and development protection and
5. more balanced macroeconomic conditions and reduced volatility in resource prices.

4.2. The need for a green economy

The transition from a "brown" carbon-based economy, which is embodying with CO\textsubscript{2} emissions, to a "green" economy with very low CO\textsubscript{2} emissions, has caught the attention of policymakers in advanced capitalist and emerging economies over the past two decades. It is necessary for each country to have a long-term plan for developing a green economy with clearly defined and prominent priority areas. In underdeveloped countries (as are western Balkan countries) the challenges are incomparably greater precisely because of the deficit of adequate resources (knowledge, technology, funding and public support) which cannot be simultaneously initiated in all areas of development. (Mitrovic, 2020: 45)

Special attention when it comes to the green economy in the Western Balkans deserves the energy sector, which faces a single double transition, as an unprecedented challenge in history: the transition from centralised systems under state control to open and competitive markets, as well as the transition to decarbonisation. It could be said that energy systems play a key role in constituting an economy of prosperity and could be the engine of greater co-operation and security in the region. Improving energy efficiency and increasing the share of sustainable renewable energy offer a number of advantages and could underscore progress in the following areas: (UENSCO, 2011)

1. Prosperity – Investing in renewable energy sources creates additional value at the local level and jobs that are safe for the future. Rising energy efficiency also leads to increased efficiency of the entire economy, while investment in technologies of the future improves the long-term position of western Balkan
It is estimated that a successful energy transition in the region could lead to an increased cumulative economic output of around 430 million euros by 2050;

2. Resilience – Modern energy systems with decentralized energy production from renewable energy sources, which are connected to efficient networks, have greater resistance to external shocks, where dependence on imports of fossil fuels is subsequently reduced. Avoiding "stranded" assets - energy infrastructure that must be abolished before it can be written off. Reducing air pollution is hurting the health of the population;

3. Regional integration and conflict prevention – The energy transition in WB 6 will work better if the power grids are connected to each other across state borders, cross-border fluctuations in wind/solar availability are balanced and storage capacities are used, which is a significant boost for closer co-operation in the region, which rather leads to potential conflicts;

4. Closer ties with the EU – A clean energy transition offers many material possibilities for closer cooperation between companies, research institutions and governments on both sides and

5. Climate Action - The European Green Agreement (EGD - European Green Deal) envisions Europe as the first climate-neutral continent by 2050 and aims to build a circular economy. However, the EGD and its geopolitical ambition would require EU external actions to fully align with its climate ambitions, especially in the Western Balkans region. In particular, hydropower in the Western Balkans has proved environmentally destructive, vulnerable to climate change and has so far been over-exploited and supported. In the coming period, it is necessary for the governments of these countries to abolish incentives for mature technologies such as hydropower and equally encourage the use of all types of renewable energy.

5 CONCLUSION

The industrial revolution that led to the pollution of the economy led to the necessity of new production methods that are most often defined as resource-effective and socially applicable in various segments of the green economy. The green economy cannot be considered a substitute for sustainable development, but as a way of achieving such development at the national, regional and global levels. Simplified, a green economy can be considered economic activity that is carried out with low carbon emissions, through which resources are efficiently spent and which is socially inclusive.

Overall, western Balkan countries lag behind in environmental protection relative to a large number of countries in Europe and the world, mainly due to air pollution, neglect of water resources and inadequate waste management, as well as threats to the impact of climate change in the near future. Unfortunately, economic policymakers in these countries have embraced the wrong and counterproductive mantra under which environmental protection must wait for better (richer) times.
The green economy should be seen as a universal and transformative change to the global status quo, which will force a fundamental change in government priorities. Achieving such a change is neither easy nor simple, but it is necessary for the Western Balkan countries if they are to reach the basic sustainable development goals (SDGs). In order to put the green economy in service of achieving sustainable development goals, it is necessary:
(1) ensure significant participation of all groups throughout the process,
(2) fight inequality and to eradicate poverty and
(3) move quickly towards a just transition that protects the planet for both present and future generations.

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Digitalization as a driver for circular economy

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ABSTRACT

This paper presents the importance of digital technologies for designing and implementing circular economy. Existing technologies are analyzed, with their advantages that represent a central role in circular economy innovations. In particular, the Big Data and Internet of Things technologies make a great contribution to the development of circular business models. It is necessary to create one business system that would network all companies around the world. The secure exchange of information would be enabled this way. Creating circular business models depends on the development of digitalization. The circular economy without a digital basis is much slower, which reduces the economic growth and development of our planet.

1 INTRODUCTION

Circular economy represents the circular motion of energy and matter as opposed to the linear economy which represents the motion of energy and matter in one direction [1]. The development of a circular economy requires long-term investment in raw materials and energy efficiency, with the replacement of fossil fuels with renewable sources, thus reducing harmful effects [2].

The predominant parameters for which companies compete are innovation and quality rather than price [3]. All of this has been influenced by the digitization process. In the last few years, the circular economy has received growing attention on advocacy, consultancy, science and policymaking [4]. This paper aims to show that innovation, digitalization and the use of new technologies can facilitate and accelerate the introduction of circular economy models in the world, which would affect the conservation of resources and the environment.

2 DIGITAL BACKBONE

Author Jensen in his paper on the circular economy and digital transformation of business argues that digitalization is critical to creating a global circular economy [5]. In order to support global circularity business models and develop circularity as soon as possible, it is necessary to build coherent digital foundations and digital
backbones [5]. Studying their analysis, it can be seen that digitalization is the key factor in solving this problem. Without the Internet, which is the basis of the development of digitalization, the circular economy would be much slower.

In the picture below (Figure 1), 5 characteristics of a digital backbone which influence the formation of circular business models are described.

Figure 1: Circular Economy- five characteristics of a digital backbone (Jensen, 2021)

3 DIGITAL TECHNOLOGIES

In his work, author Pagoropoulos describes three architectural layers throughout the review process: data collection, data integration and data analysis. The data collection distinguishes between Radio Frequency Identification (RFID) and the Internet of Things (IoT). RFID uses electromagnetic fields for the identification process and contains an RFID chip through which networked RFID systems obtain complete product information. The authors point out that IoT for data analysis and their routing from different sources through the data-to-service process is very important for the development of the Circular Economy. [6]

One of the applications of IoT in the circular economy is described in the work of the authors where they described a method that facilitates the Internet of Things (IoT) for data exchange and building a product passport. They believe that the promise of scaling huge numbers to billions of devices and items are the greatest potential of The Internet of Things (IoT). [7]

For data organization, optimization of stock and material flows, Relational Database Management Systems (RDBMS) and Product Lifecycle Management (PLM) systems are used. The figure 2 shows that one of the three architectural layers is data
analysis (machine learning, artificial intelligence and big data analytics). The application of the statistical model along with the machine learning techniques affects the circular economy through parameters: cost, time and resource constraints related to the decision-making problem [8]. The application of machine learning algorithms such as Neural Networks relies on processing large amounts of data while striving to optimize the entire system [9]. Cost and power estimation process in the circular economy improve artificial intelligence techniques [10].

The contribution of the work of the author Bag lies in the statistical validation of the theoretical framework, which provides their effects on the adoption of big data analytics-powered artificial intelligence. It is described how this affects sustainable manufacturing and how organizational flexibility and industry dynamism affect the development of the circular economy [11].

The Global Circularity Gap Report aims to realize a global circular economy and is an annual report measuring the state of circularity. The global economy is only 8.6 per cent circular according to The 2021 Circularity Gap Report. It is aiming to become 17 per cent circular by 2030 by targeting sectors with high potential for change. [12]

Startups and emerging companies analyzed the impact of the top 8 circular economy and innovations in 2022. Based on Figure 3 and their analysis, we can conclude that the greatest impact on the circular economy for 2022 has Waste-to-Resource with 35%, while the smallest impact has Repair at 4%. Startups are working on waste upcycling solutions and getting rid of the waste effectively as well as providing an additional stream of clean energy for power utilities. They are developing IoT-based smart waste management solutions which use sensors, IoT platforms, and mobile applications. [13]
Blockchain is one of the top emerging trends because it enables important functions in the circular economy which are providing transparency and traceability, as well as incentivizing circular behavior. Repair solutions offer a much cheaper alternative for companies but products often become unfit for reuse. [14]

CONCLUSION

This paper aims to highlight the importance of digitalization in the process of circular economy and to present appropriate techniques that can improve existing business models. The information technologies described in this paper have wide usage in various areas, are developing very quickly and are finding their application. It is indisputable that they have a positive impact on the development of the circular economy, and in order to achieve the best possible circularity in business, the cooperation of both international organizations and local and national organizations is necessary. Forming a platform for the circular economy is proposed in order to create partnership between institutions, the private sector, educational institutions, the creative industry et cetera [15].

It would be interesting to examine the application of such technologies in companies, in order to statistically show the current situation in the world and their contribution. This way, the problems which companies face while adopting digitalization for the development of business models could be perceived. Further research may be aimed at resolving this issue.

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Waste management in the circular economy - regional landfills in the territory of the region of Vojvodina, Republic of Serbia

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KEYWORDS - Circular economy; waste management; landfills; Republic of Serbia

ABSTRACT

The main goal of the work is the display of waste management, with an emphasis on landfills. Inadequate disposal of waste in unsanitary landfills and landfills can have a significant negative impact on the environment and human health. There is an immediate impact on the air, underground and surface water, soil. Waste is a loss of matter and energy, its collection, processing and disposal requires a large amount of additional energy and manpower. The most polluting substances emitted from landfills are nitrogen and sulfur oxides, dust and heavy metals, landfill gas. Unpleasant odors are also emitted, which have an impact on the quality of life around the landfill. Precipitation that is filtered through the mass of deposited waste dissolves harmful substances, thus polluting the soil and groundwater. An additional problem is that soil pollution does not have an exclusively local character, but leads to the pollution of soil and underground and surface water in a wider area, and indirectly to endangering flora and fauna. As an additional problem, there is the pollution of the surrounding soil by waste carried by the wind. Waste management is the implementation of prescribed measures for dealing with waste within the scope of collection, transport, storage, treatment, and disposal of waste, including the supervision of these activities and the care of waste management facilities after closure. Proper waste management protects human health, the quality of the environment and conserves natural resources. National waste management strategy adopted on July 4, 2003 by the Government of the Republic of Serbia. The National Strategy envisages the formation of multi-municipal regions and the construction of regional landfills with transfer and recycling stations in municipalities. The national municipal waste management strategy defines the proposal on the formation of regional landfills on the territory of AP Vojvodina, based on the territorial principle and the number of inhabitants. The study of the spatial distribution of regional landfills and transfer stations in the area of AP Vojvodina is divided into 3 phases: 1. Determination of criteria for locating regional landfills and transfer stations in the area of AP Vojvodina, 2. Determination of potential locations of regional landfills and transfer stations and 3. Proposal of measures and activities for the realization of the proposed locations.

INTRODUCTION

A landfill (garbage dump, landfill) is a place for disposing of waste materials, by collecting waste at one location and burying it (which is the oldest way of disposing of waste). At some landfills, waste selection and recycling can be carried out. Nowadays, waste is usually classified according to the type of waste that is disposed of.
Landfills can be engineered and prepared to utilize liquid products or gas that occurs within the landfill itself, through the decomposition of organic waste. Modern landfills must have at least one cover layer, consisting of compacted clay with the minimum necessary thickness for maximum hydraulic barrier. In larger landfills, there are waste compactors that are used to save space.

The municipal waste management region represents one functional unit. For the formation of a region, the basic assumptions are the number of inhabitants, the number of municipalities and settlements and their mutual traffic connections. According to the provisions of the National Strategy, the region should include an area with at least 200,000 inhabitants, there should be traffic connections within the region, the longest transport length between the transfer station and the regional landfill should not exceed 80 km. The region should be formed to enable the organized coverage of at least 80% of the waste that is controlled. These elements form the starting spatial-functional framework for the establishment of the region, in order for it to be sufficient, it is necessary to define the criteria for establishing the region, the legislative, legal, institutional, organizational and economic prerequisites for the formation of the region.

2. CHARACTERISTICS OF AP VOJVODINA AND DETERMINATION OF CRITERIA FOR THE SELECTION OF MACRO LOCATIONS FOR REGIONAL LANDFILLS

The autonomous province of Vojvodina occupies the southern parts of the great Pannonian plain. It borders Hungary to the north, Romania to the northeast, Croatia to the west, and the Sava and Danube rivers to the south.

For determining the region and macrolocation of regional landfills from the perspective of the population, they are:

- the region should include at least 200,000 inhabitants,
- the regional landfill should be located near the largest generators of waste within the region: urban settlements, both because of the total number of inhabitants, and because of the amount and structure of waste generated in urban settlements.

2.1. Number of inhabitants, network of settlements and traffic network

For the purposes of this Study, the number of inhabitants, the number of households, the number of inhabitants in urban areas and the number of inhabitants in rural settlements are included. These categories are included according to the regions determined by the National Waste Management Strategy. For determining the region and macrolocation of regional landfills from the aspect of population, they are:

- the region should include at least 200,000 inhabitants,
- the regional landfill should be located near the largest generators of waste within the region, ie: urban settlements due to the total number of inhabitants, as well as due to the amount and structure of waste generated in urban settlements.

Vojvodina is, are well developed, in terms of the spatial distribution of settlements, and in terms of the density and hierarchical structure of the network.
Criteria for determining the locations of regional landfills in relation to the settlement network:

- density of the settlement network
- size and spatial distribution of settlements.

A lower density of the network of settlements creates a greater possibility for locating a regional landfill, with a higher density of settlements, transport costs and the need to build a transfer station are reduced.

For the location of landfills in relation to settlements and buildings, they are determined by the Rulebook on criteria for determining the location and arrangement of waste material landfills.

The landfill can be located:

- 1500 m from the border of the residential part of the settlement,
- 400 m from the settlement if the landfill is hidden by geomorphological formations,
- with data on the purpose of the area from the urban plan of the settlement located in the gravity area of the landfill - within a radius of 3 km.

The landfill cannot be located:

- less than 0.5 km from:
  - railway/bus stations, loaders of flammable materials and military waste,
  - individual houses outside the settlement;
- less than 2 km from:
  - health facility for inpatient treatment,
  - natural health resort,
  - food industry,
  - shelter.

To protect and improve the visual and aesthetic characteristics of the area, it is necessary:

- Formation of landfill in depressions (abandoned mines)
- Choosing locations that are hidden by natural obstacles (relief, greenery...).
- Formation of artificial shelters (relief shaping, fencing...).

When determining the location of the regional landfill, planning and urban planning obligations should be met:

- planned surface uses,
- planned infrastructure systems,
- planned measures for the protection of natural and immovable cultural assets.

The traffic network consists of roads of different hierarchical levels, connecting all settlements in AP Vojvodina. The road traffic network of the modified system forms a good basis for establishing the gravity zone of regional landfills and transfer stations. General criteria are defined for locating landfills in relation to traffic infrastructure:

- The position of the landfill in relation to large sources of waste is optimally 20 km,
- The location of the landfill is a maximum of 5 km in relation to the network of main and regional roads, and a minimum of 400 m from the road route.
The landfill should be more than 0.5 km away from obstacles (rivers, canals).

- The landfill cannot be located within a radius of 3.2 km from the reference point of the airport and 13 km along the jet runway.
- The landfill cannot be located in the protective strip, which is 200m from the axis of the end tracks.
- The location of the landfill depends on the integral traffic network.
- The location of the landfill is also determined in relation to the state border.
- The location of the landfill is determined in relation to the possibility of minimizing the negative impact of the total transport activities on the environment.
- The landfill cannot be located above tunnels and underpasses.
- The landfill cannot be located in the protective track belt 200 m from the axis of the end tracks.

2.2. Protected nature and real estate, tourist zones and areas

According to the Spatial Plan of the Republic of Serbia, on the territory of Serbia:
- to protect special natural values that have the status of protection;
- define the status and space, and the protection regime for individual natural entities and areas;
- define protection priorities (for AP Vojvodina, these are water courses, coastal areas, wet and wooded areas, saline terrains and areas with autochthonous forests);
- propose the acquisition of international protection status for new natural entities.

To locate landfills in relation to protected natural assets and natural values:
- Landfills cannot be located at a distance of less than 1.5 km from a protected natural asset based on the Rulebook on Criteria for Determining the Location and Arrangement of Waste Landfills.
- In the protection zone of natural resources, works or the construction of facilities can be approved under the conditions of the competent institution for nature protection, according to the Law on Environmental Protection, based on the provisions governing the protection of natural resources.
- Landfills cannot be located on a natural asset for which a protection procedure has been initiated, that is, an act on preliminary protection has been passed, because in the sense of the Environmental Protection Act, they are considered protected.
- Landfills cannot be located in the area of the National Park and based on the Law on National Parks, and a ban on the construction of buildings in the protective zone of the National Park that could pollute the air, water and soil and endanger the flora and fauna has been issued.
- Landfills cannot be located in coastal areas, wet and forested areas and on salty terrains and in areas with autochthonous forests, because these locations have a priority of protection in AP Vojvodina as natural values.
The location of landfills must be in accordance with ecosystem protection regimes.
Criteria for locating landfills in relation to tourist zones and areas:
- The location of regional landfills cannot be determined on the territory of a tourist site.
- The location of the landfill cannot be determined on the site of a protected natural location and area.
- The location of regional landfills cannot be in the direction of tourist movements (pedestrian paths, bicycle paths, roads, next to nautical facilities, campsites...).

2.3. Water infrastructure

In AP Vojvodina, groundwater is almost the only source of high-quality water. Sources of regional importance are foreseen on the Danube and the Sava. Supply - water quality largely does not meet the physico-chemical or microbiological standards of drinking water. The reason is the poor quality of wastewater treatment. Some settlements do not treat even the smallest percentage of waste water. Filtrate from the planned landfills can be discharged into the city - residential sewers, but not to block the work of biological treatment of city waste water at the existing and planned treatment plants.

Removal of excess waste water and storm water from settlements - 44 settlements in Vojvodina have some form of waste water sewerage. On the territory of AP Vojvodina, most settlements have the advantage of building separation systems, special systems for the removal of waste water and storm water. Exceptions are Novi Sad, Bela Crkva..., applied general common planting systems without purification. 14 wastewater treatment plants were built. Biological treatment is used in the treatment of municipal waste water.

Criteria for locating landfills in relation to water management infrastructure
- The broad location should be sought on terrain that is above the possible height of flood waters from the rivers Danube, Tisza, Sava and other smaller rivers, which come from Romania.
- Terrains on the loess terraces and plains are favorable.
- The best locations are on terrains that do not drain, beyond the reach of flooding from external waters - rivers.
- Good locations are where the groundwater level fluctuates deeply during the hydrological year.

Landfills should not be located:
- In the areas reserved for the locations of regional water intakes.
- In areas reserved for multipurpose microaccumulations.
- In the areas of the existing water intakes in the area of the recharge zone of the first or subarterial aquifer layer.
- In areas planned for ponds.
- In areas planned for irrigation systems.
- In the area of the catchment area of multi-purpose microaccumulations (The most favorable location of the landfill is the one where the smallest amount of waste water is formed - the filtrate at the bottom of the landfill, during the hydrological year, collects and does not have to be filtered and discharged into the water receiver, but continuously circulates through the body of the landfill. It can be achieved if the inflow of atmospheric water into the landfills from adjacent surfaces and precipitation on the surface of the landfill body is eliminated),
- It is possible to locate the landfill in an area that is exposed to the process of erosion, if the same process is immediately stopped by implementing appropriate anti-erosion measures and works.

2.4. Relief, pedalos characteristics and distribution of forests

Criteria for locating landfills in relation to land. Respecting the legal regulations, EU directives and the National Strategy, and valid spatial and urban plans, determining the criteria for the selection of the location of regional landfills from the aspect of agricultural land protection and the agricultural production process, it is necessary to observe the following principles:

- Landfills should be located in permanently degraded areas that cannot be used for agricultural purposes.
- If there are abandoned loaned lands, landfills should be located in such areas.
- When choosing a location, take into account the quality of the land and locate landfills on poorer quality land that is unfavorable for agricultural production.
- The location of the landfill cannot be less than 0.5 km from the facilities in the atar intended for agricultural production (farms, irrigation systems, agricultural aviation runways, machine parks, etc.).
- When determining the location, look at the possibilities of using Atar infrastructure for higher human use (atar roads, canal systems, detailed and basic networks) so that during the formation, exploitation, closure and recultivation of the landfill, the process of agricultural production could proceed smoothly.
- Make it impossible to mix leachate from the landfill with underground water in the soil and water in canal systems intended for drainage and irrigation of agricultural areas.
- Land for sanitary covering should be provided from non-agricultural land and stored in the landfill complex.
- Landfills should be located at a distance of no less than 0.5 km from the draw and game bans.
- When choosing a location, follow the guidelines for the arrangement of the atar, the forest base...

In AP Vojvodina, 95.5% of the total area is state property. Based on th Law on Forests, all forests ade divided into „production“, „protection“ and „special purpose forests“.
2.5. Geological, engineering and hydrogeological characteristics

The geological and hydrogeological characteristics of the site intended for waste disposal, i.e. the construction of a landfill, are determined on the basis of geological and hydrogeological research, in accordance with the law. In particular, geological research determines:

- the geological structure of the site planned for waste disposal and the protective zone around the landfill obtained based on the results of at least five exploratory wells;
- granulometric composition and filtration coefficient of each lithological layer of the site;
- hydrogeological observation and measurement of the filtration coefficient in each research well;
- geophysical characteristics of the upper layers of the landfill site and protective zones around the landfill using geophysical methods (electroconductivity or seismic methods);
- the level of underground water at the location.

Through hydrogeological research, they determine:

- characteristics of catchment areas of surface waters at the site for the landfill in the most unfavorable hydrogeological conditions
- presentation of the hydrological parameters of the water that infiltrates and flows out of the body of the landfill, and in particular:
  - average annual rainfall in the wider area of the landfill (for a period of 15 years);
  - the highest annual amount of precipitation in the wider area of the landfill (for a period of 15 years);
  - assumed amount of moisture absorbed by the waste;
  - amount of absorbed water in the waste;
  - evaporation from the soil;
  - the highest amount of precipitation in a series of rainy days.

Modified basic level of seismicity - When determining the final locations for landfills, it is necessary to look for seismic conditions for each of them, because they can differ from the basic levels of seismicity. For specific locations, in relation to the local soil and its geomechanical properties, based on special conditions, the expected maximum intensity of earthquakes (microseismicity) will be obtained.

The criteria for locating landfills in relation to the geological, engineering, hydrogeological and geomechanical characteristics of the terrain, stability and seismicity of the soil are determined according to the provisions of the Rulebook on criteria for determining the location and arrangement of waste landfills materials and according to the "recommendations" of the EU from the Annex of Directive 99/31/EEC - "General requirements for all categories of landfills".

The choice of a place for a landfill, taking into account the requirements regarding:

- geological and hydrogeological conditions of the given area,
• danger of flooding, soil subsidence, landslides or avalanches in the field.

The geological barrier is determined by the geological and hydrogeological conditions of the area, within and in the vicinity of the landfill site, there must be a satisfactory possibility of protection, in order to prevent hazards to the soil and groundwater. The bottom of the landfill and the sloping sides of the landfill must consist of mineral layers, which meet the requirements in relation to permeability and thickness, which should achieve a combined effect in relation to the protection of soil, underground and surface water, and which are at least identical to that.

2.6. Climatic conditions

They are important for the analysis of the spatial characteristics of the AP Vojvodina area, they are in the function of forming and locating regional landfills. Climatic conditions depend on climatic factors: geographical position, ie. from the altitude, shape of the terrain, foundation and construction of the settlement. The area of AP Vojvodina is an area of moderate continental climate, without significant temperature differences between individual localities and regions.

2.7. Infrastructure system

The built and planned transmission high-voltage and medium-voltage electric power network, which consists of transmission lines 400kV, 220kV, 110KV, 35kV, 20kV and 10kV, will represent one of the factors for determining the locations of regional landfills and transfer stations in the area of AP Vojvodina. The telecommunications network, in the area of AP Vojvodina, is cabled in road corridors, and will not be a limiting factor when choosing the locations of landfills and transfer stations.

Locating landfills in relation to power infrastructure
• The landfill must be located at least 100 m from overhead power lines, regardless of their voltage level.
• The landfill cannot be located above underground installation lines. The minimum distance from underground power and telecommunication lines must be such that they cannot be endangered during any activities at the landfill, during construction and during exploitation.
• An electric power connection must be provided to the landfill, from the nearest low-voltage network or substation, to supply electricity to consumers within the landfill.

Locating regional landfills in relation to thermal energy infrastructure:
• The landfill cannot be located above underground installations of gas and oil pipelines.
• The minimum distance of the landfill from gas and oil pipelines must be 100 m.
• The location of the landfill must be 1.5 km away from active exploration and exploitation fields and from supporting facilities for exploitation and distribution of oil and gas and terminals.
The regional landfill, according to the new standards valid in the EU, must be equipped with:

- with an impermeable substrate - foil, drainage pipes for draining leachate, a gas system for collecting separated gases,
- facilities - an administrative building with a laboratory, a facility for washing vehicles and bins,
- bridge scales for weighing waste,
- wastewater treatment plant,
- traffic infrastructure: parking lots for loading and transport vehicles, parking lots for cars, non-passable roads for manipulation and movement around the landfill,
- necessary infrastructure: water supply and sewage network, electricity for powering devices, lighting, as well as for heating, hydrant network,
- fence and gate,
- pollution monitoring system,
- system to prevent birds from spreading garbage (falcons, scarecrows, etc.).

In order to properly conduct the depositing process, before the vehicle with waste enters the landfill, it is necessary to ensure the control of the type of waste and the assessment of the amount of waste to be deposited. Recyclable waste should be selectively deposited on the recycling plateau. After bringing the waste to the disposal area, it should be systematically distributed in layers.

At the landfill, control must be ensured:

- unloaded quantities and types of waste,
- implementation of the designed and prescribed technological process of landfill exploitation,
- landfill and road maintenance,
- the quality of washing and disinfecting transport vehicles,
- infectious agent,
- groundwater quality (piezometers),
- composition and amount of separated gas i
- worker protection.
- determines the structure of the waste (morphological composition) twice a year;
- provides a laboratory with equipment for the control of leached and purified water.

Necessary tools for working at the landfill are a bulldozer or compactor and a vehicle for collecting and transporting waste. It is useful to build a regional recycling facility on the site of the landfill itself, but a preliminary feasibility study must determine whether it is economically profitable and necessary.

CONCLUSION

Due to the ever-increasing amounts and damage to the environment, the landfill is considered one of the most significant environmental problems of the modern world. The generation of waste is the result of the total economic activity of each country, and as such is directly correlated with the national economy. Uncontrolled landfills are
being created in AP Vojvodina, the main landfill is overcrowded with waste, and all this is a source of potential infectious diseases of the population and pollution of all sectors of the environment: air, soil and water.

Today, the idea that waste should not be destroyed, but rather used, has completely prevailed. Burning waste is environmentally harmful and economically unprofitable, since it is a raw material that contains a number of useful components. The only solution is that, in addition to the law, the awareness of the people who will fuel the creation of illegal landfills should also be raised. According to the rules, the location of the landfill should be outside the city and populated area according to the correct regulations.

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Circular economy as a model for economic development of Republic of Serbia

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KEYWORDS - circular economy; wastes; energy; GDP; ANFIS.

ABSTRACT
Circular economy represents a concept for turning of material and energy wastes into resources for other purposes in a closed loop system. The main aim of the circular economy is to minimize the energy and material wastes. The best-case scenario would be eliminating of the wastes and turning them into the new purposes, which is the main purposes of the circular economy. Sustainable development is closely connected with the circular economy. The system represents reuse and recycling of materials in order to minimize the wastes and using of biodegradable products which could be back to the environment after rejection. There are many projects for incorporating of circular economy in order to implement best practices of the system. The best practices represent mainly recycling and reusing of materials for the same or new products in order to reduce waste and energy use. The main goal of the study was to analyse the effect of energy and non-energy material productivity on the gross domestic product (GDP) in Serbia and OECD members as well. The purpose of the investigation was to determine which sector of energy or non-energy material productivity has the more relevance on the GDP. Energy productivity represent energy consumption sector while non-energy material productivity represents the sector closely connected to the circular economy. Based on the results one can conclude what is the current status of the economic development and what needs to be improved to reduce the energy and material wastes. On the contrary GDP needs to be tracked in order determine which factor has the more influence on the GDP. For such a purpose adaptive neuro fuzzy inference system (ANFIS) was implemented since the methodology is suitable for statistical investigation of strongly nonlinear data sample due to features of fuzzy logic system. The consumption of non-metallic materials as a percentage of Domestic Material Consumption (DMC) represents the most influential factor for GDP prediction in Serbia. The results show also the consumption of metals as a percentage of Domestic Material Consumption (DMC) represents the most influential factor for GDP prediction for OECD members. The obtained results could represent the best practices for implementation of circular economy concept.

INTRODUCTION
Circular economy represents a concept for sustainable development in order to reduce material and energy wastes. The main concept of the circular economy is materials cycles to reduce negative environmental impact, to save energy consumption.
and to made economic development. Linear economy model is dominant model in industrial development which caused environmental pollution and excessive using of limited natural resources. Circular economy is based on reusing, remanufacturing, repairing and upgrading of products or material. In the energy sector the circular economy is based on renewable energy using like solar, wind, biomass and waste derived energy. One of the most important concepts of the circular economy is using of biodegradable products which could be back to the environment after rejection therefore there is no waste.

Circular economy could restructure material flow between the ecosystem and the socioeconomic system into a balanced state [1]. In article [2] has been identified the positive contribution of circular economy on the sustainable development. In article [3] has been found that changed practices can redirect the material flows and support the transformation to circular economy and municipalities collaborated with the municipally owned waste company has been important driver for the change. Since the recycling and utilization of resources and closes the resource look are the main concepts of circular economy, the mining industry has a critical role in transition to low carbon economy and moving towards circular economy [4]. There are benefits of the circular economy to banks and other financial institutions which are discuss in article [5]. Despite of sustainable development and improving of resource productivity and eco-efficiency, there are business concerns in the circular economy concept since the principle of reduce reuse and recycle is not without challenges [6, 7]. There is suggestion that the circular economy incubators would help entrepreneurs to find and pursue circular economy opportunities with a limited role for government [8, 9, 10]. Circular economy has been solution to tackle the environmental problems due to large waste generation [11]. The best way to implement circular economy concept is to follow best scenarios. In article [12] has neem analysed more than 300 circular economy scenarios in the time frame from 2020 to 2050 where it was found that the best scenario for implementation of circular economy model in 2030 could include gross domestic product (GDP), CO2 emissions reduction and employment. Results in article [13] has been shown that after implementation of circular economy the main outputs are in the improvement of economic growth in a circular way, that is, improving GDP but also the recovering and recycling activities.

There are many projects for implementation of best practices of circular economy to the system. The best practices represent recycling and reusing of materials for the same or new products. The main goal of the study was to analyse the effect of energy and non-energy material productivity on the gross domestic product (GDP) in Serbia. The purpose of the investigation was to determine which sector of energy or non-energy material productivity has the more relevance on the GDP. Energy productivity represent energy consumption sector while non-energy material productivity represents the sector closely connected to the circular economy [14, 15].

For such a purpose adaptive neuro fuzzy inference system (ANFIS) [16] was implemented since the methodology is suitable for statistical investigation of strongly nonlinear data sample due to features of fuzzy logic system.
METHODOLOGY

Circular economy concept

Circular economy represents and economic system where the main aim is to eliminate waste material and to use resources continual. The main tasks in circular economy are to reuse, to repair, to remanufacture and to recycle in order to create a closed loop system. The main goal of the circular economy is minimization of using of resource inputs and waste creation, pollution and carbon emission. The second goal of the circular economy is to keep products, equipment and infrastructure in use for longer time. Figure 1 shows the illustration of the circular economy concept. Maternal and energy wastes should ne inputs in other processes. Therefore, there is need for a regenerative approach in order to create regenerative resources and to eliminate waste materials and energy. There are five main steps in the circular economy which creates a closed loop system (Figure 2).

Figure 1: Circular economy concept
Energy and non-energy material productivity

In this study was used energy and non-energy material productivity parameter for GDP prediction and evaluation. Non-energy material productivity parameters are based on the waste materials and recycling. Energy productivity parameters represent energy consumption. In this study are used OECD Green Growth database [17] for Serbia and OECD members separately, which contains selected indicators for monitoring progress towards green growth to support policy making and inform the public at large. The database synthesizes data and indicators across a wide range of domains.

The indicators have been selected according to well-specified criteria and embedded in a conceptual framework. The main goal is to capture the main features of green growth based on environmental and resource productivity. There is need to indicate whether economic growth is becoming greener with more efficient use of natural capital and to capture aspects of production which are rarely quantified in economic models and accounting frameworks. The first dataset represents energy and non-energy productivity parameters (Table 1). Figure 3 shows the main structure of the first concept.

Table 1: Energy and non-energy material productivity parameters

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<tr>
<td>1.</td>
<td>Energy productivity, GDP per unit of TPES</td>
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<td>2.</td>
<td>Energy intensity, TPES per capita</td>
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<td>3.</td>
<td>Total primary energy supply, index 2000=100</td>
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<td>4.</td>
<td>Total primary energy supply</td>
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<td>5.</td>
<td>Renewable energy supply, % total energy supply</td>
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<tr>
<td>6.</td>
<td>Renewable electricity, % total electricity generation</td>
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</table>
Energy consumption in agriculture, % total energy consumption  
8. Energy consumption in services, % total energy consumption  
9. Energy consumption in industry, % total energy consumption  
10. Energy consumption in transport, % total energy consumption  
11. Energy consumption in other sectors, % total energy consumption  
12. Non-energy material productivity, GDP per unit of DMC  
13. Biomass, % of DMC  
14. Non-metallic minerals, % of DMC  
15. Metals, % of DMC

Figure 3: Energy and non-energy material productivity parameters impact on GDP

Energy productivity is calculated as GDP per unit of Total Primary Energy Supply (TPES). It reflects, at least partly, efforts to improve energy efficiency and to reduce carbon and other atmospheric emissions. Together with energy intensity, these indicators also reflect structural and climatic factors. TPES comprises production + imports - exports - international marine bunkers - international aviation bunkers ± stock changes. Energy intensity is calculated as TPES per capita. Total primary energy supply (TPES) is expressed in million tons of oil equivalent. TPES is also expressed as an index with values in 2000 normalized to equal 100. Renewable energy supply is calculated as a share of renewable sources in TPES (expressed as percentage). Renewables include hydro, geothermal, solar (thermal and PV), wind and tide/wave/ocean energy, as well as combustible renewables (solid biomass, liquid biomass, biogas) and waste (renewable municipal waste). Renewable electricity is calculated as a share of renewables in electricity production (%). Energy consumption in agriculture is expressed as a share of total energy consumption (%). Energy consumption in agriculture includes deliveries to users classified as agriculture, hunting and forestry by the International Standard Industrial Classification (ISIC). Therefore, it includes energy consumed by such users whether for traction (excluding agricultural highway use), power or heating (agricultural and domestic). Energy consumption in services is expressed as a share of total energy consumption (%). Energy consumption in services includes both commercial and public services. Energy consumption in transport is expressed as a share of total energy consumption (%). Energy consumption in transport covers all transport activity (in mobile engines).
regardless of the economic sector to which it is contributing. Energy consumption in industry is expressed as a share of total energy consumption (%). Energy consumption in industry includes the following sub-sectors: iron and steel, chemical and petrochemical, non-ferrous metals, non-metallic minerals, transport equipment, machinery, mining and quarrying, food and tobacco, paper, pulp and print, wood and wood products, construction, textile and leather together with any manufacturing industry not included above. Energy consumption in other sectors is expressed as a share of total energy consumption (%). Energy consumption in other sectors includes residential consumption and all fuel use not elsewhere specified.

Non-energy material productivity is calculated as GDP generated per unit of materials consumed. Domestic Material Consumption (DMC) refers to the apparent consumption of materials; it is calculated as the sum of domestic consumption of biomass for food and feed, construction minerals, industrial minerals, metals and wood. Consumption of Biomass is expressed as a percentage of DMC. Biomass materials include biomass for food and wood. Food materials include crops (e.g. cereals, roots, sugar and oil bearing crops, fruits, vegetables), fodder crops (including grazing), wild animals (essentially marine catches), small amounts of non-edible biomass (e.g. fibres, rubber), and related products including livestock. Wood includes harvested wood and traded products made of wood (e.g. paper, furniture, etc.). Total domestic material consumption refers to the apparent consumption of materials; it is calculated as the sum of domestic consumption of biomass for food and feed, construction minerals, industrial minerals, metals and wood. Consumption of non-metallic materials is expressed as a percentage of Domestic Material Consumption (DMC). Non-metallic minerals include construction and industrial minerals. Construction minerals include primary (e.g. sand, gravel, stones, limestone, excavated soil if used) or processed (e.g. glass, cement, concrete) minerals. Industrial minerals include primary or processed non-metallic minerals (e.g. salts, arsenic, potash, phosphate rocks, sulphates and asbestos). Consumption of metals is expressed as a percentage of DMC. Metals include metal ores, metals and products make of metals. Municipal waste generated in expressed in kg per person.

Real GDP was used as output factor for evaluation of economic development. The GDP is expressed as an index 2000=100. GDP measures market and government production and the associated economic activity. However, as a 'gross' measure, no account is taken of the depreciation neither of produced assets nor of the depletion of natural assets.

**ANFIS**

ANFIS network has five layers where each of the layer specific operation during training procedure (Figure 4). Fuzzy inference system (FIS) is the main core of the ANFIS network. The first layer receives input signals and convert them into the fuzzy values through membership functions. Bell-shaped membership function is used in this study since the function has the highest capability for the regression of nonlinear data.
Bell-shaped membership function is defined as follows:

\[
\mu(x) = \text{bell}(x; a_i, b_i, c_i) = \frac{1}{1 + \left[ \left( \frac{x - c_i}{a_i} \right)^2 \right]^{b_i}}
\]  

(1)

where \(\{a_i, b_i, c_i\}\) is the parameters set and \(x\) is input.

Second layer provides the firing strength of rule by multiplication of the fuzzy signals from the first layer. In the third layer there is normalization of all signals from the second layer. The fourth layer provides the inference of rules. The final layers summarize all the signals and provide the output crisp value.

Figure 5 shows ANFIS selection procedure in MATLAB software. ANFIS methodology was implemented for the selection procedure. During selection procedure non-relevant parameters could be removed. Parameters with small relevance do not have high impact on the output. The data set is arranged from the data file in Tables A1 and A2. The dataset is partitioned into a training set (trn_data) and a checking set (chk_data). The function “exhsrch” represents exhaustive search procedure within the given inputs. Figure 6 shows the main concept of the circular economy through ANFIS procedure where there are two sets of input parameters.
RESULTS

ANFIS network is trained with data section in Table 1 with 15 inputs and the GDP as output. The main goal is to determine RMS errors of each single parameter from the Table 1 based on the GDP prediction. Figure 7 shows the RMSE errors of the single parameters of energy and non-energy productivity in total for Serbia. One can note the parameter 14 has the smallest RMS error hence the strongest relevance in regard to the GDP prediction. The parameter 14 represents the consumption of non-metallic materials as a percentage of Domestic Material Consumption (DMC). Total domestic material consumption refers to the apparent consumption of materials; it is calculated as the sum of domestic consumption of biomass for food and feed, construction minerals, industrial minerals, metals and wood. Non-metallic minerals include construction and industrial minerals. Construction minerals include primary (e.g. sand, gravel, stones, limestone, excavated soil if used) or processed (e.g. glass, cement, concrete) minerals. Industrial minerals include primary or processed non-metallic minerals (e.g. salts, arsenic, potash, phosphate rocks, sulphates and asbestos).

Table 2 shows the numerical RMS errors of the all-single parameters based on the GDP prediction for Serbia and OECD members as well. There are two RMS errors, for training (trn) and for checking (chk) of the ANFIS models. 50% data were used as training data while remaining 50% data were used as checking data. There are 15 ANFIS models with single input and single output in this stage. Each of the ANFIS model is trained with one epoch in order to determine the parameters’ relevance to the GDP. One can note the consumption of metals is the most influential parameter for GDP prediction for OECD members. Figure 8 shows the two determined combinations for Serbia and OECD members respectively. Serbia needs to increase consumption of metals in order to match with the economic development of the OECD members.
Figure 7: RMS errors of the single parameters for Serbia based on GDP prediction

Table 3: RMS errors of the single parameters for Serbia and OECD members based on GDP prediction

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Serbia</th>
<th>OECD members</th>
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<tbody>
<tr>
<td>1. Energy productivity, GDP per unit of TPES</td>
<td>trn=3.2217, chk=15.3177</td>
<td>trn=15.2157, chk=11.6255</td>
</tr>
<tr>
<td>2. Energy intensity, TPES per capita</td>
<td>trn=5.4499, chk=138.9365</td>
<td>trn=15.8697, chk=13.7280</td>
</tr>
<tr>
<td>3. Total primary energy supply, index 2000=100</td>
<td>trn=9.5078, chk=65.4689</td>
<td>trn=11.8271, chk=9.8133</td>
</tr>
<tr>
<td>4. Total primary energy supply</td>
<td>trn=9.3574, chk=73.4271</td>
<td>trn=14.3457, chk=14.1199</td>
</tr>
<tr>
<td>5. Renewable energy supply, % total energy supply</td>
<td>trn=7.4236, chk=105.4331</td>
<td>trn=17.1605, chk=16.7613</td>
</tr>
<tr>
<td>6. Renewable electricity, % total electricity generation</td>
<td>trn=2.6567, chk=26.0622</td>
<td>trn=17.6626, chk=16.1841</td>
</tr>
<tr>
<td>7. Energy consumption in agriculture, % total energy consumption</td>
<td>trn=2.9346, chk=8.6655</td>
<td>trn=16.5015, chk=15.1602</td>
</tr>
<tr>
<td>8. Energy consumption in services, % total energy consumption</td>
<td>trn=1.9724, chk=12.8528</td>
<td>trn=9.5518, chk=12.9565</td>
</tr>
<tr>
<td>9. Energy consumption in industry, % total energy consumption</td>
<td>trn=1.8883, chk=11.3072</td>
<td>trn=14.9634, chk=15.8505</td>
</tr>
</tbody>
</table>
10. Energy consumption in transport, % total energy consumption
   \[ \text{trn}=11.1766, \quad \text{chk}=31.6381 \]
   \[ \text{trn}=14.6794, \quad \text{chk}=12.8508 \]

11. Energy consumption in other sectors, % total energy consumption
   \[ \text{trn}=4.1597, \quad \text{chk}=9.4468 \]
   \[ \text{trn}=16.1052, \quad \text{chk}=16.2567 \]

12. Non-energy material productivity, GDP per unit of DMC
   \[ \text{trn}=3.1699, \quad \text{chk}=28.7849 \]
   \[ \text{trn}=8.1152, \quad \text{chk}=9.3744 \]

13. Biomass, % of DMC
   \[ \text{trn}=2.7566, \quad \text{chk}=6.8070 \]
   \[ \text{trn}=15.0961, \quad \text{chk}=11.4525 \]

14. Non-metallic minerals, % of DMC
   \[ \text{trn}=0.3572, \quad \text{chk}=13.8164 \]
   \[ \text{trn}=14.6956, \quad \text{chk}=14.9097 \]

15. Metals, % of DMC
   \[ \text{trn}=2.1614, \quad \text{chk}=9.4006 \]
   \[ \text{trn}=7.7005, \quad \text{chk}=16.3203 \]

CONCLUSION

Circular economy is the economy for future development since ecological and environmental protection are in the main focus of the economy. The main idea of the circular economy is sustainability of human life. Circular economy could present a solution for overcoming the current production and consumption model where energy resources are limited. This economy is based on a closed-loop system where urban and industrial wastes represent the main energy and material resources.
The main goal of the study was to analyse the effect of energy and non-energy material productivity on the gross domestic product (GDP) in Serbia and OECD members as well respectively. The purpose of the investigation was to determine which sector of energy or non-energy material productivity has the more relevance on the GDP. For such a purpose adaptive neuro fuzzy inference system (ANFIS) was implemented. The consumption of non-metallic materials as a percentage of Domestic Material Consumption (DMC) represents the most influential factor for GDP prediction in Serbia. The consumption of metals as a percentage of Domestic Material Consumption (DMC) represents the most influential factor for GDP prediction for OECD members. Serbia needs to increase consumption of metals in order to match with the economic development of the OECD members. The obtained results could be uses as the best practices for implementation of circular economy concept.

REFERENCES


Roadmap for circular economy in Serbia

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KEYWORDS - Circular economy, environmental protection, transition, reduction, reduce, roadmap

ABSTRACT
Circular economy is a renewable so-called a regenerative economic system in which production resources, waste, emissions and energy outflow are significantly reduced by slowing down, rounding off and extending energy and life cycles in production. The circular economy model is based on the minimal use of natural resources and energy, which at the same time contributes to the reduction of waste generation, pollution and other negative impacts on the environment. We strive to maximize the life of products created and designed through clean technologies, as well as maintenance, servicing and recycling. The transition to a circular economy requires radical changes, innovations and measures in the system of production and consumption. The transition process is specific and unique for each country individually and requires a multi-year methodological approach to sustainable development, pollution reduction, conservation of natural resources and the environment. It refers to all sectors of society, and therefore it is necessary to approach this process from several aspects, namely strategic, legislative, technical, economic, but also from the angle of standards and other voluntary instruments. There is no universal pattern, because it is necessary to synchronize national policies and markets of countries with global needs and competitiveness requirements. From 2017, the program of the Government of the Republic of Serbia states that the program for the development of environmental protection will be conducted in accordance with the principles of the circular economy that refer to infrastructure projects. Improving business models of the economy and harmonizing business with the principles of the circular economy in the Republic of Serbia can greatly contribute to improving the competitiveness of national companies and solving socio-economic issues.

1 INTRODUCTION

At the end of 2019, the European Commission presented one of its key documents for the next five years, the European Green Deal. The ambitious goals of this document refer to the fulfillment of obligations from the Paris Agreement and the reduction of CO2 emissions to 50% by 2030, with the goal of reducing CO2
emissions to 55% by 2050. The aspiration for Europe to become the first climate-neutral continent was presented as a key goal, which would position it as a leader in the circular economy and clean technologies. It was estimated that by 2030, the possible economic gain would be 1.8 billion euros by switching to a circular economy.

The model of the circular economy represents the antithesis of the so-called linear model of the economy, in which natural resources are uncontrollably exploited, the amount of waste drastically increases, and the natural environment is destroyed and polluted. The circular economy changes business models, habits and ways of thinking, because it emphasizes that the use of natural resources and energy is reduced to a minimum, which therefore prevents damaged environments, reduces pollution, and ensures the production process through clean technologies. During these processes, no waste is created, more precisely, there is no residue in the production process, but "raw materials" that are returned to production through circular design and cleaner technological processes. [1].

Unlike the linear model (Figure 1), where almost every product after the end of its life was disposed of in a landfill, therefore, in addition to the use of natural resources and an increase in generated waste, it also led to a great deal of environmental pollution, the circular model implies recycling and waste treatment, as your first step. In this model, emphasis is placed on the use of materials that can be used again, to "circulate", which at the same time reduces both the amount of energy and water for their production, in some cases it amounts to over 90%.

Figure 1: Linear model

It is considered that the circular model has a regenerative relationship towards the already largely devastated nature and natural resources, where thanks to it the life of the product will be extended. Thanks to modern technologies, it is estimated that the amount of final waste will decrease, and thus pollution will also decrease. In this regard, it can be said that the circular economy model has a positive effect on human, social, natural and financial capital.
Reorientation towards a circular economy is not only a global need but also an inevitability. Each country has its own way and form of transition to a circular economy. Some of them, such as Denmark, Germany, and the Netherlands, have adopted strategies for the implementation of the circular economy model, and have made significant steps forward in this field. On the other hand, China, Brazil, and Great Britain are realizing the transition to a circular economy through individual projects. In 2008, the Republic of Serbia adopted the National Sustainable Development Strategy for the Republic of Serbia, which is one of the most important documents for sustainable development and the green economy. The transition to successful transition to a new, sustainable paradigm requires re-industrialization, sustainable consumption, a new vision of "smart" cities, a change in people's consciousness, and a culture of living.

2 TRANSITION TO CIRCULAR ECONOMY IN THE REPUBLIC OF SERBIA

Serbia is in the transition period of market liberalization and is recognized by the United Nations (UN) as a country with a transition economy [2]. The transition process is always specific and different for each country. The process of transition to a circular economy represents a multi-year and systematic approach to sustainable development, which aims to preserve natural resources and reduce environmental pollution, which will affect people's health and improve the quality of life. Sustainable development does not refer only to one sector or one area, but to all sectors of society and areas that must undergo a certain type of change towards a circular economy. In order to achieve these uniform changes at all levels, it is necessary to synchronize national policies, markets, and legislation with global needs and requirements. This is the reason why approaching and solving such a
problem can only be resorted to from several different sides, which include strategic, legislative, technical, and economic aspects. There is no universal pattern that can be applied to all countries in the course of their transition to a circular economy.

In 2017, the Government of the Republic of Serbia stated in its program that the environmental protection program will be implemented in accordance with the principles of the circular economy related to infrastructure projects [1]. What is necessary is that the transition to the circular economy is recognized not only as a necessity but also as the main strategic goal for the development of the Republic of Serbia. Improving the business models of the economy and harmonizing business with the principles of the circular economy in the Republic of Serbia can greatly contribute to improving the competitiveness of national companies and solving social and economic issues [3]. The models that should be prioritized on the way to transition are economic, political, environmental protection, and society.

As for the economic sector, before the pandemic, Serbia recorded export and GDP growth for the placement of semi-finished products, products, and raw materials on the European and world markets [3]. In order to continue growing, to increase competitiveness both on the European and world markets, it is necessary to increase competitiveness, include new business models and new technologies, open new, "green" jobs, and to open the possibility of doing business in the new the market.

As joining the European Union is one of the main strategic priorities of the Republic of Serbia, it is necessary to harmonize its policy with the policy of the EU. Serbia is expected to harmonize its policies with the Agenda for Sustainable Development until 2030 and the Paris Agreement, as well as to implement mechanisms for monitoring the activities carried out on these issues [4].

In the field of environment, the Republic of Serbia faces numerous problems. Taking into account that two heating plants on its territory are characterized as the biggest polluters in Europe and that according to the official data of the World Health Organization 10,000 people die annually from air pollution, the Republic of Serbia has great difficulties in harmonizing and implementing laws that are in accordance with European. In addition to poor air quality, the Republic of Serbia also faces inadequate waste management, illegal landfills, high energy dependence, and a poor policy aimed at green energy.

In the regulatory sense, the implementation of the circular economy in Serbia requires a multi-layered and multi-sector connection of national public policies and regulations that would enable favorable conditions for new investments [5]. In order to achieve this, it is necessary to determine national priority sectors that would be aligned with the work priority of the Government of the Republic of Serbia and infrastructural development. In order to move to a circular economy, it is necessary to introduce a national strategy, introduce national planning documents, amend existing laws, and train staff.
3 CHALLENGES ON THE WAY TO TRANSITION TO THE CIRCULAR ECONOMY

The transition to a circular economy requires radical changes, innovations, and measures in the production and consumption system [6]. Numerous technological challenges arise in the production process. One of them is product reuse. There are also conflicts of interest, the economic profitability of new business models, as well as quality standards.

One of the basic barriers is insufficient information about circular economy models and an understanding of the importance of transition in order to increase competitiveness in the market [7]. Although it is often mentioned that there are not enough financial resources for the realization of certain "green" projects, it has been shown that there is generally no adequate staff that would manage to provide that part through various European funds. The use of old technology in a community with incompetent or insufficiently educated staff leads to the problem of understanding the financial justification of the use of new technological processes.

The research potential of the scientific community is not used to a sufficient extent to contribute to the development of industry [8]. Awareness of the need for cooperation with the scientific community is insufficiently developed, so the advantage of circular design in the process itself is not understood. This leads to the conclusion that there is no adequately trained staff.

Inadequate management of both regular waste and hazardous materials, illegal landfills, show that there is a low level of awareness about the potential of waste as a raw material for production. As for the market of secondary raw materials, it can be considered underdeveloped.

Awareness of environmental protection is not sufficiently developed even among consumers, so circular demand is considered undeveloped.

4 DISCUSSION

On the transition to a circular economy, the Republic of Serbia faces many problems and difficulties. Inadequate staff and insufficiently developed awareness can be cited as the main reason.

Postponing the acceptance of the rules of the circular economy or its slower introduction can cost its citizens and the economy a lot. Indirectly, this can refer to the advantage that can be obtained by the early introduction of the circular economy, positioning of own products on the world market, and directly the complete reconstruction of the entire system.

The Republic of Serbia has major problems with polluted air, water, and land, and it is necessary to improve the system of environmental protection, reduce the exploitation of natural resources, and increase the share of renewable sources in the production of electrical energy. In order to realize this, it is necessary for the Republic of Serbia to harmonize its regulations with those of the European Union.

Although the concrete changes towards the circular economy mostly refer to the technical-technological and economic fields, they also include a change in consciousness. In order to achieve this, it is necessary to educate both professional staff and the entire population.
5 CONCLUSION

The circular economy represents not only a change in industrial processes but also in the way of thinking itself. In contrast to the linear model of the economy, which does not care about the amount of waste generated and the use of resources, in the circular economy, the priority is placed on saving and reusing products so that as little as possible ends up as waste. By introducing a new product design, existing resources are saved, the use of harmful materials is reduced, and the life of the product itself should be extended. With a longer life span, reuse of the used product, final waste is reduced and we are moving closer to the EU goal - "zero waste". There is no universal model that could be implemented, so it is necessary for each country to find the most adequate solution for its introduction.

In order to transition to a circular economy model as successfully as possible, it needs to be placed within the framework of the national strategy, in a way that is socially acceptable. The circular economy requires multiple actors and different sectors for successful implementation, so it is necessary to first identify the priority sectors and the required staff.

The circular economy is considered a new industrial revolution and therefore brings with it the modernization of industrial facilities, a shift towards new sustainable technologies, and the creation of conditions for "cleaner production".

On its way to EU membership, it is necessary for the Republic of Serbia to harmonize its policy and legislation with the EU, accept the policy of sustainable use of resources, change its energy policy, and promote renewable energy sources. It is necessary to invest in and develop cooperation between science and industry, as well as support the transition of science for the needs of industry development.

As one of the main problems that must be worked on in the Republic of Serbia is raising social awareness, i.e. education, active democratization of society, through the influence of information, participation and influence of the public on decision-making, reduction of consumerism, and greater support and valuation of domestic, local products and service.

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Threats and opportunities for the participation of energy cooperatives in the energy transition in Southeastern Europe

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ABSTRACT

Renewable energy cooperatives, as a way of organization and participation of citizens in the energy transition, although widely represented in the countries of Northern and Western Europe, and recently expanding in Southwestern Europe are almost non-existent or rarely present in the countries of Southeastern Europe.

Energy markets of Southeastern Europe, often heavily dependent on coal or other fossil fuels, are characterized by energy-producing capacities that are more centralized than the European average. The price of energy is lower than in Western and North parts of Europe, while the energy transition is delayed in comparison to the more developed parts of Europe.

In addition, general indicators, such as those related to sustainable development goals, are less favourable in this part of Europe, but also the simple indicators, such as air quality index, are (as a rule) lower in the observed countries. This also could apply to different socio-political forces shown by indicators; e.g. Corruption Perceptions Index or Quality of Democracy Index, and their correlation with the observed differences in the reached level of sustainable development in the energy sector should be investigated.

The consequences of the current situation could be immense and are raising a whole range of concerns. Turning away from small and decentralized plants to the large solar and wind farms suitable for the participation of corporations / large capital and completely excluding the citizens from the energy transition is one of the major concerns. The other important concern is the possible abandonment of renewable sources and long-term orientation toward nuclear energy in the response to the climate crisis. On top of all that, the worst-case scenario includes the possibility that these unfavorable circumstances contribute to an unfair energy transition while deepening social inequalities. The outcome of the incomplete energy transition could be so deep, resulting in the degradation of achieved civilization values, such as the degree of democracy or the level of corruption.

This paper gives an overview of the above-mentioned circumstances and difficulties the citizens from Southeastern Europe willing to participate in energy transition are facing. The proposed solutions or possible scenarios that could strengthen the position of citizens and possibly accelerate their participation in the energy
transition will be also presented. Where applicable, special emphasis will be applied to the situation in Serbia.

1 INTRODUCTION

Europe, particularly the EU-15, with over 3000 RES cooperatives, could serve as a model for citizen participation in the energy transition. On the other hand, cooperatives could be characterized as niche players, even in places where energy cooperatives are most active since their number is still insufficient (e.g. 900 energy cooperatives are documented in Germany, while Germany has 10,800 municipalities). The formation of energy cooperatives and supporting infrastructure in Eastern Europe (or post-socialist Europe) is just getting started (Figure 1.), and the presence of cooperatives in these countries still does not qualify for the title of someone who occupies a niche market.

![Figure 1: Power plant distribution and distribution of energy cooperatives members of RESCOOP in Europe](image)

Energy sectors in Southeastern Europe (SEE) (Albania, Bosnia and Herzegovina (BiH), North Macedonia, Montenegro, and Serbia) may be considered comparable. There are some differences, but the similarities are:

- Centralized production of energy;
- Production of electricity is (highly) dependent on coal and fossil fuels (except in Albania, that is predominantly relying on hydro energy). Within the borders of the EU, electricity production is comparable to the situation in Poland;
- Countries are energy dependent on other energy markets;
- The energy transition in its true sense has not yet begun;
- Exploitation of solar and wind energy is just beginning;
- The price of electricity is among the lowest in Europe (in all countries the price of electricity for households in 2022 is below 0,1 €/kWh);
Energy poverty and access to clean fuels for cooking are, on a European scale, very pronounced, especially in social groups that are already threatened, such as the Roma population;

Citizen-produced energy is almost non-existent.

On the social level, there are also similarities, the Corruption Perception Index in mentioned countries ranges from 64th (Montenegro) place to 110th place (Bosnia and Herzegovina and Albania) out of 180 observed countries globally. Within European borders, this result is proportionally lower. The democracy index for all countries is the same - Transitional or Hybrid Regime.

It is worth mentioning that the development and even existence of cooperatives in parts of Europe other than the EU-15 are understudied or underpublished, especially in the English language. They are often viewed in clusters and one label is attached to a group of countries as in. Regarding that, there are calls from the scientific community to scholars to “analyze CE developments in their countries in depth to increase knowledge, and enable fruitful comparative analysis as well as relevant policy recommendations.”

Therefore, the following observations will be made for Serbia, as a contribution to the catalog of knowledge. Besides, a large part of the conclusions are also applicable to the mentioned surrounding countries, but in that context, they should not be taken for granted. It should be mentioned that the authors are members of the Serbian energy cooperative Elektropionir, and this paper is the result of the work that the cooperative went through in search of a sustainable way of involving citizens in the energy transition, under current conditions.

2 THREATS

Postponing the energy transition and not solving the problems accumulated over decades opens the door to the tendency to solve the problems in a short time. Then the slide toward nuclear energy becomes tempting as a solution (similar to the case of Poland), opening up a series of problems. The introduction of nuclear energy means that the energy sector remains highly centralized, while for at least one decade the region will remain heavily dependent on coal, and in the same period, systematic investments in RES will be thwarted by investment in nuclear energy. A special type of challenge in the observed countries arises on the issue of transparency in such extremely investment-intensive ventures in this or any other highly centralized source of energy.

Also, the non-inclusion of citizens in the energy transition, although there are technical possibilities for their participation, creates other threats. As stated in the European RES market is already subjugated to large companies. In the SEE countries, characterized by a high level of corruption, large capital has even greater penetrability reaching decision makers easier and dwarfing citizen’s investments. In perspective, this situation may result in the transfer of electricity production potential from state-owned directly into the hands of large companies. This development of the situation reduces the possibilities for completing the energy transition, building a just society, and reducing energy poverty.
The fragility of the citizen-led RES projects in Southeastern Europe is undermined by:

- Decision makers show no ambition to involve citizens in the energy transition. This lack of ambition is expressed as an absence of an effective roadmap or state strategy(s). Although often declared, strategies are either not meaningful or not visible or they are not perceived by the public as strategies that are highly prioritized;
- Slow bureaucracy and long permission processes\(^1\);
- Administrative barriers and/or overcomplicated procedures;
- Low price of energy resulting in questionable payback periods;
- Industry and large capital can count on higher energy prices and more profitable investments since, as a rule, they invest in larger plants with lower prices per installed kilowatt. This circumstance does not directly undermine the participation of citizens in the energy transition, but it gives an initial advantage to large capital, which can result in citizens being excluded from the energy transition;
- The legacy of previous decades, wars, and transition to market economies, results in discouraged citizens who are suspicious of any form of joint action. On the other hand, the system with authoritarian tendencies thrives on this wave of mistrust, demonstrating no need to reverse this trend and restore citizens' trust in one another.

### 3 OPPORTUNITIES

Probably the greatest opportunity for involving citizens in the energy transition is the very moment in which Europe and the world find themselves, i.e. the energy crisis triggered by the Russian-Ukrainian conflict. The volatility of the energy market, and uncertainty of supply, but also accumulated problems in the field of energy and environmental protection, especially in the SEE region, are circumstances that are a good trigger for the activation of citizens.

Regardless of the current moment, grassroots movements are on the rise in all the above mentioned countries in the past decade, with different (yet the same) goals, ranging from demands for clean air to the protection of free-flowing rivers in the Balkans. While promoting different goals, they are simultaneously opposing mainstream trends that could be summed as a combination of a tendency toward authoritarianism and Balkanization.

In that sense, the principles that (energy) cooperatives are sharing\(^14\):

- Voluntary and open membership;
- Democratic member control;
- Economic participation through direct ownership;
- Autonomy and independence;
- Education, training, and information;
- Cooperation among cooperatives;
- Concern for the community;

are also the principles that are fundamentally opposing mentioned trends.
Those shared values or principles are promoting changes in various fields, from the creation of jobs, and changes in the working and investment environment, to the promotion of full partaking in the economic and social growth of all individuals. Besides, as stated in they can tie individuals with local (economic) actors, accomplishing an all-encompassing social consensus. When talking about energy poverty, cooperatives are promoting energy democracy through joint decision-making, and enable individuals to contribute to the energy transition through the infrastructure they are building.

Examples from Northwest parts of Europe are showing that the involvement of citizens (prosumers) can empower them and lead to deeper and more essential participation of citizens in the energy market: from energy storage, through the establishment of energy supply companies or P2P market mechanisms, all the way to taking over the parts of distribution networks.

Also, these specific values that cooperatives cultivate also ensure a win-win relationship with the members of the cooperative, which promotes loyalty and word-of-mouth promotion of the cooperative, which can, under favorable circumstances, result in the rapid growth of membership in a short time.

An example of a wind farm project Vép from Hungary where an investor handed over 20% of the power plant to the locals, making them co-owners, is an example of how large investments could be channeled ethically. Such a practice, if it takes root, could be particularly useful in the aforementioned communities affected by energy poverty. On the same track, cooperative Ecopower cvba from the northern part of Belgium has the justest billing structure in the Flanders region.

A huge opportunity lies in the possibility to relieve prosumers of burdensome procedures. For example, Portugal is not attaching any fees on self-consumption PV under 30 kWp, while only installations rated over 100 kWp need approval from the grid operator. In Latvia systems below 11.1 kWp also need no permits. At the same time, the time limit, if not the cancellation of procedures, could also be very helpful. E.g. Lithuania has suggested that procedures should be finished within 30 days.

Unrelated to the cooperative model, there are recent examples of good practice in SEE countries as well, which refer to the involvement of citizens in the energy transition through the prosumer model.

Interested citizens of the Republic of Srpska can apply for the energy sustainability program for households and businesses, within which 50,000 households will be selected. The project implementer is "Elektroprivreda RS", and the project will be realized so that households that receive a photovoltaic plant will pay a reduced electricity bill for the next 25 years, and for 10 years they will pay a part of the plant's value, after which it will become the property of the citizen.

Similarly, the Electric Power Company of Montenegro (EPCG) has announced an opportunity for citizens and businesses to apply for the "Solar 3000+" and "Solar 500+" programs, which will enable 3,000 households and 500 businesses to get photovoltaic power plants and become producers and sellers of electricity.

Ex-Yugoslavian countries have a great historical legacy, with numerous examples of autochthonous cooperatives that once were successful, and drivers of
(mainly rural) development. The spirit of those cooperatives, if not the mission, could be revived.

Cooperative Elektropionir, following cooperative values (education, training, and information), conducts a course "Solartehnika narodu" (solar to the people) semiannually. Answers and outcomes from communication with participants (around 210 respondents, the number varies from question to question) are shown in the images below.

Depending on the milieu from which the respondent comes (NGO, local government, or citizens), the answers to the question "who should lead the energy transition" are somewhat different. Regardless of the differences, from a quarter to a third of all respondents believe that it is the State that should lead this process. After that, trust goes to the local administration, although this opinion is not shared by the non-governmental sector. The third in order are the citizens, but now this opinion is not shared by a large number of respondents from the local administration. Corporations, industry, the state-owned energy company, and the other answers offered generally do not rank highly (Figure 2).

![Figure 2: Answers to the question “Who should lead the energy transition in Serbia?”](image)

As identified in having other-than-profit goals is a relevant motivation for citizens willing to participate in the energy transition. Energy cooperative Elektropionir confirmed this kind of interest/worldview is translated into action through the first successfully launched and in 2022 completed crowdfunding campaign for the construction of two solar power plants (total power 10 kWp) on Stara Planina, a mountain located in the southeast of Serbia.

It can be concluded that among the participants of the training there are about 1/3 of those for whom profit (or payback period) is not a priority and approximately 2/5 of those for whom profit maximization is not a priority (Figure 3 and Figure 4).
Figure 3: Answers to the question “What are your expectations from payback period in solar energy?”

Figure 4: Answers to the question “Should profit from an investment in solar energy be certain?”

Similar to the previous answers, the willingness of citizens to participate in the energy transition through participation in the work of energy cooperatives is around one-third. Another third is willing to consider this kind of involvement in the energy transition (Figure 4).
Figure 5: Answers to the question “Are you interested in joint investment in a cooperative power plant?”

Method of participation, i.e. the source of finance or goods by which interested citizens would participate in the associated citizen energy production also varies. The largest number of respondents would participate with their savings or a combination of savings and their own land. Citizens are not interested in going into debt or loans for the sake of participating in the transition (Figure 6).

Figure 6: Answers to the question “How/what would you like to invest in a shared power plant?”

Depending on whether citizens are thinking about their own power plant or about participating in a cooperative power plant, the motives for investing can be different, as shown in Figure 7 and Figure 8. The dominant answers in the case of own power plant concern environmental protection, cost reduction, but also making a profit. In the case of investing in a cooperative power plant, these motives are different. The dominant response is to save money in a model similar to that of investing in a pension.
fund. After that, the list of motives is followed by profit, and participation in the energy transition in third place.

**Figure 7:** Answers to the question “How do you see the investment in your own solar power plant?”

**Figure 8:** Answers to the question “How do you see the investment in the joint power plant?”

**CONCLUSION**

The paper identified threats and opportunities for more fundamental involvement of citizens in the energy transition in Southeastern Europe, especially through the cooperative model. The threats are mainly the result of decades of neglect of the energy sector and insufficient engagement or motivation of decision-makers to involve citizens in the energy transition.

The identified opportunities rely on the developments of the situation in recent years, but also on the circumstances created by the energy crisis triggered by the conflict between Russia and Ukraine in 2022. These circumstances have led to a change in the perception of individual citizens in the direction of accepting alternative views on investment, where other-than-profit goals are becoming more acceptable than ever in the recent past. Educating citizens so that they can see the energy sector as part of a wider whole will result in understanding the fact that inaction also entails consequences, which are often greater than those that come with the possible loss of part of the expected earnings from investing in green energy.

The opportunity created by the current circumstances opens up the possibility of moving the risks into the future since, according to everything we know now, the price of energy will continue to increase while public awareness of the importance of the environment will grow. In this way, e.g. the model of reinvestment of the profit
generated by energy production in the new production capacities a favorable financial performance could be achieved.

But even if the worst-case scenario plays out and the profit is not made, the benefits for the society such as increase in citizens' trust in each other, or the benefits for the environment, will remain as a result of this engagement.

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Sustainable tyres waste management in a circular economy

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ABSTRACT

The increase of inhabitants, the rise of living standard and the development of auto industry caused the increase of the tyre production. At the end of life span the tyre when losing its functionality become waste – the tyre waste. The tyre waste can present a danger for human health and environment if not treated adequately, apropos if burned uncontrolled or deposited illegally. The contemporary consumer-oriented society functions on the principle of linear economy “make-use-dispose”, whereas the raw material values including the waste one disposites of, apropos expulse permanently from the life span. As a response to such unsustainable way of functioning of the modern humanity a new production direction – circular economy has been developed. According to the CE the definition of waste “the product we discard” translates into the new definition “the raw material on the wrong place”. In Bosnia and Herzegovina, the management of tyre waste is still on a very low and unsatisfactory level. This Study presents the actual literature data on innovation access to tyre waste management in accordance with the CE principles, apropos “7Rs” approach (redesign, renew, reduce, reuse, repair, recover and recycle).

1 INTRODUCTION

The increase of inhabitants, fast urbanisation and grow of consumer power leads directly to higher usage of bicycles, motorcycles, buses, lorries, airplanes as well as cars, therefore increasing the tyre production. The overall tyre production in the world in 2019 was 19.25 million tonnes. In the European Union (EU) in 2018 the production was 5.1 million tonnes of tyre, including the sale of 310 million pieces of automobile and light lorries tyres and 14.2 million pieces of tyres for lorries and buses [1]. The tyres are necessary for mobility and crucial for human safety. They perform numerous functions in the vehicle: (1) carry weight of the vehicle transferring the weight to the surface, (2) ensure adhesion between the vehicle and the road, (3) act as the vibration absorbers, increase the comfort and road safety, and (4) improve the overall vehicle
performance. The 65% of overall tyre production is used in the auto industry [2]. About one billion tyres is discarded annually in the world, out of which 10% is recycled and approximately 75% is deposited [3].

As an example of good practise of tyre waste management is the system for tyre waste management in the Republic Croatia. The system of waste tyre recycling in Croatia was established in 2006, and it has been organised by the Environmental Protection and Energy Efficiency Fund. In 2020, 28,480 tonnes of tyres were put on the Croatian market. 25,066 tonnes of waste tyres were collected, and of that amount, 83% was processed, with 96% of the processed tyres having been used for materials recovery and only 4% for energy recovery. Using the tyre as a recovery materials results in the production of rubber granulate, textile, steel and rubber shavings. The recovery materials are used in the production of rubber floors for playgrounds, paths, promenades and running tracks. The rubber granulate is used in the bitumen mixture for asphalt and for production of artificial grass for football fields, floor coverings, containers’ wheels and wheels for bins. The steel from tyres is a valued raw material used in steel industry, and the textile is used by cement factories for energy recovery. The tyre waste is also a proficient energy source and can be used for fuel production, having excellent characteristics [4,5].

In Bosnia and Herzegovina (B&H) in 2021 about 18.554,71 tonnes of new and 2.472,08 tonnes of used tyres was imported and 129 tonnes of new and 246 tonnes of used tyres was exported. [6]. According to the data from the Republic Srpska (RS) Statistic agency and Statistic agency of Federation of B&H in 2018 about 78, apropos 204 tonnes of rubber waste was collected. In total 282 tonnes were collected. These are official data from the 2021 Report on rubber waste. There are no data on tyres waste, while the newer data have not been yet published. Per some researches the tyre waste quantity in B&H is 7321 tonnes per a year [7].

Managing the waste tyre in B&H is still on an inadequate level and the sub-legal acts regarding this category of waste are passed in 2021 and 2022. In RS the tyre waste management is regulated by the Rulebook on tyre waste management [8]. This sub-legal act obliges the producer, importers and salesmen placing the motor vehicles in use on the RS territory to pay a fee for encumbering the enviornment with this waste category – tyre waste, proportionately to the quantity of tyre they have place in use. The Rulebook on tyre waste management in Federation B&H has regulated this fee same as the RS[9]. The Regulation on waste depositing on the landfill in RS strictly forbids disposal of tyre waste on the landfill[10], and the Rulebook on tyre waste management in RS under the treatment of this waste category comprehends recycling and reuse of tyre waste in energy purposes.

There are two types of tyres, synthetic and natural rubber. The natural rubber is collected from the ripe trees of caoutchouc that are planted in the tropical areas. As the production of natural caoutchouc, apropos natural rubber is limited and can not meet the overall market damands the sintetic rubber was developed during the Second World War. The styrene butadiene caoutchouc is a synthetic rubber that is polymerized by using the monomer styren and butadiene. The styrene butadiene caoutchouc has become one of the most important synthetic rubbers in the World due to huge production as this type of rubber proves good resistance to abrasion and has good
stability. This is the main reason why the synthetic rubber is mainly used for production of tyres[11].

The natural rubber is used in systems that require high durability, while the synthetic rubber is used in materials for treading layers in order to secure good adhesion of pneumatics. The additives that are used in the synthetic rubber are antioxidants, processing aids in the production process, such as silicon dioxide, textile, fiberglass and iron wires (brassed, bronzed or galvanized) that provide the stability and strength of rubber [12]. The tyre contains in average 41-48% of rubber, 22-28% of carbon black, 13-16% of metal, 4-6% of textile and 10-12% of additives [13]. The tyre waste is not biodegradable [14] and presents a risk to human health and environment because they are flammable, infested by rodents, insects, reptiles and occupy a large space at the landfill [15]. In case of burning, tyres produce significant air pollution, contamination of the soil and surface and ground water problems. Preventing the burning of one tonne of waste tyre can decrease the emission of 450 kg of gasses and 270 kg of soot into the environment.

According to the statistical data of European Tyre and Rubber Manufacturer's Association [16] in 2019 about 95% of waste tyre was recycled applying one of currently available and acceptable manners: (1) civil engineering using whole tyres in safety barriers, retention tanks or backfilling, (2) energy recovery, especially incineration in cement kilns, (3) pyrolysis (4) material recycling consisting mechanical disintegration of waste tyres and further use of prepared ground tyre rubber [17]. The remaining 5% of rubber was discarded, burned or illegally deposited.

2 CIRCULAR ECONOMY

The current linear economy based on the principle „make, use – dispose“ is unsustainable because in 2020 only 8.6% of global resources have been reused[18]. In order to fulfil material needs of this traditional linear economy system we need 1.7 planet Earth [19] enforcing the life on our planet to function outside its safety and natural laws and limitations[20]. The humanity must act immediately in order to avoid the irrevocable damage of environment and sustainability of our planet. Hence, the paradigm of circular economy (CE) spread among the academics, practicians and policy creators as a promising alternative. This paradigm endeavour to use resources maximally following the “3Rs” principle: reduce, reuse and recycle. The World is moving toward the CE that is focused on waste decrease and keeping the material in use as long as possible. The CE is a new way of creating the values and ultimately the prosperity. It acts so that it extends the lifetime of a product through improved design and servicing, and moving the waste from the end of the supply chain to the beginning, actually more effective use of resources as it is reused again and again, not just once (Figure 1). The circular economy aims to keep the value of the product and material as long as possible with generating a minimal quantity of waste. The final goal of promoting the EC is a separation of the pressure on environment from economic growth [21]. The initial axiom circular economy is an economic model that encourages the so called „3Rs“ principle (reduce, reuse, and recycle). This basic axiom of EC is further
augmented to principle „7Rs“ (redesign, renew, reduce, reuse, repair, recover and recycle) [22].

From 1999 the depositing of tyre waste is legally banned by EU directive on landfill 1999/31/EC[23]. The framework directive on waste 2008/98/EC provided a concept and definitions regarding the tyre waste management [24]. Accordingly, the options for management are prevention, minimalization, reuse, recycling, producing the energy and depositing.

As for the circular economy context there is a tool for reducing the production of waste and difficulties caused by transforming the linear systems into the cirucal a concept of extended producer's responsability (EPR).

This is defined y the EU framework Directive 2008/98/CE on waste[24].An important document for the treatment of waste vehicles, which also regulates the treatment of waste tyres in the EU, is the Directive 2000/53/EC on end-of-life vehicles [25]. The implementation of extended producer responsibility (EPR) is indeed organised at various degrees by this Directive. The Directive establishes the responsability in pripor design phases and product manufacture, as well as the access of the policy according to which the producers have more significant financial and/or physical responsability for treating or despositing of theri products. Likewise, it can be defined as a system transferring the responsability on the producer for managing the waste generated when their products become waste[26]. For the rubber industry the CE starts with the development of the design of tyre for optimal performance and longevity. The tyre producers in EU have undertaken significant steps in order to ensure that their production processes use raw material able to reduce the waste in a
sustainable way and when technically possible to replace the materials having the possibility to disable the recycling of pneumatics at the end of lifetime.

During the tyre utilization the new vehicle technology aids the drivers to ensure the optimal maintenance by indicating the disfunctioning such as low pressure in tyres and suboptimal load. This has recognizable measurable effects in extending the lifetime of pneumatics. Several steps in designing the tyre have been undertaken. This enables repairments and reuse, extends lifetime of pneumatics and reduces the negative impact on environment. The lorry's tyres, for example, are designed to that they can be retreaded up to three times [27].

3 CIRCULAR ECONOMY APPLIED TO TYRES

Globally, the concern regarding the recycling and recovery of waste tyre, elimination of accumulations on the landfills and usage of by-products for natural resources preservation has increased.

In many developed countries several innovative methods for recovery and recycling of used tyre are applied [28]. The technology of reuse and recycling of tyre waste offers three key advantages: (1) reduces the global warming; (2) preserves the resources for future generations and contributes to cleaner environment; and (3) reduces the society’s dependency on fossil fuel sources [29].

3.1. Applying the CE model and “7Rs” to waste tyres

Redesign. When designing tyre, it is necessary to take into the consideration the principle of minimizing the quantity of resources used for making a product with desired characteristics. Hence, in case of tyres, the quantity of material must be optimized so that each product contains an adequate quantity of rubber or additives. If the proportion of these two components is not optimal, the final result can be a product with unsuitable characteristics causing a huge usage of material and energy. The rubber matrix can, indeed, contain different chemical additives, including heat stabilizers, plasticisers, colours and flame retardants. This diversity becomes a problem regarding the recycling of the product at the end of its lifetime. The large choice of materials can provoke issues in the process of separating and recycling the components. Hence, a solution for minimizing the usage of different types of materials should be adopted, but simultaneously the functionality of finished products should be ensured [30].

The implementation of CE in the tyre production should fulfil following basic demands: (1) using the raw materials and additives that can be recycled, (2) redesigning the products in order to ensure material structure homogeneity, (3) redesigning the shape of products is order to extend the lifetime, but to clearly indicate the parts of the product that show certain homogeneity of structure, (4) setting the phase of designing the product structure, so that those parts that are functional and valuable after the product is discarded, can be return for further reuse and/or reconfiguration in the new product [31].
Self-sealing, innovative tyre concept and design (Figure 2), includes the need for a sealing material placed as an inner layer under the treading layer, so called self-sealing tyre. When the tyre is flat, the seal prevents the loss of air pressure by sealing the hole. This modification of tyres enables the driver to travel safely up to 80 km. Also, the self-sealing tyre eliminates the need for using the spare tyre, preserving the natural resources and freeing the space in the boot [33]. The tyres can lose approximately 3-6% of pressure per month without driver’s knowledge and cause increase of fuel usage up to 4%, simultaneously reducing the lifetime of pneumatics for 45%. Many manufacturers also develop sophisticated detection systems (chips or sensors) that integrated in the tyre can wirelessly pass the information on pressure, tyre temperature and scuffing of the treading layer, alerting in case of malfunction[34]. In practise there are two types of tyre sensors: (1) sensor/pump installed in the pneumatic structure eliminates the need for driver to control the tyre pressure manually and (2) sensor for tracking the tyre pressure that alerts the driver in case of pneumatic perforation or inflation under the allowed threshold. These sensors improve the safety, pull, driving, fuel usage decrease, break efficiency rise, reduce tyre scuffing and extend lifetime of pneumatics [35].

Renew. The rubber production from the renewable sources has a goal to attain sustainability and reduction of dependability on fossil fuel, conditionally this natural tyre must be resistant to tearing, impacts and wearing. The production of natural rubber from the caoutchouc tree (*Heveabrasiliensis*) cannot fulfill rising world demand and therefore new alternative solutions are being researched. Two plant-based cultures can present the alternatives for caoutchouc tree: (1) Russian dandelion (*Taraxacum kok-saghyz*) and (2) guayule (*Parthenium argentatum*). The Russian dandelion is fast-growing resource and produces a large quantity of biomass, and the natural rubber from the Russian dandelion shows excellent chemical and physical properties [36]. The natural rubber from guayule has similar properties as the natural rubber from caoutchouc tree, but it takes two years for this plant to mature [37]. Russian dandelion flourishes in cold climate, while guayule flourishes in arid climate. These facts should be considered when choosing the natural resource and location for production facility. The lack of using these plants in the production is still high as these processes for tyre production are quite expensive. [32].

Reduce. The reduction consists of optimal material usage in the tyre production, apropos this industry branch aims to reduce the rubber weight. Approximately the quarter of rubber material corresponds to fillings such as carbon black. The aim is to reduce or replace the carbon black with other fillings such as other types of carbon,
black lead, etc. The new approach in tyre design focuses on tyres with small rolling resistance. The reduction of rolling resistance is an effective method for reduction of fuel consumption and \( \text{CO}_2 \) emission. When the tyre rolls on the road, the mechanical energy is spread as a heat due to friction, which is known as the roll resistance. The roll resistance, therefore, plays a key role in vehicle fuel consumption increase. The advantage of tyres with small roll resistance for the environment induces the demand for such products all over the world [32]. The tyre producers search for innovations that will lead to sale rise and efficiency per demands for more dependable, sustainable and more innovative products. For the buyers, the sustainable tyres have smaller impact on environment, last longer and improve fuel cost-effectiveness. For producers, the sustainable tyres improve the market cut, reduce discarded products and rise profit margin. The particles of tyre wearing and roads, even though it is not strictly speaking microplastic, are present in the environment, especially in the water eco-systems. The assessment shows that freed particles of tyre wearing contribute from 5-10\% to plastic discharged into the oceans [38].

**Reuse.** The reuse is every procedure by which the product or its parts that are not waste are reused for the same purpose for which they were initially made. Indeed, the reuse presents the extension of the lifetime of the product until the product reaches the time for its final disposal. The treading layer of the tyre is the most critical part of the tyre because by the friction process it is used and damaged. The renewal or re-treading the tyre is a technology enabling the reuse of the used tyres by changing the used or damaged external layer with a new rubber layer. The load structure of the tyre usually last longer than the treading layer and that is the main reason for developing the re-treading as a method for tyre renewal. If the load structure is preserved, instead of disposing the tyre, it can be rethreaded and reused. The re-treading is a safe process of reusing that implies changing the treading layer by applying the heat and pressure, preserving the structure and maintaining the tyre performances. The tyre can be renewed several times depending on the type and conditions. The renewal is also the way of reusing that saves energy, material and natural resources. It is safe, cheap and ecologically acceptable solution [32].

The whole disposed tyres are used for specific purpose such as protection of the banks, construction of erosion barriers, artificial underwater reefs, piers, avalanche shelters, stabilization of slides, forming the road buffers, placing the noise barriers, etc. In the USA (in the area of the town Fort Lauderdale on Florida), at the coastal area on specific location a million whole waste pneumatics are deposited per a year. This pneumatics serve for construction and extension of the artificial underground reef. The research shows that such reefs are inhabited in time by sea fauna and flora and fish accept them as natural inhabitants. The purpose of this project is the return of some otherwise vanished types of fauna and flora to the mentioned area. The price of such reef is much lower than the artificial underground reef made of concrete material [39].

**Repair.** The repair is a part of CE principle whose purpose is to extend the lifetime of a product. The repair enables raw material and energy savings and enables the waste reduction. Inspired by nature the scientists have been motivated for a long time to develop materials for self-healing. As a result, different types of materials for self-healing, from solid concrete to soft elastomers were introduced. Some of these
materials have excellent mechanical properties, repeated self-healing and easy processing [40]. Achieving such healing in rubber is extremely challenging as transversal links constrain the polymer chains to form new links over the previously damaged areas (Figure 3). Different dynamic reversable groups, such as hydrogen bonds, disulphide and ion interactions have attracted even larger attention in the tyre area in order to self-heal. The combination of different mechanisms for self-healing at the moment occurs as a strategy for ensuring the optimal compromise between mechanical performances and repairability [32]. Even though this field of research is rising and gaining attention all over the world, the self-healing tyre are still far from acceptable for use in the rubber industry due to its low mechanical firmness [41].

![Figure 3: Mechanism for tyre self-healing [42]](image)

**Recover.** Recovering the energy and material offers complementory alternative for solving the tyre waste issue and obtaining the goals for sustainable development within the principles of CE. The pyrolysis, gasification and incineration are technologies of thermo-chemical conversion that convert tyre waste into the valuable chemical products, fuel and energy[32].

The pyrolysis of tyre is separation of micro-molecules in the tyre with preservation of bonds between carbon and hydrogen. The processes happen on higher temperature (>430°C) without oxygen. The tyre present the raw material with a high content of carbon and the products of ist pyrolysis are: (1) gas (CO\(_2\), CO, H\(_2\), H\(_2\)S, carbo-hydrogens), (2) oil (aliphates and aromatic compounds),and (3) carbon dust. Cooled pyrolytic gas can be used as fuel oil, apropos for production of lubricants[43].

Gasification is a process of a partial oxidation that uses pressure, heat and reactive agents (air, oxygen, hydrogen or steam) for converting the waste tyre into the mixture of gas, so called synthetic gas that consists of CO, H\(_2\), CO\(_2\) i and light carbo-hydrogen (CH\(_4\)). The synthetic gas is used as a fuel in combustible cells or gas turbines for obtaining a wide specter of other fuels and chemicals [32].

Incineration is the oxidation of combustible material in order to get inert waste. This is an exothermic and spontaneous process with high temperatures (1000 °C). The waste gas are H\(_2\)O, O\(_2\), CO\(_2\), dioxins, etc. By incineration of tyre the energy is produced and it can be used as fuel for cement furnace, in thermo-electric plants, paper and cellulose factories, steel mills, steam boiler industry, installations for waste water purification or farms[32].

**Recycle.** The recycling of waste tyre comprehends splitting, apropos tearing tyres into the tiny parts. Depending of applied temperature and method, the mechanical recycling can be: (1) cryogenic crunching (crunching previously frozen tyre with liquid
nitrogen at the temperature of -80 to -100ºC. At this temperature the tyre is breakable and can be cut easily and more easily the textile and metal parts of the tyre can be separated from rubber parts. The lump granulate obtained by this method of crunching if from 0.4 to 0.6mm) and (2) mechanical grinding (performed at the room temperature whereas the tyres are crunched or torn to smaller pieces. After shredding a process of separation follows. In this process the iron threads and canvas are separated from the rubber granulate. The rubber granulate is a fraction of 0.4 to 4 mm, depending on the size of toothed roller in the pulverizer and number of repeating the cutting process) [44,45].

The rubber granulate is used for making new rubber products: (1) in construction as lining for roof insulation, noise barriers, waterproof membranes, rubber pipes, (2) in traffic (as an addition to asphalt for increased treading, better breaking, vibration and noise reduction, when constructing the railroad crossing), (3) sport and recreation (base for sport fields and playgrounds), (4) households (rubber objects, floor, coverings), (5) agriculture (floors for stables and in equestrian sport).

**CONCLUSION**

This Study confirms that the tyre waste represents a valuable resource and that it is essential to manage the tyre waste in accordance with the strategy set by the model CE and principle “7Rs” (redesign, renew, reduce, reuse, repair, recover and recycle). In the production phase, due to optimization and redesigning of tyres the performance of pneumatics would be improved and consequently the process of recycling with a positive effect regarding the energy consumption in the waste recycling and reduction of negative impacts on environment. In the consumption phase, the re-treading and repairment processes extend tyre lifetime and this technic has ecological advantages. The phase after the consumption is the main management ways are focused on application for energy and material recovery.

The tyre waste management in B&H should be improved through: (1) better availability and tracking the data on tyre waste quantity, (2) reducing the activities of uncontrolled waste disposal on illegal dump sites, (3) focusing on tyre treatment after the consumption such as re-treading, using for energy purposes or reuse. In order to obtain the goal of sustainable tyre waste management it is essential to develop an overall system for managing the used tyres and change the paradigm in which the tyre waste is considered just a waste, instead a resource.

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(Management of used tyre, world achievements and state in Serbia)


(Option of optimal process of pneumatic waste management)

(Recycling and redoing of pneumatic waste, Conference on quality – Festival of quality)
Energy transition – looking for a different perspective

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ABSTRACT

With challenges ahead of us, the energy sector needs a new culture of energy consumption based on responsibility and democracy, on renewable energies, energy efficiency and savings. Energy communities, especially in the form of renewable energy cooperatives (RE Coops) has brought the increasing acceptance of renewable energy and overcoming uncertainty and indifference regarding renewable energy projects in parts of the world where it was accepted by policymakers and incentivized. This paper is looking at the aftermath of feed-in-tariff withdrawal, its consequences on RE Coops and the lessons learned for business models in today's energy market. It should also be a valuable review of possible business models for RE Coops in the countries that cannot count on the favourable legislative and incentives like countries in South-East Europe.

1 INTRODUCTION

Broadly acknowledged for the long-term energy transition, energy communities occupy a prominent place in the European policy makers' vision of an Energy Union. Energy communities represent an alternative type of market actor, and alternatives to traditional ownership structures. The most common form of energy communities are cooperatives and municipal utilities [1]. Hence, after the liberalization of the energy market and changes in legislation, many RE Coops were founded and they started the implementation of numerous renewable energy projects. However, they are not the only ones. There are two more forms of energy community: Citizen Energy Community (CEC) which is contained in Directive (EU) 2019/944 (recast Electricity Directive) [2], and Renewable Energy Community (REC), which is contained in Directive (EU) 2018/2001 (the recast Renewable Energy Directive) [3].

Even though there are differences within definitions and structures of cooperatives, RE Coops, CECs and RECs, they are a way to ‘organise’ citizens that want to cooperate together in an energy-sector related activity based on open and democratic participation and governance, so that the activity can provide services or other benefits to the members or the local community. The primary purpose of energy
communities is to create social innovation - to engage in an economic activity with non-commercial aims [4]. All these organizations perform three main economic functions: the generation, distribution and retailing of (renewable) energy, usually under the form of electricity, although examples also exist for heating and transport.

Also important to be notice is the aspects commonly shared by different types of energy communities are the principles of cooperatives, which are the following [5]:
1. Voluntary and Open Membership
2. Democratic Member Control
3. Member Economic Participation
4. Autonomy and Independence
5. Education, Training and Information
6. Cooperation among Cooperatives
7. Concern for Community

Around 3000 organizations have been reported as RE cooperatives across Europe, mostly spread in Western Europe (Germany, Denmark, the Netherlands, Belgium, Austria, Northern Italy, Sweden, the UK and France), and to a lesser extent in Spain and southern Italy. In general, European RE cooperatives started in the 1970s and 1980s with the promotion of community-owned wind energy projects but, as time went by, new technologies are being incorporated such as PV, as well as covering heating needs by the use of biomass boilers or solar thermal panels connected to district heating networks [1]. However, in spite of a high share of wind energy, no signs of local and democratic energy projects were found in Portugal and the Baltic countries. This is also the case for other countries where energy supply is dominated by fossil fuels, such as many of the countries in Eastern and Central Europe. The model, with a great diversity of typologies, is present and growing in other regions of the world, such as Asia, Latin America and Africa [1].

Even though there is no straightforward explanation for addressing the differences in the level of development of RES cooperatives in different countries, key factors are the historical influence of the ecologist and anti-nuclear movements, the spread of municipal utilities, the impact of the oil shocks in the 1970s, together with the related policy-responses and the particular socio-political-cultural context. On the other hand, a widespread mistrust of the cooperative institutional structure, born out of its misuse by the establishment during the socialist era seems to lead to less interest for energy communities in Eastern, Central and South Eastern Europe [6].

As researchers and part of academy, we have been observers and actors in energy policy creation and implementation in Serbia since 2004. Unfortunately, we have been the witnesses of the controversy over small hydropower plants in Western Balkans (mostly Serbia and Bosnia and Herzegovina). Under pressure of growing civil movement the Assembly of the Federation of Bosnia and Herzegovina adopted a declaration on the protection of rivers and prohibited the construction of small HPP on the territory of this entity (in June 2020). On the other hand, the new law in Serbia (adopted in 2021) has increased the controversy regarding public criticism of small hydropower plants. Part of the Serbian public is concerned about the proposed new legal norms. Incentives for (small) hydropower plants are a point of issue due to the
potential damage to the environment and the negative impact on natural habitats and on quality of life [7].

From the technical aspect (known and mature technology) and examples of good practice all over the world, the failure of small hydropower plants in energy transition was quite a surprise. Driven by this situation and inspired by the paper of Capellán-Pérez at. al. [1], the researchers of this paper have joined the energy cooperative Elektropionir in 2020 (one of two energy cooperatives established in Serbia).

Elektropionir is a pioneering, Serbian member-owned energy cooperative [8]. It was established in 2019 with the aim to become one of the key actors in empowering ordinary people to more actively participate in the transition of the Serbian energy sector to renewable energy sources. The cooperative aims at establishing a network of decentralized rooftop solar power plants and collective, citizens-owned solar parks throughout Serbia. Elektropionir is also active in facilitating households to become prosumers. Their team is multidisciplinary (architects, engineers, sociologists, philosophers, political scientists, etc.) well connected with research and civil society organizations and other cooperatives in Serbia, the region and the EU. They are also a member of REScoop, the European federation of citizen energy cooperatives, with a growing network of 1,900 energy cooperatives [9].

2 THE DEVELOPMENT AND EVOLUTION OF RENEWABLE ENERGY COMMUNITY BUSINESS MODELS

In this section of the paper, a review of past, current and potential business models of RE Coops will be analysed. The development of community photovoltaic (PV) projects has been dominating activity so in the paper will be analysed energy coops and communities gathered around solar energy generation, distribution and retailing.

Community energy, especially in the form of renewable energy cooperatives (RE Coops), has been credited both by researchers and policy makers with increasing acceptance of renewable energy and overcoming uncertainty and indifference regarding renewable energy projects. Community energy is further said to increase the positive socio-economic impacts of renewable energy projects and to provide an opportunity for democratic governance of renewable energy [10].

Community energy projects typically combine market available technologies with novel technical and social ideas, such as business models, in context-specific arrangements. In so doing, communities are said to perform ‘configurational work’ and are influenced by learning processes internal to the community and from the wider flow of ideas, knowledge and competences via intermediaries moving from project to project. This implies that no two community energy projects are alike. Rather, they share common elements, such as technologies, business models, funding sources etc., that are packaged together according to local circumstances and needs, and according to available policy and regulatory support at a given time. What distinguishes community-orientated projects from developer-led projects is the extent to which they follow participatory processes and deliver local and collective outcomes [11].
There have been three archetypal community PV business models as having played a key role in the evolution of community renewable energy to date:

- Community renewable business models based on grant funding
- Small community PV projects based on Feed-in Tariff scheme (FITs)
- Large community solar PV projects based on FITs and Power Purchase Agreements (PPAs)

By the early 2000s, and through continuous research and development activities, PV costs had dropped to the extent that various governments started providing incentives for deploying solar PV [12]. From then on a range of government support programmes were launched to help community initiatives to form, network and develop capacities before taking on a range of energy efficiency and renewable energy projects. The business model was underpinned by grants and was ‘savings-based’, deriving its revenue from substituting power purchases on the community site. Grants provided support for communities aspiring to own renewable generation projects and certainty for winning groups. They facilitated access to market finance, making projects economically viable. The resultant business model focused on grant specifications and the application process. Groups benefited where they had previous grant writing expertise. Grants also proved surprisingly good at developing a thriving community ecosystem despite the fact they could only ever support single projects: further grants were required to expand group activities [11].

The introduction of FITs significantly altered the landscape in which community PV projects were designed and delivered. It removed community groups’ previous reliance upon grants and encouraged the formation of ‘community enterprises’ with revenue-based business models. The FITs allowed community groups to develop their business cases and secure additional finance around a guaranteed source of income and grid connection [11]. Numerous renewable energy projects were implemented, seemingly in alignment with long-term energy policy [10].

However, in Germany, as in many countries, energy policy has shifted away from providing subsidy support for energy community and towards integrating renewable energies into the energy markets. Changes in the tariffs for solar PV in Germany made typical REC projects less profitable after 2012. Similar happen in UK and Spain in 2010. Structural parallels also exist with developments of wind cooperatives in Denmark and the Netherlands. Under new policy reality, RE Coops have to turn to a new business models.

Reducing margins for small-scale PV projects subsequently pushed communities towards larger installations and encouraged further business models adaptations, which concentrated on the sale of generated electricity through long-term PPA contracts. PPA contracts require a two-step process involving complex legal negotiations, which increases demand for at-risk capital. The ability or nature of borrowing also depends on the PPA contact, which makes it significantly more difficult for community groups to attract investors. This greater emphasis on client-contractor relations increases complexity and transaction costs [11].
2.1 Emerging post subsidy community pv business models

These new emerging business models involve larger, riskier projects that are more complex and require more know-how. For example, one of the most prominent RE Coops in Spain, Som Energia has adapted to this new policy reality through financing the facilities for renewable energy production. Another business model has been adopted by Goiener S. Coop., which acts as an agent in the electricity market and the Technical Accreditation Certificate to access the Spanish Electricity Information Systems.

A variety of post subsidy business models are emerging. New RE Coops business models could be summarized in three areas [13]:

- Investments,
- Energy marketing and
- Energy related services.

Four principal models exist [11]:

1. Existing assets acquired post-construction,
2. Community groups partnering with an established utility to develop renewable energy projects,
3. Refinement of existing PPA models through the incorporation of onsite electricity storage,
4. Reminiscent of virtual power stations and allows generation to be matched with remote clients to create a proxy supply relationship without geographical constraints.

Smart energy systems innovations can be used as one of the tools to provide services or other socio-economic benefits to the members and/or the local community, however the main aim of energy communities is to self-organise around an energy-related activity (e.g. generation and sale of renewable energy) in order[14]. One of the prominent examples for that is Som Energia the first Spanish RE cooperative that in order to deal with the regulation shift and pursuing the objective of installing new RES capacity, in 2015 launched the “Generation kWh” project. This innovative project allowed cooperative members to make investments on “energy-shares”, where the investment is returned in the form of energy consumption reduction in the energy bill, with no interest rates (i.e., interest zero loan), during the lifetime of the power plants built in this way. In this system, an energy return is guaranteed instead of a financial one. So far, nearly 3.5 million € have been invested by 3500 cooperative members and the first plant developed by this mechanism (a 2MW PV plant) has been producing energy since the beginning of 2016 [1].

3 CASE STUDY OF SERBIA

Europe has a leading role in the field with over 3000 organizations reported as RE Coops and even more community energy projects, however, these are mostly concentrated in North and West Europe; on the contrary, their spread in post-socialist European countries has been reported to be much more limited. Key factors for addressing the differences in the level of development of RE Coops in different countries appear to be many (the historical influence of the ecological and anti-nuclear
movements, the spread of publicly owned municipal utilities, the impact of the oil shocks in the 1970s and the derived policy-responses). In addition, there is the socio-political-cultural context of post-socialist countries, in particular, widespread mistrust of the cooperative institutional structure, born out of its misuse by the establishment during the socialist era. The purpose of this section is to give review contribution and possibly recommendations for innovative business models to RE Coops growing in this environment with less favourable legislation and incentives.

3.1 Energy cooperatives in Serbia and their role

In 2019, two energy cooperatives have been established in Serbia, Sunčani krovovi in Šabac and Elektropionor (EP) in Belgrade. There are no known energy cooperatives (or other energy communities) in North Macedonia, Bosnia and Herzegovina, Albania, Montenegro and Kosovo*. The one active energy cooperative in Croatia is ZEZ [15] with which EP has established close cooperation.

As already mentioned, authors have been closely observing government creation and implementation of the energy policies and laws, public opinion, civil movements around RES projects in Serbia and the region for the last 18 years. In last two years, pushed by obvious climate change, air pollution and current energy crisis there have been significant changes in the energy legislation in the Western Balkan and subsequent incentive programmes.

Western Balkan countries have introduced a legal framework to encourage and promote energy production from renewable energy sources. Thus, support policies have received increased attention with a focus on the power generation sector, while much less attention is devoted to transport and heating and cooling. Even though the countries have defined targets for RES in their energy policies, there are gaps between these targets and the actual results, as national government are facing various energy challenges. The main barriers common to all countries are regulatory uncertainty and low levels of transparency, slow and unpredictable planning process and limited regional market integration[7]. Additionally, incentives and subsidies are deployed ad hoc. Just in the period of less than a year, there have been significant increase in number of policies and programmes across Western Balkan that promoted and incentivised RES. One of strongly promoted policies is a prosumer status of households and industry that just backlashed with many unfinished fiscal policies or other obstacles found in practice (for instance mismatch between electricity billing according to the Ministry of Energy and according to the Ministry of Finance). Such uncompleted ad hoc policies in combination with resistance of regime and utility companies create hostile regulatory and economic context. However, it is been known that energy cooperatives have been promoted by citizens and communities in times of crisis [1].

One of the main preconditions for the successful deployment of RE Coops lies in the existence of an informed and confident social base with strong and continued motivation to selflessly support the project over time, thus having the potential to overturn the hostile regulatory context [1].

During two year period authors have observed the work of energy cooperative EP and have been the witnesses growing interest for the work of EP and building the trust of the community in information given by EP. Since the end of 2019,
Elektropionir is opening the space for citizens to become active participants in the energy sector, as well as to add much-lacking renewables power generation to the Serbian energy mix through distributed PV generation. While the cooperative still unfolding its range of activities, in the short time since its inception it has gained recognition in the energy sector and beyond. This culminated in invitation of the Ministry of Energy to EP to join the working group for removing barriers for prosumers.

While the landmark legislation is now in place, crucial bottlenecks for a successful rollout of citizens’ renewable generation remain firmly in place. This centres around the difficult position citizens have – due to lack of good accessible information – to set themselves up in this novel field, combined with the current reluctance of vested actors to open up for citizens’ participation. Both provide substantial roadblocks and major risks.

Elektropionir has taken a leap in informing citizens that seek to enter PV energy generation through the course Solartehnika narodu (Solartech to the People) Households in Serbia that aspire to participate in the generation of renewables face many unknowns: a lack of clear and accessible guidance from the side of regulators, lack of real-world examples, and little insight into the parameters that make PV solar in Serbia a viable option for households (also financially). On top of this, novel prosumers encounter a substantial information gap that they are forced to bridge regarding terminology.

Launched in 2021, the course Solartehnika narodu is specifically tailored to provide individuals, households, and communities the necessary background, insight and step-by-step guidance on becoming renewable PV energy producers themselves. The setup is modular, multi-day, and comprised of distinct segments (energy transition, technical components, procedures, sizing, optimisation, etc.) that are largely online, supplemented with an on-site segment including a field visit to a larger PV plant.

The current reluctance – even resistance – of vested actors to provide access to the electricity network and market are substantial roadblocks and major risks. This not only blocks individual citizens, but also aggregated households (in citizen energy cooperatives and communities) to successfully take part in the sector and energy transition. It should be noted that RE Coops are social enterprises that share social motivations going beyond the market logic. Hence, these organizations can act as laboratories for innovative solutions. Innovation and resilience is vital to surviving in a hostile context [1].

One of such innovative socio-technical solutions are flexibility services:

- Demand-side flexibility to maximise self-consumption and offer reduced retail electricity prices
- Aggregating loads as resources to use on balancing reserves of Transmission System Operators

As wind and solar energy are variable resources and require flexible ways to integrate them into a decentralising energy system, the electricity market is set to change from commodity-oriented business models towards a market based on a new set of flexibility services to support a dynamic grid. This enables the cooperative at the
same time to unfold a range of innovative activities, further speeding up transitioning the Serbian energy mix towards clean, renewable energy.

Therefore, Elektropionir is now building the roadmap how they could become an energy aggregator holding control over such a crucial gateway by citizens. This provides a much more secure position for the cooperative and can fast track EP for readiness towards a fundamentally changing energy market.

4 CONCLUSION

Confronting the climate crisis and working to mitigate and adapt to climate change will mark the rest of this century. Over two-thirds of the total emission of greenhouse gases is the result of the burning of fossil fuels (coal, oil and gas). Changing this way of energy production is crucial. In Serbia, it is also a solution to one of the burning problems - air pollution.

Citizens have proven to be a significant motivating factor and catalyst for the transition to clean energy. A special emphasis should be placed on active public engagement and raising awareness of all the economic, energy and ecological benefits that the energy transition can bring. The energy cooperatives are one of the key actors in empowering ordinary people to participate more actively in the transition of the energy sector to renewable energy sources.

The Western Balkans energy markets are highly fragmented with resources scattered across six countries. The integration of these markets into a regional network would potentially reduce risks for investors and enable the exploitation of economies of scale [7] and this is also a place where energy cooperatives could have a crucial role.

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Acceptance of hybrid working model according to transformed work conditions in the pandemic and green economy approach

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KEYWORDS - green economy, covid-19, HRM, working model, hybrid working model.

ABSTRACT

It is a fact that World is facing not only lack of resources, but also great risk of ecological and climate changes. Aiming to reduce environmental risks and ecological scarcities economies aims for sustainable development without degrading the environment. Green economy is systematic approach toward economy development designed for benefits of businesses, society, economy and environment. Green economy is regenerative concept that allows to step aside resources that are limited in the environment and use reusable ones. Besides these risks, the World is challenged with pandemic that has deepen lack of already limited resources. Covid-19 pandemic is affecting our everyday life in all possible ways. It is also affecting companies and their employees. During the pandemic many workers have developed a taste for a more flexible working model. Some are facing the benefits of working from home, but for some it is not such a positive experience. Human resources management should adjust to the new needs. Those needs are new forces that are driving transformational changes across companies, industries and economies issuing new strategic platforms in companies. Digitalization is promising a new era for working life according to new cultural transformation. All of this raises the need for the companies to change strategies and models in a way to adjust working conditions according to alteration of their employees in each way. Hopefully, this model will give its effects on saving resources that we all use every day. Of course, this should lead to sustainable economies and clear environment. In this paper we would point out the benefits and risks of working from home in order to save resources that are limited. Also, we would analyze the legal frame in the Republic of North Macedonia, boundaries, and perspectives for modernization of Labor law in way to be customized to green economy approach. According to the results from the questionnaire that we will provide, we will suggest models for human resources transformation in the companies that will be more effective for the management and employees and in the same line with the new approach of green economy.
1 INTRODUCTION

World population is raising, so is raising the need for resources that are limited. Only wise usage of resources will lower energy usage and pollution of the environment. At this point, worlds usage of the resources contributes with 45% of worlds pollution. Climate change and environmental degradation are an existential threat to Europe and the world. To overcome these challenges, the European Union in 2020 approved the European Green Deal. The main aim of this Deal it is to transform the EU into a modern, resource-efficient, and competitive economy. It is a new growth strategy that aims to transform the EU into a fair and prosperous society, with a modern, resource-efficient, and competitive economy where there are no net emissions of greenhouse gases in 2050 and where economic growth is decoupled from resource use.[1] it is well-known that that transport energy consumption and related pollutant emissions are influenced not only by technical efficiency, mode choice, activity levels and carbon/pollutant content of energy, but also by the way we live (or lifestyles).[2]

In almost same time Covid -19 caused changes everywhere- at home, at work, in the economy, in the society. Management in the companies should be more open to those changes. This gives us a clear picture of need for changing working model to a hybrid one instead of traditional, to promote model that is going forward both for the employers and employees. The shift is in the mindset and the adoption of technology is helping in this new working arrangements. But not only the companies should be prepared for such changes, also employees should be educated what is essential in this model and what is expected from them. This has raised a need for some changes in the education. These changes should be made according to this model, with all its characters, positive and negative effects. According to information of International Labor Organization it is estimate that during the second quarter of 2020, 557 million workers worked from home, accounting for 17.4 per cent of the world’s employment. Prior to the COVID19 pandemic, 7.9 per cent of the world’s workforce, or approximately 260 million workers, were home-based workers, on a permanent basis [3]. In 2021, 70% of US and EU companies announced that are shifting to hybrid working model. Accompanied by the hybrid working model managers should be educated with the core of this concept, on what way this should be implemented in the society in order to leave greater impact. Opportunities from green economy are big: new working places can be opened, innovation is stimulated, greater competition, eco-designing in the production with lowering pressure on the environment, greater efficiency and productivity in the companies with reusage of the resources that are reusable, clearer environment etc. According to EU data, implementation of green economy should increase BDP for extra 5% and create 70.000 new workplaces till 2030 [4]. Hybrid model should give great impact for these aims. Also, society would have advantages from green economy: quality of life should rise, sustainable economy on greater period, vital eco-system, new innovative products that will influence products’ life etc.

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2 The International Labor Organization (ILO) is the United Nations agency for the world of work. It sets international labor standards, promotes rights at work and encourages decent employment opportunities, the enhancement of social protection and the strengthening of dialogue on work-related issues.
2 DEFINITION OF HYBRID WORKING MODEL AND GREEN ECONOMY

Hybrid work model is a flexible model in which employees can work from both onsite and offsite locations [5]. This model can be worked out between employer and employees depending on the work. The hybrid model means employees work partly on-site or in the office and partly remotely depending upon working requirement and productivity [6]. It is essential to promote effectiveness and productivity of work. The hybrid working model is a location-flexible arrangement, allowing employees to combine onsite and offsite work as they and their employers see fit [7]. This model considers employees’ general feelings towards their workplaces, productivity and wellbeing during pandemic. Hybrid working is a “blended working” that’s combining work on site or working remotely. Employees are allowed to split their time between working remotely or attending the workplace [8].

When pandemic hit in 2019, companies transitioned to remote working. Remote work has been growing in popularity due to greater digitalization of work roles, faster internet, and availability of cheaper equipment. Companies were forced to create processes, and IT infrastructure needed to support working from home. There are several positive sides for companies from such model:

+ Helps to find best talented employees by looking beyond company’s geographical region;
+ Reduces the cost of office space.
+ Ensures employee productivity and engagement.
+ Ensures information security.
+ It makes tracking employee performance easier.

Also, we can address some pros and cons for the employees:

+ Norms of social distancing makes the model safer option.
+ An efficient work-life balance.
+ Increased productivity.
+ Risks of employee isolation;
+ Difficult to separate work from personal life.
+ Obstacles in building relations and establishing communication with employees

To maximize the benefits from hybrid working, management should have a plan that outlines clear responsibilities, addressing employee well-being and prioritizing meaningful work.

According to UN Environment program, green economy is defined as low carbon, resource efficient and socially inclusive. In a green economy, growth in employment and income are driven by public and private investment into such economic activities, infrastructure and assets that allow reduced carbon emissions and pollution, enhanced energy and resource efficiency, and prevention of the loss of biodiversity and ecosystem services.

The International (ICC) defines green economy as "an economy in which economic growth and environmental responsibility work together in a mutually reinforcing fashion while supporting progress on social development" [9].
The Green Economy is an alternative vision for growth and development; one that can generate economic development and improvements in people’s lives in ways consistent with advancing also environmental and social well-being. Benefits from green economy are multiple: rational usage of the resources (energy, water, materials etc.), generating minimum waste, treating the waste as a resource and approach, “Life Cycle”. Implementing the system for managing the energy and concept for clearer production are great opportunity for receiving double benefit- saving resources and protection of the environment.

By defining hybrid model and green economy, we can conclude that both concepts lead toward greater productivity of the employees, reduced costs, smaller number of used resources and of course, lower negative impact on environment. There are a lot of studies which have revealed that during lockdown the overall carbon emissions from commuting had fallen from pre-lockdown levels, which must be a strong argument for increased or fully remote working [10]. According to the conclusions of these studies future work should address the extent to which forced behavioural shifts can become embedded in the commute demand reduction and wider decarbonisation polices [11].

3 BRIEF REVIEW OF LEGAL FRAMEWORK ABOUT GREEN ECONOMY AND WORKING MODELS IN R. N. MACEDONIA AND CURRENT SITUATION

According to Constitution of Republic N. Macedonia, everyone has a right of healthy environment. Everyone should take care and promote nature and environment. Republic provides conditions for accomplishment of these rights. Preventing the nature, environment and human health is one of rare conditions that can limit freedom of the market and entrepreneurship with the law.

Republic N. Macedonia has ratified international conventions in field of environmental protection and climate changes with purpose to promote sustainable development in our country. Republic N. Macedonia is dedicated to global goal for stabilizing concentration of glass gases in the atmosphere at the level that will stop global warming for more than 2°C.

According to World Bank, Macedonia has the most polluted air in Europe, which is mentioned in the Green Growth Assessment in the country [12]. According to the report for air quality in 2018 of European Health Association, Macedonia has highest annual level of concentration of PM2.5 with 52 μg/m3. According to the estimation of the level for 2016, among the first categories with greatest values of ktCO2-eq (including emission sources and sinks) at sector level is road traffic (16.6%). [13]. As one measure for this is reducing individual transportation and altering with other usage of transportation or public transportation. This is one of the purposes when practicing hybrid model of working in order to alter individual transportation to work and reducing air pollution.

According to the legal framework that regulates labour relations in the Republic of North Macedonia, established by the Law on Labour Relations [14], the legislator, normatively, in terms of the place of operating is familiar only with two models:
primary, which is presumed to be working at the employer's headquarters and working from home. If the employment contract does not include a provision for the place of work, the legal assumption will apply that the worker works in the employer’s headquarters. The second working model – working from home is established as of April 2003 when the Macedonian legislator regulates the option of working from home [15]. According to the Law on Labour Relations working from home is considered as doing work by the worker in their home or in rooms they selected outside the business premises of the employer. According to the Employment contract for working from home between the employer and the worker, it can be agreed that the worker will perform work belonging to the business activity of the employer or necessary for realizing the employer’s activity from home.

According to the legal framework now, the Law on Labour Relations in RNM does not have a separate legal decision for working according to a hybrid model, i.e. a combination of working from the employer’s headquarters or working from home. The legislator has established that the employer and the worker can choose between one of the two options. Still, it is not forbidden for the employer and the worker to regulate the mutual rights and relations in the employment contract by choosing a combination of these two models. According to the principle that the employment contract, i.e., the collective agreement can determine the more favourable rights for the workers than those established by this Law, it is not excluded to stipulate such working terms if those are more favourable for the worker.

To decrease the spread of the Covid-19 virus, the Government of the Republic of North Macedonia, on the 13-th session, held on 20.10.2020, adopted a recommendation for organizing the work of the whole state and public administration, municipalities, and courts in shifts or online from home or reduced by a system of rotations depending on the characteristics of the working process of the institutions. The recommendation was expanded and referred also to private sector employers. The recommendation was widely accepted by the private sector too and there was an option to organize working from home or by a rotations system, in accordance with the working process and the employer’s business activity.

4 RESEARCH RESULTS

Due to a lack of information about the working model practiced before the beginning of the pandemic, during the pandemic, and benefits of using hybrid working model, the authors conducted a survey to successfully realize the defined research purpose. With this survey we have obtained information and knowledge through statistical analysis and statistical conclusion of data regarding the modifications of the working model according to the modified working conditions during the pandemic. The questionnaire was structured in three parts: first part was about basic information for the employees and employers; second part was about advantages and disadvantages by the respondents according working model before and at the Covid-19 time; and third part searched information about respondents’ opinion and decision about possible working models that would be more likely to perform after pandemic. The questionnaire was distributed on-line in the period between 27.01.2022 to 10.02.2022.
We have reached 90 respondents (employees) and received their answers. This is a statistically significant sample. Answers were statistically processed by SPSS.

Descriptive analysis is used for graphical and table data presentation. Also, in this statistical research, appropriate and significant evaluation is defined with reliability of the results for 5% risk or safety threshold of 95% in statistical conclusion. This means that suggested hypotheses were tested with nonparametric statistical tests: contingency tests ($\chi^2$) that were realized within SPSS.

**Table 1: Descriptive statistic for basic data**

<table>
<thead>
<tr>
<th>Basic data from employees and employers</th>
<th>Descriptive statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Working arrangements</strong></td>
<td>All respondents are full time employed. (100%)</td>
</tr>
<tr>
<td><strong>Industry where employees come from</strong></td>
<td>50,00% are employed in education or some other industry that was not defined in the question. Least, or 16,7% respondents are employed in trading, banking or hospitality.</td>
</tr>
<tr>
<td><strong>Employment of respondents by sector</strong></td>
<td>61,1% of respondents are employed in the private sector and only 38,9% are employed in the public sector.</td>
</tr>
<tr>
<td><strong>Age structure of respondents</strong></td>
<td>67,7%, are between age 31 to 50; 17,8% are between age 20 to 30; and a 14,5% of respondents are older than 50.</td>
</tr>
<tr>
<td><strong>Origin of the company</strong></td>
<td>88,9% of companies are domestic legal entity and 11,1% of them are foreign legal entities.</td>
</tr>
<tr>
<td><strong>Where is situated domestic legal entity</strong></td>
<td>71,1% of respondents are employed in companies that are situated in Skopje and Prilep; 17,78% are employed in companies situated in Bitola, Stip and Ohrid; 11,11% of respondents are employed in companies that were not defined in this question.</td>
</tr>
</tbody>
</table>

**Source:** Authors’ questionnaire results (2022)
Picture 1: Model of work that the respondents practiced before the beginning of the pandemic. Source: Authors’ questionnaire results (2022)

Picture 2: Model of work that respondents practiced during the pandemic. Source: Authors’ questionnaire results (2022)

Table 2: Descriptive statistic for respondents’ attitudes about working model they prefer after Covid-19

<table>
<thead>
<tr>
<th>Descriptive statistic for respondents’ attitudes about working model they prefer after the end of Covid-19</th>
<th>Descriptive statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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Possible working model to choose after the end of COVID 19

30%, have chosen a combination of the two working models- 3 days work from home and 2 days from office; 26,7% have chosen to work 5 days from office; and 17,8% of respondents chose a combination of working models- 1 day from home and 4 days from office. (Picture 3)

Offered opportunities by management to choose combined working model

44%, of respondents would choose combined working model, offered by management with no consequences on salary; 36,7% would choose combined working model offered by the management, with condition employees’ to be accessible for employer till the end of daily working hours; 18,9% would choose offered combined working model by the management with the condition employer to procure computer/equipment for work from home.

Possibilities for respondents to consent for lower salaries in order to choose combined working model

83,3%, of respondents answered that they would not give consent to work for lower salaries when choosing combined working model proposed by management; 13,3 % would give consent, when working combined working model, their salaries to be lowered, but not more than 5%; and only 3,4% would give consent, when working combined working model, their salaries to be lowered, but not more than 10%.

Opinion of the respondents about usage of different working model in connection with transport costs

More than half of the respondents, or 53,8%, has graded the highest (5) work from home or combined work comparing with time and costs spent in transportation from and to work. In addition, 30,7% of respondents have graded with 3 or 4 this advantage, and only 15,4% has graded 1 or 2.

Source: Authors’ questionnaire results (2022)
*Combination of both models: 1 day from home, 4 days from the office; 2 days from home, 3 days from the office; 3 days from home, 2 days from office and 4 days from home, 1 day from office.

**Picture 3:** Attitudes of the respondents about the possibility of choosing a model of work after the end of the pandemic

**Source:** Authors’ questionnaire results (2022).

According to the respondents’ answers almost 54% of them answered that during they practice hybrid working model or working from home it was very important for them that they spent less time on traveling to the workplace. Almost 85% of them answered that spending less time and money to travel from workplace to their homes and vice versa was important for them.

**Picture 4:** Attitudes of the respondents about the importance of spending less time for traveling to work place **Source:** Authors’ questionnaire results (2022).
From the chart in picture 5 we can see that there is a difference in respondents’ attitude about preferred working model before and during pandemic time. According to this data, most respondents prefer the office working model, and only few respondents prefer the home working model before pandemic. During the pandemic most of them preferred a combined working model. Also, we can see that there is a difference in the number of respondents preferring the working model after pandemic time. According to this data, after ending the pandemic most of them preferred a combined working model, and few preferred working model from home. We can make conclusion that for almost 85% of the respondents one of the benefits of practicing hybrid working model was spending less time and money to travel from workplace to their homes and vice versa. Shortening of travel time, means lower usage of resources, less air pollution, more free time for the employees etc.

4.1. Hypothesis testing

According to the subject and goals of this research, we have concluded following hypothesis:
Hypothesis 1: There is no difference in the respondents’ attitudes in different periods of the pandemic according to preferred working models.
From this general hypothesis we have drawn following hypothesis:
Hypothesis 1.1: There is no difference in the respondents’ attitudes for the preferred working model before and during pandemic.
Hypothesis 1.2: There is no difference in the respondents’ attitudes for the preferred working model before and after ending the pandemic. 
Hypothesis 1.3: There is no difference in the respondents’ attitudes for the preferred working model during and after ending the pandemic.

When using the test of independent variables such is contingency test ($\chi^2$) for gathered data, we have concluded following information for the statistical conclusion. This information is presented in the table below:

**Table 5.** Data for statistical conclusion about the respondents’ attitudes according to different working models in different periods in the pandemic.

<table>
<thead>
<tr>
<th>Hypothesis 1.1.</th>
<th>Degrees of Freedom</th>
<th>Alpha Error</th>
<th>Critical chi-square</th>
<th>Computed chi-square</th>
<th>p value</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypothesis</td>
<td>2</td>
<td>0.05</td>
<td>5.9915</td>
<td>68.1923</td>
<td>0.0001</td>
<td>Reject Hypothesis</td>
</tr>
<tr>
<td>Hypothesis 1.2.</td>
<td>2</td>
<td>0.05</td>
<td>5.9915</td>
<td>66.4723</td>
<td>0.0001</td>
<td>Reject Hypothesis</td>
</tr>
<tr>
<td>Hypothesis 1.3.</td>
<td>2</td>
<td>0.05</td>
<td>5.9915</td>
<td>19.5732</td>
<td>0.0000</td>
<td>Reject Hypothesis</td>
</tr>
</tbody>
</table>

**Source:** Authors’ questionnaire results (2022)

From the results shown in the Table 5 we can see great statistical deviation between calculated and theoretical values of $\chi^2_{test}$. Calculated statistics of the test (68.1923; 66.4723 and 19.5732) are greater than theoretical values of the test (5.9915). We have come with the same conclusions by comparing calculated p-values (0.0001; 0.0001 и 0.0000) with theoretical p-value (0.05). According to this conclusion, with threshold security of 0.95, all hypothesis mentioned above are rejected, so the conclusion is as follows:

- there is a difference in respondents’ attitude about the working model before and during the pandemic,
- there is a difference in respondents’ attitude about the working model before and after ending the pandemic
- there is a difference in respondents’ attitude about the working model during and after ending the pandemic.

According to this statistical conclusion, we can reject general hypothesis. Namely, we come with conclusion that there is difference in respondents’ attitude according working model and different period in the pandemic.

Also, according to the results of the questionnaire, one of main reasons for employees’ preferences of hybrid working model, is the shortening of travel time, more free time for the employees instead of commuting, spending less money for travelling, etc.
5 CONCLUSION

According to the obtained results from the research by the authors, it can be concluded that the pandemic has significantly changed the manner of work of many employers in the country, and the preferences of the workers for practicing a hybrid working model. As a forcibly imposed working model, the hybrid manner of work at a stage when the pandemic is losing its strength has become the preferred and desired model of work by workers.

Starting with number of approximately 88% of respondents who had worked from office before the pandemic, in time of almost 2 years the number of respondents who will want to work from office after the pandemic decrease to almost 27% respondents. Opposite the number of respondents who prefer hybrid working model after the pandemic is drastically increased to almost 69% of respondents. Also, it is very interesting that for almost 85% of respondents was important that they spend less time for traveling to work place while they were practicing hybrid working model. Considering ILO Centenary Declaration for the Future of Work, for further development of human-centred approach at work, the employers must direct their efforts in the following field: provide scope for achieving better work–life balance by enabling workers and employers to agree on solutions, including arrangements on working time and place, and consider their respective needs and benefits.

In the period when research took part and most employees worked from home or used hybrid working model, there were great positive effects on the environment and reduced air pollution. Hybrid working significantly reduces the number of vehicles on the roads every day, without impacting productivity or profits, which is great news for the carbon footprints of the company and individuals alike. Also, there were a lot of studies that have revealed that during lockdown the overall carbon emission from commuting had fallen from pre-lockdown levels.

We can agree that from employee’s perspective, and from global environment perspective practicing hybrid working model has a lot of benefits in way to make the World go greener.

Hybrid working model can be solution for resources to be more rationally used, to protect environment and to decrease the pollution, to reduce energy consumption and to minimize waste production. According to the fact that our country is ranked as a high-risk country for pollution, we all should emerge with every possible solution that can lead us to protect environment and decrease or if possible, to stop air pollution. Maybe it is about time to make changes in our lifestyles.

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Circular economy course in University Educons new curriculum with best practice case study firm Biofor System in eco-innovations

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KEYWORDS – circular economy, eco-innovations, knowledge management, business economics, green employment

ABSTRACT

The aim of the paper is to present and promote changes in the curriculum in accordance with the needs of the market, but at the same time in the merciless and unpredictable race with innovations in industry and production. Educons University as an educational institution dedicated to projects that promote the transfer and exchange of knowledge and skills, through the creation of long-term partnerships and opportunities for (new) employment, which inspires innovation, entrepreneurship and creativity through the development of new approaches in teaching and learning. One of examples of good practice in “initiatives to meet the market changes” is reflected and proved in study program Organic agriculture Course entitled Circular economy. The circular economy aims at renewing natural resources, keeping raw materials in use and extending the life of products through application of appropriate design that allows end-of-life products not to become waste and do not contribute to pollution.

In order to respond as soon as possible to the needs of the market and to be closer to its partner companies, Educons university included successful companies in the Board of directors and included their needs to its new curriculums. One of companies in the prestige society in the Board of directors is the company Biofor, which has excellent cooperation with the Faculty of Ecological Agriculture. The Case Study presented as a good practice example is supported by the activities and products of the company Biofor, whose eco-innovation products are available on our and regional market.

1 INTRODUCTION

The circular economy [1] is a model of production and consumption, which involves sharing, leasing, reusing, repairing, refurbishing and recycling existing materials and products as long as possible. In this way, the life cycle of products is extended. The circular economy model [2] is designed so that the use of natural resources and energy is reduced to the smallest extent, but the creation is also made for reduced waste, pollution and other negative impacts on the environment. Circular economy has primacy in sustainable production in a way that it prevents damage to the

¹ Research presented in this paper has been partially funded by AP Vojvodina, Provincial Secretariat for Higher Education and Scientific Research, Republic of Serbia, within the project “Transition of AP Vojvodina towards circular economy: analysis of the level of knowledge and definition of inputs for strategic design”, Project No. 142-451-2589/2021-01/1.
environment, reduces pollution, and ensures the production process through clean
technologies. Circular economy business models provide a solution on micro level to
improve and harmonize their production processes with market needs and on macro
level in accordance with new economic global trends. During the production process
circular economy business models do not have "waste", that is, they do not recognize
it the rest in the production process, but "raw materials" that are made cleaner through
circular design they bring technological processes back into production.

Educons University as an educational institution dedicated to projects that
promote the transfer and exchange of knowledge and skills, through the creation of
long-term partnerships and opportunities for (new) employment, which inspires
innovation, entrepreneurship and creativity through the development of new
approaches in teaching and learning. Close cooperation with companies helps
universities develop their teaching programs that are practically oriented and meet the
needs of students, the labor market and society as a whole. At the same time, students
acquire relevant and practical skills and adopt new ways of thinking that are necessary
for the labour market. Proof of the concept is contained in one of the courses curriculum
entitled Circular economy. Course is implemented in Educons University’s
undergraduate studies at Faculty of Ecological Agriculture.

2 THE CONCEPT OF CIRCULAR ECONOMY IN THEORY AND
PRACTICE

Although there are numerous critiques [3] addressed to the circular economy and
circular business models, claiming that the circular economy has diffused limits,
unclear theoretical grounds, and that its implementation faces structural obstacles.
Circular economy is based on an ideological agenda dominated by technical and
economic accounts, which brings uncertain contributions to sustainability and
depoliticizes sustainable growth.

The main subject of this work is not to determine the justification, ideological
and political basis for the creation of a modern term perhaps based on some previous
recycled theories. The goal of the work is to give a concrete example from the domestic
environment that is beneficial with its concrete contribution, but also as a statistical
figure in the still insufficiently measured eco-innovations. Likewise, critics of the
modern concept of the circular economy [3] complain about the neglecting of
established knowledge, but the question of importance is how much we managed to
measure the impact of the green economy and eco-innovation, and to what extent we
can preserve resources such as clean air, soil and water in the long term with this
approach. Accordingly, in March 2020 [1], the European Commission presented the
circular economy action plan, which aims to promote more sustainable product design,
reduce waste and empower consumers, for example by creating a right to repair). There
is a focus on resource intensive sectors, such as electronics and
ICT, plastics, textiles and construction. In February 2021, the Parliament adopted a
resolution on the new circular economy action plan demanding additional measures to
achieve a carbon-neutral, environmentally sustainable, toxic-free and fully circular
economy by 2050, including tighter recycling rules and binding targets for materials
use and consumption by 2030. In March 2022, the Commission released the first package of measures to speed up the transition towards a circular economy, as part of the circular economy action plan. The proposals include boosting sustainable products, empowering consumers for the green transition, reviewing construction product regulation, and creating a strategy on sustainable textiles.

The road map for Serbia shows different approaches to the reasons for the transition to a circular economy, as well as economic models and possible ways to increase national productivity through new global economic growth trends that lead to reducing the use of natural resources and negative impact on the environment [2].


Figure 1. Linear Economy

Figure 2. Circular Economy
Given this context [4], we want to extend best practices and business cases that are in line with the principles of the Circular Economy model: 1. Preserve and improve natural capital: controlling limited reserves and balancing resource flows. 2. Optimize the use of resources: distributing products, components and materials with maximum utility in both technical and biological cycles. 3. Promote the effectiveness of the system: detecting and eliminating negative externalities (Figure 1 and Figure 2).

3 EDUCONS UNIVERSITY’S STUDY PROGRAMME ECOLOGICAL AGRICULTURE WITH CIRCULAR ECONOMY IN NEW CURRICULUM

One of examples of good practice in “initiatives to meet the market changes” is reflected and proved in study program Organic agriculture Course entitled Circular economy [5]. The course aims to enable students to master the terminology and structure in the field of circular economy. The importance of the course is a detailed acquaintance of students with the segment of sustainable development related to business that is based on the circular economy. The emphasis is on researching examples of good practice around the world, and business opportunities in line with sustainable development.

Table 1. The course content Circular economy

<table>
<thead>
<tr>
<th>Theory classes</th>
<th>Circular business model and modern industries in which circular economy is applied</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Circular economy of the European Union</td>
</tr>
<tr>
<td></td>
<td>Employment in the sectors of circular economy in the world and in the Republic of Serbia</td>
</tr>
<tr>
<td></td>
<td>Introduction to Sustainability and Sustainable Factors of Production (Defining Sustainability and its Link to Excessive Consumption and Excessive Production from a Business and Economic Perspective. Presenting Multiple Indicators for Measuring Sustainability, including UN Sustainable Development Goals.)</td>
</tr>
<tr>
<td></td>
<td>Sustainability premise (Analysis of opportunities for sustainable development and models for designing sustainable business processes.)</td>
</tr>
<tr>
<td></td>
<td>Circular economy and sustainable business models (defining the basics of circular economy and characteristics of circular business model, business advantages of transition to circular business model.)</td>
</tr>
<tr>
<td></td>
<td>Encouraging innovation through efficient solutions (Sustainability as a driver of eco-innovation and eco-innovation that founded the concept of sustainability, frameworks and models for creating sustainable innovation.)</td>
</tr>
</tbody>
</table>
Economic and social aspects of investing in the circular economy and sustainable development.

| Practice classes | Case studies, presentation of relevant examples of good practice that apply the concept of circular economy, debate on topics in the field of circular economy. |

Source: https://educons.edu.rs/wp-content/uploads/2021/09/Table-5.2.-Curriculum-BAS.pdf

Finishing the course Circular economy students acquire basic and additional theoretical and practical knowledge in the field of circular economy, as well as concepts related to sustainable development strategy. The student acquires current knowledge about this segment of economy by researching the global goals of the circular economy, as well as the recommendations and plans of the European Union and the Republic of Serbia. Determining sustainable development, which is basically related to improving the quality of life in a way that can be maintained - economically and environmentally, long-term supported by the country's institutional infrastructure. For this reason, students will look at sustainable development through four main dimensions: social, economic, environmental and institutional.

4 A CASE STUDY - COMPANY BIOFOR SYSTEM IN ECO-INNOVATIONS

Educons University established Boards of Directors [6] for integrated study programs or faculties within the university. The Board of Directors was established with the intention of assuming part of the responsibility and has an advisory role in relation to the Faculty Deans and their Vice-Deans in their areas of responsibility. Directors' councils represent an organizational innovation within the organizational transformative processes in the management and leadership of faculties within the university. The resulting opportunities are innovations in the teaching and research process, primarily in the sense of improving study programs, academic staff and student scholarships. Also, students are offered the possibility of direct employment opportunities through the scholarship won and professional practice, which the students perform in those companies. The Board of Directors is designed as an organizational unit that provides support to the Deans in the academic management of the faculty by holding working meetings on an annual level, in order to create responsible policies for the education of the next generation of students, to create new knowledge and skills, and in this sense, they assume responsibilities for the support of the Educons Mission of the University.

The Board of Directors consists of the most successful examples of business firms and successful individuals, who together form the first and founding board of the Board of Directors at Educons University. The Directors' Councils provide direct support to university institutional management and represent an important link for networking the labor market and the academic environment. Directors' councils become an integral part of the university's organizational and transformation processes.
In order to respond as soon as possible to the needs of the market and to be closer to its partner companies, Educons university included successful companies in the Board of directors and included their needs to its new curriculums. One of companies in the prestige society in the Board of directors is the company Biofor, which has excellent cooperation with the Faculty of Ecological Agriculture. The Case Study presented as a good practice example is supported by the activities and products of the company Biofor, whose eco-innovation products are available on domestic and regional market. A company Biofor is specializing in research and development in microbiology. Today, their products are present on the markets of Serbia, Slovenia, Croatia and Bosnia and Herzegovina. Applying scientific achievements and respecting nature, the company came up with the formulations of Biofor microbiological fertilizers. Eco-innovationing the products [7] by company Biofor is presented in Table 2.

Table 2: Eco-innovations in Biofor product portfolio

| Biofor Soya | Inoculation of soybeans, a mandatory agrotechnical measure, enhances the natural ability of soybeans to enrich the soil with nitrogen in symbiosis with soil bacteria. Present in our fields for 9 years. Biofor Soya was developed through scientific projects with the Faculty of Agriculture in Zemun. Biofor Soya is a microbiological fertilizer for soybeans because it contains Bradyrhizobium japonicum - a strain of bacteria contained in the first such product "Nitragin"

| Biofor Soya Liquid | A liquid nitragin containing strains of Bradyrhizobium japonicum enriched with 3 other strains of bacteria to mobilize phosphorus and potassium. The advantage is that with liquid nitragin for soybeans, you have the option of applying it to soybean seeds two to three weeks before sowing, if you are working on a farm. In seed processing centers, it is possible to treat soybean seeds three months before sowing. The bacterial strains contained in Biofor Soya Liquid have been tested in unfavorable soil conditions. Inoculation with Biofor Soya Liquid is extremely effective even in acidic soils.

| BioNest | Contains plant growth stimulator bacteria that produce natural growth factors auxin and gibberellin. BioGnezdio is a preparation that contains zinc, which is important for the synthesis of enzymes (especially in corn). BioNest encourages the germination and sprouting of plants. In field conditions, no matter how well the pre-sowing preparation is carried out, a number of sprouts fail. It is usually said that the seed is not good. The real truth is that in real conditions there is a danger of poor soil conditions and as a result you have losses in the assembly. BioNest is a huge help in cold springs because it increases the number of seedlings and gives the seed extra energy to survive unfavorable conditions.

| Biofor Active | Soil activator contains useful live soil bacteria that supply plants with necessary nutrients from the soil. Biofor Active increases
soil fertility by accelerating soil processes. A better soil structure is formed by the action of soil bacteria. Biofor Activ contains phosphorus activator bacteria and this is a natural way for the plant to be supplied with phosphorus from the soil. Allowed and inspected under European regulation EC/834/2007 and American Regulation NOP (National Organic Program). Inspected by ECOCERT SA F-32600

<table>
<thead>
<tr>
<th>Product</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td><strong>Biofor BioP</strong></td>
<td>Microbiological preparation, composed of many different bacteria that are the key to supplying plants with phosphorus. Biofor BioP is recommended for soils with high and low total phosphorus content. The Biofor BioP component is also Bacillus subtilis, which is the most widely used biofungicide in the world.</td>
</tr>
<tr>
<td><strong>BioEcho</strong></td>
<td>A new generation of natural biostimulators. BioEcho contains: growth factors - auxins and gibberellins bacteria Bacillus amyloliquefaciens and their products (enzymes). BioEcho significantly affects the acceleration of metabolic processes of plants, which leads to an increase in the number of fruits, preservation of leaf mass and rapid recovery of plants after hail. Application in soybeans and oilseed rape is extremely important because BioEcho encourages the branching of plants.</td>
</tr>
<tr>
<td><strong>NitroGenius</strong></td>
<td>Helps us achieve a balance between the nitrogen needs of plants and the amount of available nitrogen in the soil. It takes advantage of bacteria's ability to fix large amounts of nitrogen from the atmosphere and make them accessible, growable crops. NitroGenius uses the natural process of supplying nitrogen to plants to enable high yields to be achieved despite the reduced addition of mineral nitrogen from fertilizers. This preparation contains azotobacter as one of the most useful bacteria in the soil, which has the property of fixing nitrogen from the air, embedding it in the body of the microorganism and thus providing a safe reservoir of nitrogen for cultivated plants. This amount of nitrogen is safe from leaching and other ways of loss that occur in nature, and on the other hand, this nitrogen is still accessible to plants and is given to plants at the times when they need it most.</td>
</tr>
<tr>
<td><strong>Bioplug</strong></td>
<td>Breaks down the remains, humus builds them up. Microbiological preparation for the treatment of crop residues. It contains living microorganisms naturally &quot;responsible&quot; for the decomposition of organic matter. The goal is to use BIOPlug to speed up and direct the processes of transformation of crop residues to the formation of humus. In this way, the application of BIOPlug compensates for the lack of manure on our fields.</td>
</tr>
</tbody>
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Source: http://biofor.rs/proizvodi
5 CONCLUSION

In the regulatory sense, the implementation of the circular economy in Serbia requires a multi-layered and multi-sector connection of national public policies and regulations that would enable favorable conditions for new investments. Concretely it means defining priority sectors at the national level in accordance with work priorities Government of RS, infrastructural development and institutional capacities. This requires creation and harmonization of national planning documents, amendments and additions to laws (by sector) and technical regulations, promotion of voluntary instruments, introduction economic instruments in accordance with budget planning and the development of mechanisms for monitoring the implementation of regulations that contribute to the sustainable use of resources. In the institutional sense, a unified attitude of the representatives of the executive power and the Parliament on the creation of a policy of sustainable use of resources is necessary in the context of the circular economy. In addition to this, it is necessary to educate representatives of the state administration about the new concept of production, as well as the need for improvement and simplification of certain administrative procedures for new investments [2].

As specified in document Road map for circular economy in Serbia, the research potential of the scientific community is not used sufficiently to contribute to the development of industry. Awareness of the advantages of circularity is insufficiently developed design in the production process. There is insufficient knowledge and information about the importance of digital platforms for the needs of the circular economy. There is a lack of trained staff among industry and business representatives for new businesses models in the circular economy. Capacities are insufficiently developed at the local level, but there are also large differences in economic power in different regions in Serbia. The time frame and respect for the time frame by the executive authority and agility in the creation of public policies can greatly contribute to the acceleration of the transition and the stimulation of the economy towards new investments. The infrastructure and economic justification for business connections between companies is insufficiently developed. Insufficient industry knowledge of new business models and sources of industry financing to change the way of doing business in the context of the circular economy. It is necessary to change the resource policy in such a way that the state will influence the preservation of natural resources through various measures and emphasize through public policies the sustainable reuse of already used resources and materials [2].

An example of good integration into business strategy and direct business output in eco-innovations was achieved by the company Biofor, partner company of the University Educons. The continuation of education and the creation of new staff is made possible by the innovative teaching program of the faculty of ecological agriculture through the Circular economy course.

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4 Obstacles to the implementation of the circular economy in Serbia were identified during the interactive workshop with various representatives of the professional public at the closed workshop "Circulation" held in May 2019. in the framework of the UNDP project Circular Economy Platform for Sustainable Development in Serbia. Road map for circular economy in Serbia, p.33
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New Digital Tools for a Circular Economy in the Construction Industry

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KEYWORDS - digitization; Building Information Modeling; construction sector; circular economy

ABSTRACT

The focus is on the development of new concepts, methods and digital tools to support the further design of industrial processes for recycling, remanufacturing, recovery and reuse of manufactured products and components. Digital technologies can be applied at any stage of the life cycle of a construction object, from the concept of an object to its final operation. Construction companies are using more and more available technology solutions, increasing mobility and safety on the construction site and facilitating the construction process. Digitalization is increasingly affecting the modernization of the management and operation of buildings, saving time, facilitating decision-making, saving financial resources and reducing energy and material costs.

Ensuring long-term sustainable prosperity is the challenge of our lives. The European Union (EU) is currently facing a number of challenges that could undermine people's long-term prosperity. Ongoing climate, political and environmental crises threaten the planet, human well-being and business prospects. The EU must and must align its ends and means, carefully examine its governance structure and economic instruments, and build on its strengths in addressing these challenges.

The world scientific community is united in its terrible caution: our planet is on the verge of a climate catastrophe. If everything stays the same, global temperatures are expected to rise by 2°C by 2060, at unprecedented economic, social and environmental costs. Our activities directly affect our environment. For example, the extraction and processing of raw materials account for half of the world's carbon emissions and 90% of biodiversity loss [1].

While environmental issues are global issues, Europe has an important role to play in them. Europeans consume more resources and contribute more to global environmental degradation than most regions of the world. Moreover, as the European Environment Agency's report on the state of the environment in Europe shows quite clearly, the EU is currently unable to achieve its own sustainable development goals [2].

The construction industry is one of the world's largest consumers of resources (sand, building materials) and generates a significant amount of waste. At the same time, it is one of the leastdigitalized industries. With increasing levels of urbanization, scarcity of resources, and the problem of landfill management, the policy of circular
economy (CE) or circular economy is becoming more and more important in the construction industry. The European Union is committing by 2025 to recycle construction and demolition waste up to at least 70% by weight for all construction projects.

The construction sector is a key pillar of the economy of the European Union (hereinafter referred to as the EU), providing 18 million jobs and almost 9% of GDP. In addition to its economic weight, this sector has significant social, environmental and climate impacts, including on the quality of life of EU citizens or CO2 emissions and waste.

Although the construction sector is a key driver of the EU economy, it faces a number of challenges, including labor shortages, competitiveness, resource and energy efficiency and productivity. In fact, the productivity of the construction sector has grown at about a quarter of the rate of production (1.0% vs. 3.6% respectively) over the past two decades. This issue is especially important at a time when the construction sector is facing labor shortages and declining profitability. The sector also produces 374 million tons of construction and demolition waste (CDW) in the EU, making it the largest producer of CDW in the EU by mass. At the same time, digitalization in construction is one of the main objectives of the EU action plan for the application of digitalization.

Digital technologies and their integration in the construction sector are often seen as a key element that can help solve some of the aforementioned problems. However, the construction sector is one of the least digitalized sectors of the economy [3,4]. With the exception of Building Information Modeling (BIM), several digital technologies have become widespread [5]. However, as recently highlighted in a European Commission (EC) report, the digitalization of the construction sector goes beyond the exclusive use of BIM and includes data collection, process automation and other technologies related to digital information and analysis.

Digital transformation, also referred to as digitalization or digitization, is the process when an organization integrates digital tools, workflows, and approaches into all aspects of a business. Digitalizationrelevant for every industry and vertical, helping companies become more agile, efficient and value-driven. Digital transformation often goes hand in hand with Industry 4.0, smart manufacturing, industrial Internet of Things, artificial intelligence and machine learning, but it is more than just the adoption of digital tools. It affects people, processes and technology. Digitization includes steps such as replacing manual processes with digital ones, automating workflows, and merging teams and departments, but it goes beyond them. Digital transformation is best understood as a shift in culture that changes the operating norms of each department, forcing everyone to embrace constant change and work more interconnected throughout the organization. Thus, we assume

Digitization in the construction sector has the potential to open significant opportunities throughout the value chain, not only by improving existing practices, but also by integrating disruptive technologies and tools that can lead to new processes, business models, materials and solutions. Thus, digital technologies can help the sector improve and solve several problems, including labor shortages, labor productivity, waste and greenhouse gas emissions, health and social problems [6-13].
Digital technologies in construction are divided into three categories: data collection, process automation, and digital information and analysis.

Data collection refers to the unprecedented availability of vast amounts of data from sensors, scanners and connected devices (IoT) relating to every aspect of construction, from georeferencing to humidity levels, from energy use to air quality, from video recordings to seismic measurements. The availability of this data will expand the range of analytical services to improve performance in the construction process in all its stages (for example, design and engineering, construction, operation and maintenance, etc.) and its subsectors (for example, real estate, manufacturing, architecture and engineering).

Automation processes through the introduction of robots, 3D printing, drones and other mechanisms play a very important role in the development and modernization of the industry. By automating certain activities, not only does the final quality of the project improve, but workers are less exposed to risks, and new materials and methods can be used. Thus, this category of digital technologies is most relevant for the construction phase, which is often overlooked when it comes to the digitalization of the sector.

Thus, taking into account the two categories just mentioned, digital information and analysis is critical to connecting all the innovative technologies in the sector and processing the available data, leading to significant improvements and transformations in the way work is done. In fact, the added value of having real-time information, accurate measurements and historical inventory databases will be increasingly important and essential to the sustainability and competitiveness of the sector.

The presented technologies are in some cases highly interconnected. For example, the report analyzes sensors, drones and robotics as three separate technologies; however, drones can be equipped with various sensors and robotic parts. At the same time, 3D scanning, BIM, augmented reality and Digital Twins are also deeply interconnected, as they refer to similar technologies used in different ways, or to different stages of the same technology (for example, augmented reality in in the construction sector can be seen as a combination of BIM projects with visual sensors; Digital Twin is a BIM project that is regularly updated using data from multiple sensors, scanners, etc.).

Digital technologies can be applied not only at all stages of the construction process, but also at any stage of the life cycle of a building. However, these technologies tend to be used mostly in specific cases, such as in heritage assets for asset valuation and in newly constructed buildings, because it is easier and more cost effective to integrate them from the start and structure the project based on their use, and not to make additional investments for their implementation in existing buildings.

However, as recognized by the European Commission in the Renovation Wave Communication [14], the renovation of existing buildings plays a very important role in addressing climate change, as most existing buildings are not energy efficient [3]. In fact, 85% of the European building stock was built before 2001 and will probably still exist in 2050 [15]. This poses a major challenge as failure to embrace the green and digital transformation of the construction sector (including renovations) will hamper the achievement of EU objectives in terms of competitiveness and sustainability.
Preserving the value of products and materials for as long as possible, minimizing the use of resources and waste, increasing repair, recovery (re)use of materials and products, and their recycling rates will reduce the pressure on European (and global) resources and reduce greenhouse gas (GHG) emissions. For example, it is estimated that about half of the carbon dioxide emissions from heavy industry in the EU by 2050 could be prevented by making industry more closed [16]. Globally, 40% of carbon dioxide emissions from basic materials (e.g. cement, steel, plastic, aluminium), almost 50% from the food sector, 40% from construction and 70% from the vehicle sector could be reduced if these sectors By 2050, they would make the most of the advantages of the DE [17].

The combination of a circular and digital agenda will contribute to climate change mitigation, addressing environmental challenges such as resource depletion and pollution, enhancing competitiveness and innovation, promoting industrial upgrading and security, and supporting social cohesion (Figure 1).

![Figure 1. Interaction between the circular economy, digitalization and the European Green Deal](image)

In real life, data and digital solutions such as online platforms, smart devices, artificial intelligence (AI), Internet of Things (IoT) and blockchain are used to support the transition to sustainable development of the DE. They are used to improve design, production, consumption, reuse, repair, recycling and waste management (Figure 2).
Based on the results of our research, we have developed several useful approaches to improve the efficiency of the circular economy in various industries.

This article describes the tools of the digital circular economy for the construction industry. These tools include, among others, the development of data sheets for materials and components, scanning and data collection for resource and energy assessment using digital building information modeling.

It is important to understand that the transition to the principles of a circular economy allows you to get both environmental and economic benefits.

The article makes a certain contribution to the development of the foundations of the circular economy, which is intended to change the classical model of linear production, focusing on products and processes that minimize the production of waste and most types of pollution. The basic principles of this economy are based on the renewal of resources, recycling of secondary raw materials, the transition from the use of fossil fuels to more intensive use of renewable energy sources.

A circular economy, (circular economy) (CE) is an economic system that closes material and energy cycles in production and consumption systems. In this context, digital technologies (DT) are seen as solutions for implementing a circular economy. However, while the use of digital technologies in industry is growing, their specific impact on the circular economy has not been widely explored. Based on a review of the literature, we assessed the relationship between the circular economy and digital technologies using the TechDom business model integrating R-principles such as reuse, remanufacturing and recycling. This relationship is briefly presented below.
Digital technologies can be applied at any stage of the life cycle of a construction object, from the concept of an object to its final operation. Construction companies are using more and more available technological solutions, increasing mobility and safety on the construction site, optimizing the construction process. Digitalization is increasingly influencing the modernization of the management and operation of buildings, saving time, facilitating decision-making, saving financial resources and reducing energy and material costs. There is not only an increase in investment by construction companies in domestic start-ups, but also the opposite phenomenon associated with the interest of technology companies in the construction investment market.

The circular economy aims to shape a new sustainable development path by decoupling economic growth and resource consumption, demonstrating significant potential to create new business opportunities in the global economy and greatly improve resource efficiency in industrial systems. The vision of the circular economy is to fundamentally change the current linear economic “take-make-recycle” approach that generates huge waste streams. On the contrary, the circular economy paradigm offers restorative and regenerative approaches and technologies.

However, there is a structural gap between this view of the circular economy and current manufacturing practices. The circular economy model is currently only efficient and economically sustainable for simple products and certain material classes such as steel.

The most interesting opportunity for the development of sustainable value networks for high value-added products is the production of cross-industry closed value chains, where the residual value of the product at the stage of its use is maximized through the creation of alliances between stakeholders in various sectors and the transfer of product components and materials from one sector to others.

The circular economy also enables economic growth while reducing and optimizing resource consumption - it profoundly transforms the models of production and consumption chains and stimulates the development of new efficient business models.

The digital revolution in the circular economy means that more digital data is being created than ever before. Numerous digital solutions - digital sensors, mobile phones, connected devices - generate and collect new data. When this data is obtained, systematized, processed and analyzed, it can become useful information. In addition, shared information can bring great social and economic benefits if it helps solve problems, enhance collaboration, and enable relevant stakeholders to take the necessary actions. This type of information transfer is already happening and will increase thanks to various digital solutions in the interests of the digital economy [18].

Stakeholders inside and outside the value chain often use online platforms to exchange information about materials and products, which contributes to a more efficient implementation of DE. Cloud solutions, a network of remote servers hosted on the Internet, store, manage and process huge amounts of data from different providers and thus ensure efficient database management and use of related information.
The Internet of Things is becoming an effective tool, providing communication and information coming from sensors and digital tags, which forms the radio frequency identification of components and materials involved in technology. IoT-based solutions improve the communication of information along value chains and monitor and predict the need for maintenance and repair.

It is useful for CE, and in certain situations, it is necessary to use blockchain technology. Blockchain is a distributed ledger that records information and ensures its appropriate exchange. Since information can be managed decentralized, this minimizes information security issues. The information provided using blockchain technology cannot be changed without leaving a trace in the system, which increases trust between stakeholders. Blockchain-based solutions can ensure that DE-related information moves along the value chain along with products and materials, and also secures intellectual property rights.

DPP (Digital Product Passport) includes (i) a unique product identifier (i.e. a code similar to a personal identification number); (ii) a digital tag (i.e. a machine-readable representation of an identifier, such as a QR code that a smartphone can scan); and (iii) reference information about the product in the digital label. By scanning the tag, manufacturers, consumers, waste operators and government agencies (such as law enforcement) can access and download the information. In this way, DPPs can facilitate the flow of information to improve the cyclical management of a product throughout its life cycle, especially if it is supported by more complex tools (e.g. blockchain, IoT).

Achieving digitalization for data management and the development and deployment of digital solutions will greatly benefit people, businesses, society and the economy. Along with the greening of ICTs, using digitalization to enable and accelerate the transition to a more sustainable society and economy must be the foundation of a green and digital transition.

At present, there are already numerous examples of data and information exchange between value chains for the benefit of DE.

The most fundamental communication challenges for DE are related to data protection issues, fragmented data ecosystems, underdeveloped digital solutions, and a lack of incentives for businesses and consumers to share data and information. That is why it is necessary to provide a favorable basis for the transfer of information. It is necessary to use the full potential of data and digital solutions to ensure the wider use of DE.

The benefits from this will be significant: greater resilience, competitiveness and resilience of the European economy.

In the context of a globalized economy, it is equally important to create global rules and standards for the transfer of information for the digital economy.

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The potential of a circular economy for construction sector: experience European Union

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KEYWORDS - digitization; Building Information Modeling; construction sector; circular economy

ABSTRACT

The construction industry contributes to resource scarcity by consuming vast amounts of natural materials and producing large amounts of waste, which contribute significantly to the environmental impact caused by the needs of the world's growing population. The study presented in this article is aimed at identifying the main problems associated with the introduction of the principles of the circular economy, as well as the associated potential for the development of a circular economy in the construction industry.

1. INTRODUCTION

The construction sector is one of the most resource intensive sectors in the European Union. Over their entire life cycle, from the extraction of materials to the production of building products, construction, use and maintenance, buildings in the EU account for about half of the extracted materials and energy consumption, as well as a third of the water consumption and waste generated. On the other hand, the construction sector also has a significant impact on the social and economic level. This sector is estimated at 10% of global GDP and employs 111 million people [1].

The Roadmap to a Resource Efficient Europe highlights buildings as one of three key areas for attention. Better construction and use of buildings can contribute to significant resource savings: 42% of final energy consumption; about 35% of total greenhouse gas emissions; 50% of extracted materials; and up to 30% of water in some regions [2].

The production of most building materials requires large material and energy resources. However, these materials are either recycled or end up in waste after demolition. Consequently, the construction industry manages to exploit only a small percentage of the inherent economic value and durability of building materials. However, the need to increase the efficiency of resource use will grow in parallel with the growing human needs to meet these needs in the future. The principles of the circular economy can potentially contribute to minimizing the aforementioned unresolved problems that arise in the construction industry through the recycling of building materials. For example, existing solutions for mechanical connections may allow them to be designed for disassembly,
Recycling and energy recovery are the most common circular economy practices in the construction industry, although the economic and environmental benefits of recycling are thought to be much higher. The reuse of concrete structures has the potential to avoid a large proportion of the CO₂ emissions embodied in a building and provide economic benefits. In addition, by replacing concrete with alternative materials such as wood, steel and glass, there is increased savings in dismantling for reuse and recycling. However, the main challenges preventing the industry from seizing this potential are identified as: focus on short-term goals, complex supply chains, lack of cooperation between stakeholders and lack of implementation of the circular economy in the industry. The choice of building materials has a marked effect on the environmental impact of a building.

At current rates, the production of materials in the EU alone will account for 900 billion tons of CO₂-eq. The buildings construction sector bears the largest share of responsibility: in 2017, this sector (including the production of materials, transport, etc.) accounted for 36% of global final energy consumption and 39% of energy-related CO₂ emissions [3]. According to our calculations, the sectors analyzed in this paper must decrease from 2250 TWh in 2015 to 1434 TWh in 2050 in order to comply with the Paris Agreement [4].

This article outlines the commitments made by European industry so far and compares them to some of the potential climate benefits of circular economy policies. The following proposes circular economy measures that are financially competitive, reduce the amount of green energy and materials needed to achieve efficiency, and make a corresponding contribution not only to decarbonization, but also to other European Green Deal targets.

2. THE POTENTIAL OF THE CIRCULAR ECONOMY IN THE CEMENT INDUSTRY

In the construction sector, the production, transport and use of cement/concrete is the most important source of CO₂ emissions. Cement production accounts for 8% of global emissions and is also a significant source of emissions in the EU: 114 Mt CO₂ per year. In the normal scenario, growth in demand for cement will outweigh improvements in production processes, hence emissions in 2050 will be the same as today, at 113 Mt CO₂ per year.

If you look closely at the production process, it is the production of clinker that creates 60-65% of all technological emissions in the production of cement.

Circular economy regulations are already in place to some extent in the cement industry; 46% of its fuel is being replaced by alternative fuels and feedstocks derived from various waste streams. However, this poses several problems in terms of emissions, and local social acceptance of the practice is generally very low. The highest carbon footprint in the production of cement is associated with the production of clinker. Thus, the cement industry is focusing on clinker substitutes such as "additional binders" (for example, blast furnace slag can offer very high clinker replacement rates, up to 95% in some types of cement). Currently, about 25 million tons of blast-furnace slag is produced in Europe per year, of which about 87% is granulated for use as a
component of cement binders, concrete or road building materials. Replacement usually occurs where installations are in close proximity to each other, such as in Belgium where 63% of the blade is replaced with locally abundant steel slag.

The CO₂ emission level of GG blast furnace slags is typically around 67kg CO₂/t, which can reduce CO₂ emissions by up to 30% for conventional CEM I products.

The Cement Industry Association has released a carbon neutrality roadmap that aims to achieve zero emissions in the value chain. Unfortunately, it relies heavily on biomass, carbon capture and sequestration, and the use of carbon capture, and the current 2030 does not appear to be in line with the EU's climate ambitions.

The massive use of waste and biomass for energy generation raises concerns about its sustainability. The European Cement Association aims to achieve 60% alternative fuels (mostly waste) containing 30% biomass by 2030 and 90% alternative fuels with 50% biomass by 2050.

Clinker content in cement is slowly decreasing, but the pace of the process seems too slow to achieve significant results: the goal is to rise from 77% to 74% in 2030 and to 64% in 2050.

Two other major technical solutions envisaged by the industry are CCS and CCU (using CO₂ emissions to produce algae) and increasing carbonation in processes where cement and concrete will act as CO₂ absorbing materials.

Circular economy measures can reduce emissions throughout the production, use and end-of-life of cement.

As far as the process is concerned, improvements can be achieved by reusing 30-40% of the clinker, which often remains unused (or unhydrated) and, in principle, can be reused to replace the virgin material.

Qualitative innovations in clinkers other than Portland cement can lead to 20-30% reductions in CO₂ emissions in certain applications, as this reduces both the amount of limestone in the formulation and energy consumption. A particularly interesting development is LC3 cement, where calcined clay largely replaces calcined limestone in the cement, thereby reducing emissions by about 40%, both from heat and process.

To sum up the growing number of digitized elements, major gains can be made in the use phase by reducing excessive specifications and rethinking building design: According to the European Cement Association, the amount of cement in concrete could be reduced by 5% by 2030 and 15% by 2050. Reducing excessive requirements could, in turn, reduce the use of concrete in buildings by 5-10% by 2030 and by 10-30% by 2050. This will be very relevant for the 2050 targets.

The end-of-use phase will also play a key role: if cement recycling becomes widespread, it will reduce the average CO₂ intensity of cement production by 23%, from 0.62 to 0.48 tons CO₂ per ton of cement.

Overall, reclaimed cement can replace up to 80% of new cement in construction, cutting nearly half of building-level CO₂ emissions.
3. THE POTENTIAL OF THE CIRCULAR ECONOMY IN THE STEEL INDUSTRY

With the exception of power plants, the largest individual sources of carbon pollution in Europe are all steel mills. Steel workers emit almost two metric tons of CO₂ for every ton of steel produced.

Demand in Europe before Covid-19 was approximately 150 million tons per year. This will mainly be steel for electric arc furnaces, while virgin steel, five times more saturated with CO₂, will be mainly intended for export. It is noteworthy that about the same amount of steel is lost every year due to production losses and insufficient scrap recovery.

In its climate neutrality paper in 2018, industry committed to reducing emissions by 80% by 2050 as part of a circular economy. This result, according to Eurofer, will largely depend on the reuse of CO₂ emissions through so-called "smart carbon". A path that focuses on biomass and plastic waste as an energy source and on CCU to convert CO₂ emissions into hydrocarbon liquids (ethanol) or solids (plastics). This, according to the industry, will help reduce plastic waste.

If the European steel industry switches to bioenergy, about 200–250 million tons of biomass and waste will be needed annually. However, this assessment does not address competition with other sectors, does not take into account the fact that plastic waste must be phased out and that sustainable biomass is relatively rare and faces competing demands.

Arcelor Mittal, Europe's largest steelmaker, has pledged to cut CO₂ emissions by 30% by 2030 and achieve carbon neutrality by 2050 through technological innovations such as DRI (direct blast furnace injection) and Smart Carbon, albeit on this path relies heavily on fossil fuels.

ThyssenKrupp, another major player in the market, has committed to avoiding climate change in both indirect and direct emissions by 2050 with the same technologies.

The impact of circular economy measures on the steel market varies according to research. Rumboll noted that in 2050, 50% to 60% of steel in construction could be made from recycled steel, and that reducing over-spec at the design stage could reduce emissions by 36-46% compared to the BAU scenario.

The economics of materials presented a scenario where up to 85% of steel production in the EU in 2050 could come from secondary steel production. Achieving such a high recycling rate without shifting emissions would require "that almost all of the available scrap be recycled, high-quality steel production from scrap be feasible, and copper pollution eliminated." Electric arc furnaces (EAFs) achieve more than a fourfold reduction in CO₂ emissions (<0.2 t CO₂ e/tonne of steel produced) on the secondary scrap path, especially when powered by renewable electricity sources. It also has the added benefit of significantly reducing air pollution (particularly SO₂, NOₓ, dust and heavy metals) [5].

Since 2016, several steel producers have announced plans to phase out blast furnaces and switch to hydrogen processes. These commitments now increase the production capacity of 30 million tonnes of green steel, more than enough for the 22
million tonnes of primary steel required to fully implement the ambitious circular economy policy.

In the long term, Tata Steel and Arcelor Mittal partnered with the REDUCE project, which successfully demonstrated that steel for building construction can be designed to be 100% reusable.

4. THE POTENTIAL OF THE CIRCULAR ECONOMY IN THE PLASTICS INDUSTRY

Plastic emissions are a worldwide concern: if plastic production continues to grow as currently planned, plastic emissions could reach 1.34 Gt per year. By 2030, the emissions equivalent of more than 295 new 500 megawatt coal-fired power plants [6]. By 2050, total greenhouse gas emissions from plastic could be over 56 Gt, which is between 10% and 13% of the entire remaining carbon budget. In addition, there are serious concerns about plastic waste on land and in waterways, seas and oceans, as well as their impact on the environment, economy and health.

The production of plastic requires a significant amount of energy and emissions. The cracking of alkanes to olefins, the production of chlorine (mainly for PVC), the polymerization and plasticization of olefins into plastic resins, and other chemical refining processes generate significant emissions: on average, 2.5 tons of CO\textsubscript{2} is emitted for every tonne of plastic produced.

Buildings account for nearly 20% of the plastics market. The various types of plastics produced for this market (e.g. PVC, PS, expanded PS, PP) are in the form of pipes, cables, coatings, panels, films, windows and doors, and their presence in the market is growing as they are a key component of insulating materials and intelligent service solutions. PVC is a particular problem both because of its climate impact, highly polluting manufacturing process, and because of the toxic chemicals it contains (phthalates in coatings and cables, lead and other heavy metals in rigid products such as window frames) because they hinder recycling.

In 2018, only 29 million tons of plastic were collected separately after use, of which only 32.5% was recycled. Taking into account losses in the recycling sector, the total amount of recycled materials is now estimated at about 10% of demand.

According to the PVC industry, about 300,000 tons of window profiles and related building materials were recycled in 2017. But the situation varies from country to country - of this total, 70% of windows, shutters and profiles have been recycled in Germany and the UK, and 30% in the rest of the EU-28. To the best of our knowledge, only one facility in the EU has the right to recycle PVC coating.

In the case of polyolefins (PP and PE), 2 million tons of recycled polyolefins per year are currently placed on the European market through new products.

Plastic Europe has published some general industry commitments, including improved plastic roundness and production efficiency. This was accompanied by the goal of greater use of recycled materials, but no mention was made of extending life and reducing demand. The main focus is on the use of very controversial technologies, such as chemical processing [7].
Since 2000, VinylPlus, a voluntary consortium of the European PVC industry, has been implementing some circular economy measures. Specifically, it has committed to converting at least 900,000 tons of PVC per year into new products by 2025 as part of the overall target of 10 million tons set by the Commission for the Plastics Industry. However, the goal for 2030 is to increase this amount to only 1 million tons, which would be approximately 40% of the available waste. It is worth noting that PVC recycling is mainly carried out by introducing a proportion of recycled PVC into a cleaner material, which effectively brings even more PVC to the market.

For polyolefins, the industry association PCEP has committed to increase the use of recycled polyolefin waste such as polypropylene and polyethylene in new products to 3 million tons per year in 2025, with an increase of 1 million tons per year.

In the field of polystyrene and expanded polystyrene (Styrofoam), industry organization SCS has pledged to dramatically increase and accelerate the commercial use of revolutionary technologies such as depolymerization and dissolution to make polystyrene-based products fully and repeatedly recyclable, creating closed cycles.

Circular economy measures in this sector are applied throughout the entire value chain, with key deliverables from design (development for longevity and reuse) to the end-of-life phase. Recycling can and should be reinforced in closed loops to prevent recycling. Most plastics are recyclable and recycling reduces 90% of CO$_2$ emissions associated with new production. In a detailed assessment of the types, flows and uses of plastics, we found that a combination of reuse and recycling could meet 60% of all plastic demand by 2050, cutting CO$_2$ emissions in half.

5. THE POTENTIAL OF THE CIRCULAR ECONOMY IN THE GLASS INDUSTRY

Sources of CO$_2$ emissions from glass production are primarily high temperature heat (between 1300 and 1500°C) from fuel combustion for melting (which accounts for 75% to 85% of total CO$_2$ emissions) and process emissions associated with the decomposition of carbonates in the batch (between 15% and 25% of total CO$_2$ emissions). Switching to electric smelting using renewable electricity is not yet an option for large furnaces (200 to 100 t/d) such as those producing container glass and sheet glass, which account for 85% of production and emissions in Europe. The use of other technologies such as CCS/CCU is also limited by the fact that the industry is characterized by small, dispersed units, mostly located in old fields, making transportation difficult.

Saint-Gobain, one of the main players in this market, has announced its strategy for zero carbon emissions in 2050. They also committed to reducing by 2030 33% of their direct and indirect emissions and 16% of their value chain emissions compared to 2017 levels. It is noteworthy that they provide for an increase in recycling volumes (-80% of unrecovered waste) due to improved logistics in the short term. Innovations at the design stage, such as tighter integration of recycled content and design for recycling, are only foreseen in the medium term. Unfortunately, the design of lighter products is the only indicator of material efficiency on the list, and no specific stream of reuse research/applications is mentioned.
A larger coalition of glass-related industries has announced a European action plan called "Close the Glass Loop" to try to achieve 90% separate collection and recycling of glass containers by 2030.

Given technological innovation and that carbon capture and storage (CCS) may not play an important role in this sector, reductions in air emissions should be achieved through circular economy measures such as extending the life of products through the recycling of container glass and window glass. Reusable window designs and increased harmonization of product specifications can promote reuse and extend the life of products.

Approximately 3 million tons of CO2-eq. can be obtained by recycling 26% of container glass, which ranks first in the glass sector in terms of tonnage, and today still remains in waste.

Unfortunately, as in the photovoltaic sector, the glass industry claims emission savings in the value chains of buildings due to the insulating properties of their products: we believe this is an unacceptable double counting of savings in the building sector.

**CONCLUSION**

To fully achieve the European Green Deal's goals of climate neutrality and zero pollution, and to fully emerge from the economic crisis, industrial transformation must go beyond process-oriented technical feasibility measures.

Transformative actions must extend across the entire value chain and involve a skilled workforce, new quality-based business models, rethinking products as services, improved green design and transparency.

To ensure a sustainable path to carbon neutrality, starting with the European Industrial Strategy, the following high-tech circular economy strategies need to be put in place:

- Improving resource efficiency in industrial production by systematically setting environmental performance levels associated with best available techniques for resource consumption and waste prevention, based on production outcomes. Amend the EU10 policy framework to make these BAT standards explicitly mandatory.
- Increase the utilization rate of circular materials in the next decade by at least 100%, which goes beyond the targets of the European Commission's new Circular Economy Action Plan on Circular Economy based on transparent benchmarking of sectors.
- Introduce a minimum share of recycled renewable raw materials from renewable sources in line with EU climate targets in key building market products such as cement and plastics.
- Improving closed-loop production systems by improving the segregation of waste streams and setting quality targets for recycled materials.
- Ensure that the waste hierarchy (prevention, reuse, recycling, recovery) is strictly enforced and supports the creation of a sustainable market for the reuse of products and materials, especially for high impact sectors and resources.
- Ensuring transparency of information on the chemical constituents of all products to facilitate digital reuse, refurbishment, repair and recycling.
The goal of carbon neutrality must go hand in hand with the goal of zero pollution, as investment in industry tends to have a long shelf life: the chance must be seized to use post-COVID recovery funds and incentives to give way to unprecedented modernization or EU industrial enterprises aimed at achieving both goals.

- Support for low-carbon products through demand-side measures such as green public procurement and international green bidding procedures.
- Establish carbon footprint and sustainability information requirements for materials placed on the EU market, including recycled content, requiring a demonstration of “better performance” than Union standards.
- Promote mandatory harmonization of environmental and safety standards in the EU.
- Redefine the approach to identifying best available technologies to be based on achieving the best balance of environmental impact versus public goods or services provided in a value chain approach and based on technically feasible levels of productivity rather than economically acceptable levels of exploitation for industry.
- Ensure that appropriate benchmarking tools are used (e.g., revised PRTR/EU product register) to ensure that the data continue to be used in a transparent and user-friendly manner to ensure comparability and room for progress.

The key goal of reducing material consumption and emissions can be achieved with a set of win-win options focused on design and market requirements. Reducing the consumption of materials will greatly reduce the pressure our economy puts on the environment, especially on pristine habitats like the seabed.

- Make resource efficiency (energy and materials) a prerequisite for all innovation and refurbishment projects in industry.
- Drive consumption of raw materials to planetary limits by setting a goal of halving the material footprint by 2030 for metals, minerals and plastics.
- Set targets for the prevention of commercial and industrial waste, requiring reductions in residual fractions (similar to halving the target for reducing municipal residual waste by 2030, as outlined in the new document).

Supporting the establishment of stringent, Paris-compliant environmental performance for all energy-intensive materials, regardless of their intended use under the Raw Materials Alliance and The Strategy.

- Extend the life of building materials by introducing sustainable design requirements. This should result in building materials that are durable and recyclable, and once they are discarded or reach the end of their useful life, they are collected through closed loop systems, decontaminating and recycling them with equivalent functions as virgin materials.
- Include building and transport material emissions in energy and climate related legislation such as the Energy Performance of Buildings Directive.
- As part of the "Renovation Wave", ensure that new buildings are zero-based during construction, as well as in subsequent stages of the life cycle.
- Promote the adoption of provisions for economical design of new structures, which will help to minimize the ratio of use of materials and functionality in building codes and regulations.
• Introduce minimum requirements for recycled content in new buildings, increasing access to reusable and recycled materials in the market - such content must be detoxified no later than 2025.
• Give priority to the circular economy in R&D, especially innovations in processes that replace greenhouse gas emitting materials, those that aim to transform buildings into “buildings as a material bank”, and those that provide longer product life and wider use through digitalization.
• Create an enabling framework (assessment, regulation, financing) to enhance the role of digitalization in the decarbonization of industrial production, both in terms of energy consumption and resource efficiency.

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The European “Green Deal” and the Common Security and Defense Policy of the European Union

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ABSTRACT

This paper represents a comparative analysis of European Union’s Common Security and Defense Policy and European “Green Deal” as a key agreement of both essential strategic documents from the domain of the common security but also the ecological policy of the European Union. According to that, the context and the circumstances in which these doctrinal documents were brought together with credibility of the each act individually, have been explored. At the same time, this has been appointed to the problems of realisation and the institutional implementation of these strategies in the midst of the dynamical geopolitical and security surroundings of European continent. A special priority has been given to the identity recognition of the EU which moves forwards to establish itself as a continental, but also as a global leader, in the recent decades, when it comes to the problems in the ecology domain and the common security to boot. In this paper one can notice the intent for the critical perception of the strategies in which the EU continues to control crises, particularly in the midst of the incongruent interest and the political views of its members, together with the sudden alternated circumstances on the world’s security stage.

INTRODUCTION

Ecological security, in which all the attention has been concentrated to the relationship of the man and the environment, in the last decades, and especially these past years, has entered with a bang in the contemporary security discourse. Environmental and global ecological preservation is a process which variably has been in motion ever since the end of the Second World War, the moment when the civilisation became aware of the specific dangers of the nuclear weapons and the overexploitation of the environment. The second half of the 20th century brought us a mass appearance of ecological movements which have intensively highlighted negative climate change as an irreversible change caused by a grand demographic and economic development globally, which lead to the formation of the stand, in scientific but also in the wider social community, that ecological problems must be treated as security problems. In the 21st century, Ecological security discourse emerged as a consequence of the fact that the challenges, risks, and threats for the environment are rarely directly noticeable and the change occurs consequently, in some cases almost obscurely and therefore they do not struck the entire planet evenly and with the same intensity,
therefore the consensus for the environmental preservation for the decades has been the issue for the unsuccessful international debates and national conferences. Consequently, during the 20th century, over 900 multilateral agreements concerning climate change were signed, and at the same time over 28000 ecological organizations were established [1], the entire world has entered the 21st century unprepared to adequately face the threats coming from the ecological sector.

The second decade of the 21st century has brought a great concern globally when it comes to further climate change which, possibly, could permanently change the world as we know it in a negative way. In order to prevent this scenario, the United Nations formed The Paris Agreement on 12th December, 2015 in Paris. The issue in questions is the first act which was signed by all sovereign countries of the world, and which predicts the global cooperation of all international parties, based on the plan to fight climate change, in other words to reduce the global warming, which was establish as a reaction to the bad results of the Kyoto Protocol, 1997 and the Copenhagen Summit, 2009 (The 2009 United Nations Climate Change Conference). The Paris Agreement is an act by which the entire international community finally comprehends that "climate change is a common concern of humankind" [2].

COMMON SECURITY AND DEFENSE POLICY OF THE EUROPEAN UNION AND EUROPEAN “GREEN DEAL” AS THE BASIS OF THE COMMON EUROPEAN IDENTITY

In order to create and completely affirm the Common European Identity, ever since the signing of the Maastricht Treaty in 1992 the European Union has been striving, apart from economic and political, to form a unique security community and put itself as a regional, and possibly global leader to preserve security. Therefore, during 1999 The Common Security and Defence Policy – CSDP was established as a part of Common Foreign and Security Policy – CFSP so that the EU, in the international community, would be recognized as an important party on crisis management and global security preservation. The original title of the strategy was European Security and Defence Policy (ESDP), but after the Treaty of Lisbon became effective at the end of 2009, the platform was renamed in the Common Security and Defense Policy of the European Union (CSDP). In order to adequately promote and alleviate the integration among member states of CSDP, in the middle of 2004 European Defence Agency - EDA was formed, which acquired a key role in common defence capacity development and defence technology and equipment to boot.

Taking into a consideration, that the European continent, along with the whole world, is facing new security challenges and more and more complex and insecure environme, CSDP has been created as an integral part of a comprehensive approach of the EU to manage crises, which together with civil and military capacities also includes political, diplomatic, legal, developing, trade and economic instruments. The basis for the development CSDP was set during June in 2016 by publishing `A Global Strategy for the European Union's Foreign and Security Policy`, which was materialised by enacting the `Implementation Plan on Security and Defence`, leading to an enactment of `Defense Pact` by the EU in December, 2016, which consists of three interconnected elements – application of `Implementation Plan on
Security and Defense”, `European Defense Action Plan` and strengthening cooperation between the EU and the NATO [3]. It is clear that, the European Union, trying to define its own multidimensional identity, particularly by creating the security and defense community, has requested help in the NATO alliance, headed by the USA, which, from the very beginning of European security community formation, has observed this strategy with suspicion, fearing the decrease of influence that this military alliance had in Europe, especially among European community members during the 20th century. Therefore, the cooperation between the EU and the NATO was going slowly, and only just after the CSDP was established the EU has ceased to be submissive to the NATO and the USA, and showed a clear intention to impose itself as an independent subject, and as a leader of European continent, when it comes to security. However, the current security challenges, risks and threats reactualise the EU’s vulnerability, not only of its identity, but also of the Union`s ability to manage crises through enhanced military and defence potential.

Apart from common security and defense policy, during recent years, the European Union has strived to execute a unique strategy in the ecological security protection field, via its own institutional arrangements. Consequently, the EU ratified the Paris Agreement on October 5th 2016, after which its executive organs started creating a strategy to execute a sustainable economy on the continent. European `Green Plan` i.e. European `Green Deal` was introduced by European Commission in Brussels on December 11th 2019 [4] and after the series of reports by the European Environment Agency, which warned about the severity of the situation connected to ecological threats, especially during the 2019, and also appealed to start immediate problem solving to protect the environment [5]. This strategic document was created in order to react, adequately, to current ecological, but mostly to climate security challenges present, not on the Old Continent alone. The Introductory part of the document defines the European `Green Deal` as a radically new strategy of multidimensional growth of the EU with whose implementation, this supranational organization will transform into a more righteous and more prosperous people`s community with completely reduced greenhouse effects, where the economy growth will not be strictly correlated with exploitation of natural resources. Considering that the ecological security threats are gradual and invisible, but they also demand a unique approach globally and this strategy cannot be performed by The European Union solely, but as a broader ecological performance through UN Agenda 2030: the 2030 Agenda for Sustainable Development [6].

The second chapter of the European Green Deal predicts the European Union`s economy transformation through the number of policies which would allow the European continent to become completely climate-neutral by 2050. With that in mind, it is necessary to achieve a provision of cleaner, economically more accessible energy, to create an environment in which the industry would function in the conditions of clean and circular economy, where the waste becomes a resource with a multiple new implementation. Furthermore, a part of this multilayer strategy is designing a food system that does not endanger environment, and which will be based on preservation and renewal of ecosystems and maintaining the biodiversity. Regardless that the ecological challenges demand a global response, the European Green Deal defines the
European Union as a leader in implementing the sustainable growth strategy which, in the long term, has a goal to fight against negative climate change effects. Hence, all state members of the EU must support this strategy, for that reason the European Commission has called upon the European Parliament and European Council to absolutely support the European Green Deal and all the measures which are inevitable to implement it completely.

As a part of the implementation of the European Green Deal, the European Commission started the European Climate Pact on December 9th 2020 by which public was called upon i.e. all agencies interested in participating in pacifying the negative climate change effects via information exchange, public debates and direct activism. This platform was envisioned as a support for the European Green Deal and the green transition strategy whose goal is to transform the European Union into a righteous, healthy, prosperous and sustainable society [7].

In the middle of the following year on June 30th 2021 the first European Climate Law was proposed [8]. It was proposed by the European Commission, and it was adopted by the European Parliament and European Council, and this law represent concrete strategy which predicts that Europe would become the first climate-neutral continent by 2050. The European Climate Law defines the basic climate goal of the EU, and that is to reduce net greenhouse gas emissions by no less than 55% by 2030, compared to pollution parameters back in 1990. As one of the most important results of proposing this Law is forming of European Scientific Advisory Board on Climate Change [9] whose assignment is to make reports of the EU measures to prevent greenhouse effects, and also to obtain independent scientific advice in the field, in order to integrate climate policies on the continent with the European Climate Law and international EU obligations ratified by the Paris Agreement.

If we compare and analyse common defense and ecological policies of the EU, we can easily see that the green agenda implementation, as a part of security and defense policy domain, so far has been realised in the most difficult way possible, particularly when it comes to the EU’s military potential. Fossil fuels reduction in the intense economy sectors such as military industry and infrastructure is practically impossible to achieve in short term, and such goals are mostly set by European Green Deal. Additionally, in the previous decades the stand has been cristallised into believing that the green agenda can only been applied to the civil society, and therefore there is not enough room for military industry to apply agenda with an obvious pacifist component, clearly stated in the European Green Deal. However, one can notice the intent for the enhanced energetic autonomy in European military industry by using renewable energy, and the supply problem of conventional energy sources for military requirements is particularly visible in the currently Ukraine-Russian Federation conflict. In addition, the European Union energy dependence by the Russian oil and gas could additionally accelerate the diversification of energy supply, especially in the west of the continent and therefore influence the faster switch to the lower carbon emission energy. Ongoing conflict in the east unambiguously points out that the current levels of energy consumption in the military industry are incompatible to an ambitious strategy to decarbonise the EU, which is expected in the next three decades [10].
The essential transformation of the EU’s Common and Defense policy in accordance with the Green Deal could be the crucial step in the radical reduction of the harmful gases emission, by which Europe could truly be identified as a climate-neutral continent with an independent and competitive military infrastructure. Ukraine conflict will demonstrate whether the EU is actually ready to reform its defense and military capacities in accordance with the European Green Deal, i.e. whether the enormous funding which will be invested in the defense fund in the next few years, actually be spent in accordance with the ecological security protection strategy. According to that, a new significantly greater transparency is necessary when it comes to informing the public about the investements in the military potential of every state member, in such a way that the authorities which implement ecological strategy have the possibility to monitor the influence of the course, within the military industry, on the harmful gases emission on the continent. Finally, it is necessary to take into a consideration a fact that, within the military industry sphere, there is a greater number of those who advocate a theory - any type of energy transition in the military sector has a negative influence on its operational efficiency in the long-run. Therefore, we must strive to set the climate goals, in the European Deal, as a positive influence on the transformation and modernisation of the defense and military potentials.

On the other hand, the climate change paradox lies in the fact that the European and North-American continent, which have had the biggest influence on climate change during the previous centuries, both because of the geographical position, but also thanks to the technological, political and economical development will suffer the minimum damage from the negative climate change effects, i.e. these gradual threats will most likely manifest in the so called `Third World Counties` (Malawi, Ethiopia and Zimbabwe were struck by intense droughts, island countries together with Vietnam, Egypt and Tunisia were struck by a sea level rise, Sudan and Senegal suffer from desertification, while the Philippines and Madagascar were struck by frequent storms) [11].

Uneven climate disbalance consequences cause not only the devastation of the environment in a large scale, but also create additional political tensions and security threats caused by food and water shortages, energy shortages and spreading deseases, together with the lack of institutionalised capacities of underdeveloped countries to answer these threats adequately. The ecological component is definitely significant if we analyse the mass migrations globally, considering that the shortage of natural resources in certain regions is caused by populist explosions and climate change seldomly causes armed conflicts, but also activates frozen conflicts, which significantly have started the violent migration flows from Asian and African countries towards Europe. In addition, during the proposal of the Paris Agreement and the latter European Green Deal, mass migrations were the biggest security challenge that Europe has faced ever since the Fall of the Berlin Wall and the Dissolution of the Soviet Union and the SFR Yugoslavia, considering that the Eurobarometer research conducted in November, 2015 showed that 58% of the EU citizens believe that the migrations are among the biggest problems this political and economic community is facing [12].
CONCLUSION

The environment securitization is a process which was directly started after the Cold War ended, when the international community assumed, that focusing on ecological problems as an important issue, would become a logical consequence of the military problems desecuritization, because the armed confrontations of super-powers and military alliances have represented the basic and nearly sole threat to global security for decades. However, the current conflict raging in the east part of the continent has showed that the direct implementation of the ecological measures, as well as medical strategies crash immediately i.e. the armed conflicts, even in the modern world represent a primary security threat globally, regardless the alarming situation when it comes to ecological security. In the same manner, a significant number of desecuritization agents as the invisible adversaries of the global ecological security, emerge from economy and military industry i.e. emerge from the zone, which should be particularly reformed in the midst of the ecological measures implementation. Regardless the specific collective desire of our civilization, together with multisector action started as a plan to protect the planet, the events like global pandemic or armed action in Europe are sufficient to make the implementation of collective action plans to protect the environment postpone indefinitely. In the same way, a clear intention to form a common action when it comes to solving problems created by climate change is not enough to overcome this multilayer problem, which has been created gradually for decades, and even centuries, because the preliminary five-year assessments, after the Paris Agreement show that the carbon emission reduction in order to decrease global warming must be obliged, which is nearly impossible to achieve, according to the schedule, in the midst of the energy crisis.

Both the European Green and security and defense policies are evidently a product of an identity recognition of the European Union, which strives to pose itself not only on the continent as an economic and political leader, but also as an ecology and security leader for decades. This is a process which has faced impossible challenges, with the COVID-19 viral pandemic and Ukraine-Russian Federation conflict as the most important ones, and have caused the unthinkable energy crisis in the 21st century, and especially in the past couple of years, but also taking into a consideration the fact that the current problems will not be ended in a foreseeable future, Europe would have to engage all its state institutionalised mechanisms in order to pacify the negative effects, not only of the contemporary issues it faces, but also of the ever growing problems created by the changed health and security circumstances.

It is clear that the reality, not only in Europe, but all around the globe is changing rapidly faster than it can be followed by the international legislature and complicated international mechanisms which were establish by the EU though the decades of its existence and expanding. The solution to the problem, which the EU faces momentarily, ever since the implementations of the unpopular health and security protocols to the uncontrolled migrations, not only from Africa and the Middle East, but also from the Eastern Europe, certainly show the Union’s foreign politics, which can not only be recognized by making strategic but also with their complete implementation in order to be indentified as a leader both inside and outside of the Old
Continent. The ambitious projects connected to the collective security and ecological challenges on the continent are far from being realised, and the first security challenges undoubtedly show that Europe is about to experience turbular years in which it would be extremely difficult to remain focused on ecology and issues connected to the greater independence, when it comes to the defence policy. The crisis caused by the COVID-19 viral pandemic, Ukraine crisis and reactualised migration challenges pose the questions to which the European Union can not answer clearly and momentarily. Therefore, the very European identity is being tested and it will have to endure the new stages of reconceptualization and redefinition in the following period, which is a process that takes years, and even decades to implement common strategies across the entire continent.

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Insilico clinical trials vs classic clinical trials
In process of testing vascular stents

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ABSTRACT
The world stent market has an estimated value of €6.4 billion, of which 37% is generated in the US and 10% in the EU. Coronary stents are now the most commonly implanted medical devices, with more than 1 million implanted annually. Coronary stents are currently the most widely used for treating symptomatic coronary disease. This paper presents the innovative platform and its separate modules that can be used as a standalone tools developed within EU funded project InSilc (GA number 777119, H2020 programme), for designing, developing and assessing coronary stents. This integrated solution was developed by international consortium within this project (2017-2021). After almost four years of intensive work on different modules, presented in this paper and their integration in the platform which will be offered as a service to interested stakeholders, consortium is planning the commercialization of the solution. In this paper the potential benefits of using this platform instead of classical clinical trials are presented.

INTRODUCTION
An appropriate level of scrutiny and rigorous testing must be undertaken in the process of developing and commercialization of any medical device as well as coronary or peripheral stent. Last stage of this process are clinical trials, a process that is carried out in three phases and targets the evaluation of the safety and efficacy of stent on live patients. The difference between the three phases is the number of the enrolled patients, as well as the variables of interest in each of these phases. In the first phase, only a small number of patients were enrolled while the ultimate objective is to ensure the safety of the medical device. In the other two phases, the medical device is tested on a larger number of patients towards evaluating its effectiveness and potential side effects (Phase II), and in multiple hospitals and countries (phase III) to demonstrate the efficacy in a larger population. After this testing and the approval by relevant bodies, post-marketing multi-center studies are performed to estimate and assess the effectiveness of the new stent compared to already available in the market.
InSilc project aimed to develop an in-silico clinical trial platform for designing, developing and assessing drug-eluting bioresorbable vascular scaffolds (BVS), by building on the comprehensive biological and biomedical knowledge and advanced modelling approaches, to simulate their implantation performance in the individual cardiovascular physiology [1].

In accordance with Directive 2010/63/EU, the principle of the 3Rs (Replacement, Reduction and Refinement) needs to be considered when selecting testing approaches to be used for regulatory testing of human and veterinary medicinal products. Testing of new models of vascular stents, scaffolds and balloons in real clinical trials is time consuming, expensive and highly inconvenient for the patients included in the study. Therefore, the intention is to replace, reduce and refine the real clinical study with the insilico clinical study and insilico testing of the innovative models of stents in order to decrease the costs and the time required to perform real clinical study. In this paper we are presenting the innovative solution for designing, developing and assessing coronary stents which is developed within the EU funded project InSilc. The main question that has been raised and answered in this work is what the benefits of using insilico trials are. Market analysis of available platforms and software has shown that there is no similar integrated solution on the market and that potential savings are significant.

METHOD

The stent manufacturer provided the average results of uniaxial tensile tests performed on a number of dog-bone samples with a different gauge length, width and thickness. Tests are conducted at different temperatures. For each temperature, different curves were available referring to different strain rates: Results are in accordance with typical PLLA behavior: at each temperature, the curves show a common initial elastic response, a strain rate dependent yield point and plastic behavior ending with a strong hardening. At higher temperature or lower velocity, stress values decrease despite the increasing final strains [2].

The InSilc platform is based on the extension of existing multidisciplinary and multiscale models for simulating the drug-eluting BVS mechanical behaviour, the deployment and degradation, the fluid dynamics in the micro- and macroscale, and the myocardial perfusion, for predicting the drug-eluting BVS and vascular wall interaction in the short- and medium/long term.

The developed InSilc platform consists of different simulation modules/tools - some of which can be considered as stand-alone modules and, therefore, can be used separately if there is such demand from the targeted users. These modules integrated in the InSilc platform are: Mechanical Modelling Module, 3D reconstruction and plaque characterization tool, Deployment Module, Fluid Dynamics Module, Drug
Delivery Module, Degradation Module, Myocardial Perfusion Module, Virtual Population Physiology and Virtual Population database (Figure 1). These tools are applicable all types of coronary and peripheral stents, such as Bare Metal Stents (BMS), Drug-eluting Stents (DES) and Bioresorbable Stents. This is a great advantage of InSilc allowing this way the penetration of InSilc platform and modules to a wide range of market and interested stakeholders [3]. The paper presents the detailed comparative analysis of the costs and time required for the real clinical trial and insilico clinical trial performed using the presented solution.

Figure 1. InSilc cloud platform

RESULTS

The purpose of the Deployment Module is the simulation of the coronary stent implantation within stenotic coronary artery models. This simulation provides detailed information of the short-term outcome after stenting, in terms of deployed stent and vessel configurations as well as the stresses and strains in the two elements. These data are useful in predicting the in vivo performances of a new device.

The Stent industry follows standard mechanical stent testing in the whole process of stent evaluation, i.e., according to ISO test standards. Mechanical tests are very time-consuming, expensive and require many cycles/iterations, while in some cases total redesign of the stent are required or even the examined stent design is abandoned. The Mechanical Modeling module assists in reducing the required number of real mechanical tests and the associated costs. In brief, the module provides the ability of the following mechanical tests to be simulated in silico: Simulated use – Pushability, Torquability, Trackability, Recoil, Crush resistance, Flex/kink, Longitudinal tensile strength, Crush resistance with parallel plates, Local Compression, Radial Force, Foreshortening, Dog Boning, Three-point bending, Inflation and Radial Fatigue test.
The risk of fatigue failure is also predicted using fatigue criteria for metal stents with polymer.

The whole process for the Mechanical Module development includes the design, set up and implementation of several finite element simulations performed with the advanced and beyond the state-of-the-art in-house BIOIRC’s solver PAK [4]. The solver achieves the simulation of nonlinear material and geometry problems, nonlinear contact problems, dynamics and statics with residual stress and strain analysis. The process that is followed, in general, includes the following steps: (i) creation of the 3D stent geometry (in case this is not available directly in a 3D format from the manufacturer), (ii) mesh generation, (ii) application of appropriate boundary conditions (depending on the test a variety of boundary conditions are applied). BIOIRC has developed a nonlinear material model that is applied in the finite element solver PAK for prescribing material property from uniaxial stress-strain experimental curves. It is an Open module used only in the Mechanical Modeling Module (Figure 2).

Figure 2. Mechanical Modeling module: Three point bending stent testing

The Deployment Module requires detailed information about the delivery systems to be simulated to create reliable and realistic virtual FE models of the devices involved in the stenting procedure. In silico simulations of the stenting procedure consists of the following steps, to be repeated for each device (stent or balloon): (i) device positioning, (ii) balloon inflation and, (iii) stent deployment. Most of the computational steps are automatized and this allows a significant reduction in preparing and performing the simulations. In turn, this allowed a reduction of the process to be sustained by the users of the Deployment Module (Figure 3).
The Drug delivery Module (Figure 4) has been developed to model the in vivo release kinetics of the drug from the coating and its spatial distribution within the tissue over the course of weeks to months. Pharmacokinetics has been separately examined for the coating and the tissue. First, a mathematical empirical-trained model was developed to simulate release and extract the drug flux out of the drug-eluting surface, validated with the manufacturer’s experiments. Then, a physics-based three-dimensional advection-diffusion-reaction model was developed wherein using continuum mechanics equations the convection of drug by the plasma infiltration, diffusion of the drug within the tissue, and binding/unbinding of the drug to the extracellular matrix and specific receptors have been considered. Drug delivery is modelled for a sustained period of time to monitor both the early burst of drug as well as long-term retention and ultimate clearance rate.
The Degradation Module (Figure 5) simulates the degradation pattern of implanted BVS. The InSilc degradation framework has been implemented within both Johnson-Cook and Parallel Rheological Framework (PRF) constitutive models, which have been found to form the basis for the mechanical behaviour of several commercial BVS.

The InSilc Degradation module depends on detailed input from the Deployment module, whereby the implanted configuration of the relevant device and artery has been predicted. The post-deployment stent-artery configuration and the material stress-strain history at all model integration points are imported and these form the starting point.
for the InSilc Degradation module. This approach ensures that model parameters remain consistent between the Deployment and Degradation modules, with continuity maintained in the discretisation/mesh, element type, underlying constitutive model and many of the numerical parameters that control the solution process (e.g., step times, mass scaling etc.) allowing for a consistent predictive mechanical framework. The InSilc degradation module predicts the spatiotemporal progression of degradation. Based on this, the predicted long-term biomechanical performance can be related to several clinical endpoints relevant to implanted stents, including, minimal stent area, malapposed stent struts, stent fracture or dismantling.

![Graph](image.png)

**Figure 5. Degradation module**

Fluid Dynamics Module (Figure 6) is developed to compute the velocity, pressure and shear stress patterns in stented segments of human coronary arteries. The Fluid Dynamics Module requires two main inputs: geometrical information and flow boundary conditions. The geometrical information consists of two STL-files, one describing the lumen of the vessel wall, the other the surface representation of the stent. These two STL-files are combined to form the mesh of the fluid domain by using a commercial platform (ICEM, ANSYS). The boundary conditions consist of time-dependent inflow and outflow curves. These data are used to feed in a commercial solver (FLUENT, ANSYS) to compute velocity, pressure and shear stress patterns. The output is formed by 2D maps of pressure and shear stress derived parameters in the stented region (Figure 6).
The Myocardial Perfusion Module (Figure 7) simulates the post-treatment performance of the drug-eluting BVS in improving myocardial perfusion distal from the treated vessel. The Myocardial Perfusion Module predicts the whole-heart perfusion in the cardiac muscle, and generates virtual myocardial perfusion maps. The module takes as inputs CT coronary angiography (CTCA) images, the model-generated pressure boundary conditions, and the outlet flow conditions from the Fluid Dynamics Module. Prediction of post-operative perfusion is then provided by solving a multi-compartment poroelastic flow model, from which the perfusion maps are estimated. By combining the Myocardial Perfusion Module with the boundary condition variability model, it is possible to simulate perfusion differences under both rest and stress. By varying the boundary conditions between rest and stress and computing the Summed Difference Score (SDS), a threshold value of SDS > 4 can be used to gauge whether the virtual patient is at risk of post-operative myocardial infarction and other major adverse cardiovascular events (MACE).
CONCLUSION

The main benefits of using insilico clinical trials instead of classical (on live patients), are significant savings of costs and time for performing one. Clinical trials performed by supercomputers, based on the described modules of the InSilc platform will help stent industry to have more efficient development of innovative models of stents, because the costs and time for performing testing phase on developing model will be significantly reduced.

The main obstacle for using insilico clinical trials is unclear regulatory system. In that sense, USA has more regulated framework than EU and that is the field in which significant changes should be done in the future. These are main prerequisites for further development of European biomedical industry which is the fastest growing industry in the world.

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The EU and the Western Balkan response during the Migrant Crisis: is the European Green Deal inclusive for all?

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KEYWORDS – european green deal, migrant crisis, european union, western balkans, integration, labor market mobility, anti-discrimination

ABSTRACT

This paper examines the inclusiveness of the European Green Deal in regard to the general migrant population. The author has conducted a qualitative analysis of the success of migrants' labor market mobility, their risk of poverty or social exclusion, and anti-discrimination policies in the European Union. The research was limited to the EU countries with the highest number of migrants (Germany, France, Sweden, and the United Kingdom) during the period of 2014 to 2020. The analysis concerning the United Kingdom was restricted to the withdrawal of the UK from the EU. This timeframe was selected because the global pandemic of 2019-2020, which has led to lockdowns, produced a significant impact on the increased influx of migrants to the EU. Refugees and migrants from the Middle East, West and South Asia, and Africa who were en route to Western and Northern Europe used the Western Balkans as a transit region during this period, and the region remains as one of the most important migrant routes towards Europe.

A comparison of the labor market mobility and anti-discrimination aspects of migrant integration in the Western Balkans and of the EU is made in order to gain a comprehensive perspective of the outcomes of the crisis. The qualitative analysis of publicly available documents and policies regarding migrant integration from 2014 to 2020, revealed that the Western Balkans countries have attained an "equality on paper" score, and that non-EU citizens within the EU, in fact, face a higher risk of poverty or social exclusion than EU and national citizens. Additionally, it is observed that there is a need for a more systematic method of collecting migrant integration data within both EU member states and Western Balkan countries. Furthermore, the research shows that there is insufficient data on migrant employment in the green industry. The author concludes that an intensive effort is required to assist migrants in acquiring the skills required to transition and adapt to new processes of the European Green Deal.

INTRODUCTION

In December 2019, Europe stepped forward and offered a possible solution to stop the climate clock from ticking; the European Green Deal. The main goal of the Deal is for the EU to achieve climate neutrality as the first continent by 2050, which would lead to a "cleaner environment, more affordable energy, smarter transport, new jobs, and an overall better quality of life" [1]. However, in the past decade a number of humanitarian crises that have affected the EU, such as the 2014 Migrant crisis, the
Global pandemic, and the Ukraine war, have made the burden of combating climate change overwhelmingly heavy. All facets of society have been impacted by the global pandemic, and the crisis's effects are still to be determined. The Ukraine War brought, *inter alia*, new waves of migrants to the EU, which in turn sparked a second migrant crisis. All three crises are still going on, and it is difficult to say which one is receiving more attention. There is a proliferation of papers that elaborate on the benefits of the Deal, but researchers haven't focused as much on the (un) just transition of the general migrant population to the green industry. The current labor market in the EU will need to be transformed in order for the Deal to be successful. Although the Deal has been eagerly awaited, only “one direct reference is made to the nexus between climate change and migration/displacement, and current proposals tend to refer mainly to EU citizens as the constituents, targets, or beneficiaries of the Deal” [2]. It appears that there is a gap between the Deal and one of its likely consequences: exclusion for (low-skilled) migrants.

1. **IS THE EUROPEAN GREEN DEAL INCLUSIVE FOR ALL?**

The European Green Deal's primary goal is to transform climate and environmental challenges into opportunities for trade, development, and international cooperation whilst creating the EU's economy sustainable [3]. In the EU Green Deal document, it is emphasized that the transformation towards green and sustainable economies relies on the development of new knowledge and skills [4]. This process creates a lot of room for new jobs to emerge, but it also makes it necessary to think about how to acquire the skills, knowledge, and competencies that society will require in the future in a more systematic way. This paper focuses on understanding how this transition impacts the migrant population, and it examines how institutions and policymakers have dealt with this problem.

The European Union has committed to implementing the European Green Deal in a way that is "just and inclusive for all of its citizens, particularly for the workers in the impacted industries” [4]. As part of the European Green Deal, the European Commission has also disclosed the European Green Deal Investment Plan, the Just Transition Mechanism, the European Climate Law, the European Industrial Strategy, the Circular Economy Action Plan, the Farm to Fork Strategy, the EU Biodiversity Strategy for 2030, and the European Climate Pact [1].

The Just Transition Mechanism, a tool to guarantee that "workers in carbon-intensive sectors and communities that depend on those sectors benefit from the transition to cleaner and more sustainable economies," is a key component of the European Green Deal [5]. The Just Transition Mechanism aims to engage “impacted communities, local governments, social partners, and nongovernmental organizations in addition to providing financial support” [6]. In the document it is mentioned that “it will also strive to protect the citizens and workers most vulnerable to the transition, providing access to re-skilling programmes, jobs in new economic sectors”[7]. Contrariwise, the aforementioned document doesn’t mention general migrant population in any shape or form.
In the publication of International Labor Organization (ILO) “Extending social protection to migrant workers, refugees and their families, a guide for policymakers and practitioners 2021” an emphasizes is made on the importance of providing unemployment compensation and other forms of governmental assistance (social protection) for migrants [8]. The (ILO) deliberates that extending “social protection to all, including migrant workers and their families, is key to ensuring income security for all, reducing poverty and inequality, achieving decent working conditions and reducing vulnerability and social exclusion” [8].

According to the International Labor Organization (ILO), the four pillars of a Decent work agenda are “social dialogue, social protection, rights at work, and employment” [9]. The International Labour Conference adopted a resolution and a set of conclusions at its 102nd session (2013) regarding sustainable development, decent work, and green jobs, outlining a regulatory framework for a just transition [10]. Despite the ILO's support for a just transition, none of the recent publications address migrants in the green industry through a Decent work agenda. This demonstrates the need for a more thorough and effective strategy for the migrant population is imperative. Due to the uneven nature of the transition, it is essential to "address" migrants as a significant component of economic prosperity, and a specific, more thorough employment and social protection strategy needs to be applied to them [2].

2. MIGRANT INTEGRATION: IS IT JUST A THEORY OR A REALITY?

The causes of poor integration have been debated by academics, who have looked at “the characteristics of migrants themselves, the effects of governmental policies like multiculturalism, racism, and unfair treatment of minorities by the majority population in the country of destination” [11]. In 2010, Angela Merkel (the German chancellor at the time) said the concept of people from various cultural backgrounds coexisting amicably "side by side" did not work and that the burden of assimilating into German society, falls on (im)migrants, adding that the [multicultural] approach has failed [12]. After reviewing publications concerning migrant integration, the author noted that there is no consensus among academics regarding what constitutes successful integration. The traditional assimilation theory, in the author's opinion, is consistent with the reality of migrants in the EU today.

The traditional assimilation theory was first put forth by Warner and Srole (1945), who held that immigrants were expected to change almost entirely to assimilate with the dominant (mainstream) culture and society [13]. Numerous researchers criticized their approach, but Blanca Garcés-Mascareas & Rinus Penninx offer a succinct critique of this theory in their publication "Integration Processes and Policies in Europe?:

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5 Decent work sums up the aspirations of people in their working lives. It involves opportunities for work that is productive and delivers a fair income, security in the workplace and social protection for all, better prospects for personal development and social integration, freedom for people to express their concerns, organize and participate in the decisions that affect their lives and equality of opportunity and treatment for all women and men.
1. The problematic nature of the term "mainstream," which presumes the existence of a social environment that is homogeneous and cohesive.

2. The significance of structural injustices that could hinder or even prevent immigrants' integration, such as discrimination in the housing and employment markets.

3. The diversity of integration processes is reliant on collective actors (such as the state and its policies), the public, ethnic communities, and civil society), and environmental factors (such as the economic situation) [14].

The EU's policy toward migrants can be explained using the critical analysis of the traditional assimilation theory which was mentioned. Although the identity of immigrant minorities may be obvious in a local setting, in larger discussions, very diverse groups are “frequently treated as if they were one homogeneous group or are simply broken down by generational status only” [11]. These exclusionary processes in turn, might lead to “reactive ethnicity on the part of marginalized ethnic groups, working in the opposite direction to cultural assimilation and serving to maintain distinct ethnic identities” [14]. Secondly, systematic reviews of field experiments suggest that “racial discrimination in the labor market persists against non-white groups both in Europe and America and against the second generation as well as the first, thus inhibiting structural integration” [14]. The revised European Agenda for the Integration of Third-Country Nationals, which added the countries of origin as a third important actor in the process of immigrants' integration and thus introduced the three-way process, marked a significant shift in policy framing. The Agenda proposes that the "countries of origin can support the integration process in three different ways: 1) by setting up the integration process before the migrants arrive; 2) by providing support to the migrants while they are in the EU, such as through support from the Embassies; and 3) by helping the migrants prepare for their temporary or permanent return by using the experience and knowledge they have gained” [15] (EC 2011, 10) Despite the optimism that seemed to accompany this change in integration policies, the outcomes are too marginal. Growing income inequality in developed countries, especially in many other Western and North European countries like Sweden, Germany, and the Netherlands, is another significant difference between the current 21st century context and the earlier context [14]. There are potentially greater risks of entrenched disadvantage for minorities than there were in previous eras due to the declining opportunities for disadvantaged members of the majority group to achieve upward mobility.

3. METHODOLOGY

The author analyzed different types of reports such as studies, monographs, articles, and announcements concerning the EU and Western Balkan response to the Migrant Crisis. The author primarily relied on the secondary analysis of data, which implied the use of existing data sets and their interpretation (desk research of secondary literature). The European statistics (Eurostat) Database was used to generate a statistical overview of the "Persons at risk of poverty or social exclusion by group of
citizenship (population aged 18 and over, male and female) " from 2014-2020. The Migrant Integration Policy Index (MIPEX⁶) reports were used to measure the success of migrant integration policies (labor market mobility and antidiscrimination) in the EU and the Western Balkan countries.

3.1 THE EU RESPONSE TO THE MIGRANT CRISIS- MIGRANTS AT RISK OF SOCIAL EXCLUSION?

According to the OECD elaborate report from 2015, statistical analysis of unemployment rates shows that in most countries in the EU, “unemployment rates are higher among the foreign-born than among the native born, whether men or women” [16]. This report argues that among the members of the EU, foreign-born immigrants who have attained a tertiary education face high level of unemployment. Furthermore, it is concluded that unemployment and inactivity⁷ in the labour market can result in “social exclusion if they persist over time” [17]. According to the available data on EUROSTAT from 2019, for those residing in the EU27, the risk of poverty or social exclusion was:

- 20% of national citizens,
- 26% of citizens of other EU Member States,
- and 45% of non-EU citizens.

The high percentage of non-EU citizens from 2019, who are at risk of poverty or social exclusion led the author to conduct a comparable analysis with an extended timeframe; from 2014 (as the beginning of a high influx of migrants) to 2020 (the beginning of the world pandemic) to determine whether or not the influx of (im)migrants has affected the risk of poverty or social exclusion rate.

The goal of this analysis is determining the current position of the migrant population in the EU labour market. The author selected the EU countries that are perceived as favourable⁸ destinations by migrants and extracted data from the EUROSTAT Database regarding the "Persons at risk of poverty or social exclusion by group of citizenship (population aged 18 and over, male and female) " from 2014-2020. The data was divided into three separate categories: EU28 countries (2013-2020) except reporting countries, reporting countries, and non EU28 countries (2013-2020) except reporting countries. In the charts (1.-1.2) below, the author combined the statistical data and presented a visual presentation of the results.

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⁶ Discouraged workers are willing to and able to engage in a job but are not actively seeking work or have ceased to seek work because they believe there are no suitable available jobs. This involuntary inactivity is an indicator of labour market exclusion.

⁷ The MIPEX reports define a "favourable" destination for migrants’ countries that have the highest overall MIPEX score (80-100). In the heading that follows, the author will elaborate more.
Chart 1. Persons at risk of poverty or social exclusion by group of citizenship-population aged 18 and over, male and female (Reporting country) Source: Eurostat

Chart 1.1. Persons at risk of poverty or social exclusion by group of citizenship-population aged 18 and over, male and female (Foreign country) Source: Eurostat

Chart 1.2 Persons at risk of poverty or social exclusion by group of citizenship-population aged 18 and over, male and female (non EU28 nor reporting country) Source: Eurostat
An analysis across the EU Member States between national citizens and foreign citizens reveals that, generally, a higher share of foreign citizens were at risk of poverty or social exclusion in 2014-2020. Foreign citizens living in Sweden were 3.8 times as likely as national citizens to be at risk of poverty or social exclusion, while the risk of poverty or social exclusion was 2.9 times as high for foreign citizens in France. The statistics also show that the risk of poverty or social exclusion for foreign citizens in Germany are at the highest rate in 2020. The UK rates demonstrate an increased 10% (2014-2018) difference in the risk of poverty or social exclusion for foreign citizens. The aforementioned statistics show that non EU citizens de facto have a higher risk of poverty or social exclusion, especially in Sweden, which could negatively affect the just transition of migrants in the EU labour market. Namely, if it is harder for migrants to attain a job, than it is for national citizens or citizens of the EU, will it be harder for migrants to attain a “green” job?

3.2 MIGRANT INTEGRATION IN THE EU AND THE WESTERN BALKANS

The most unified approach in the assessment of successful migrant integration policies was conducted by the Migrant Integration Policy Index 2020 MIPEX. MIPEX is a tool which can measure policies concerning the integration of migrants (MIPEX 2020). An overall score was set to all countries based on their success of implementing the corresponding laws and policies based on eight areas: Labour Market Mobility, Family reunion, Education, Health, Political participation, Permanent residence, Access to nationality and Antidiscrimination. For the purposes of this research the Labour market mobility and Antidiscrimination policies are compared within the EU countries and in the Western Balkan9 countries. The scores are rated as follows: 1-20 unfavourable (immigration without integration), 21-40 slightly unfavourable (equality on paper), 41-59 halfway favourable (equality on paper), 60-79 slightly favourable (temporary integration), 80-100 favourable (comprehensive integration) [18].

In the 56 MIPEX countries, “it is observed that the Labour market mobility policies qualify as only halfway favourable for promoting equal quality employment over the long-term (49/100)” [18]. In most countries, family members and permanent residents can access the labour market and job training, as well as social security and assistance. However, full equality of rights and opportunity in the labour market is still “far from being achieved, especially in the public sector” [18]. As with the majority of areas of integration, “no significant reforms have been observed in the labour market over the last five years in 33 of the 56 MIPEX countries” [18]. The MIPEX 56 average score did not change between 2014 and 2019.

According the MIPEX reports Serbia’s is considered “a regional leader, as its policies are more developed than in Albania, Croatia and North Macedonia”, and the Labour market mobility is scored as “halfway favourable” (57/100) [19]. The report suggests that “permanent residents and reuniting families enjoy equal access to the labour market, including self-employment, however, these newcomers only receive general and no targeted support to improve their professional skills” [19]. Slovenia

9 There are no MIPEX reports available for the Republic of Montenegro and Bosnia and Herzegovina.
ranks as “slightly unfavourable” (26/100), with non-EU workers “facing obstacles and weak targeted measures to access the labour market and many temporary non-EU residents cannot equally access several measures used by national and EU citizens to improve their jobs and skills” [14]. According the MIPEX report France “delays and discourages the labour market mobility of non-EU immigrants more than most Western European/OECD countries”, while Sweden is ranked with the highest score. Non-EU citizens in Sweden enjoy “equal access to rights in the labour market and to the country’s social safety net” [19].

Anti-discrimination policies are a major area of strength across most countries within the Western Balkans and traditional destination countries. However, the Antidiscrimination scores in Albania reveal that people are “protected from discrimination on ethnic/racial, religious but not nationality grounds, unlike the trend in most European countries” [19]. According to the MIPEX reports Germany’s anti-
discrimination policies require “stronger policies can help to improve public attitudes, discrimination awareness, reporting and trust in institutions, society and democracy” [19].

4. CONCLUSION

The high rates of risk of poverty or social exclusion of migrants in the EU, and the MIPEX scores depict the inequality and entrenched disadvantage migrants experience. It is necessary to recognise the key role that migrants play in sectors which will be impacted by the transition and their contribution to the advancement of the Deal. Including migration in the European Green Deal would help to ensure that an important part of the population in Europe could be involved in the transition process. Moving forward, it will be important to ensure that these issues are reflected in the operationalisation of the Deal, and that migrants are engaged in participatory processes related to its implementation.

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Barriers and priorities of Serbia on the way to a circular economy: A case study of electrical and electronic waste management

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KEYWORDS – Barriers sustainability, waste management, circular economy, WEEE, Serbia.

ABSTRACT

The circular economy (CE) is the antithesis of the current, so-called linear model of the economy, which implies the uncontrolled exploitation of natural resources and the flow of materials from the stage of production, use, and finally inadequate disposal in landfills. The circular economy is a chance for the development of Serbia since the necessity of changing the business model of the national industry is increasingly highlighted through the transition to CE. These changes promote an ecologically sustainable way of doing business through the application and introduction of standards in production processes, eco-design, and promotion of ecological materials and technologies in the context of new market demands and needs. As an example, we took the managed electrical and electronic waste (Waste of Electrical and Electronic Equipment - WEEE or e-waste), as one of the fastest growing waste streams, whose proper handling and recycling can provide a significant amount of secondary raw materials (SRM). The aim of this paper is to identify deficiencies in WEEE management in Serbia and to provide recommendations for overcoming the obstacles that stand in the way of the effective implementation of CE. In addition to the introductory part, materials, and methods, this work is characterized by an analysis of the current WEEE management system, pointing out the weaknesses of the system and giving recommendations for overcoming barriers in the efficient implementation of the circular economy in Serbia. At the end of the paper, the positive effects that can be achieved by introducing circular models are summarized. Through the final considerations, emphasis is placed on the harmonization of public policy and the development of a model based on the European Union (EU) countries, as well as the inclusion of all interested parties in the CE integration process as one of the most important strategic goals for the development of the Republic of Serbia.
INTRODUCTION

Given the signing of the Sofia Declaration on the "Green Agenda for the Western Balkans", on November 10, 2020, Serbia, along with other countries in the region, accepted the European Green Deal as a new growth strategy, with the aim of a modern, climate-neutral and competitive resource economy that uses efficiency [1]. The adopted measures are related to the areas of climate change and pollution prevention, energy development, mobility and circular economy as well as biodiversity development, sustainable agriculture and food production [2, 3].

The circular economy, which is the subject of this paper, represents the antithesis of the linear model of the economy, which implies the ideology of uncontrolled exploitation of natural resources and the flow of materials, from the stage of production, use and finally inadequate disposal in landfills. This means that the linear model of the economy is based on the ideology of take - make/use - dispose, in which the product after the end of its "lifetime" is disposed of in landfills, where the exploitation of natural resources increases the amount of generated waste [4]. The opposite thesis to the previous linear model is the concept of circular economy, which emphasizes the circular creation of energy and materials, i.e. in the direction of product-waste-product [5]. Waste treatment or recycling represents a step forward in the way of thinking and orientation of society. Recycling saves raw resources (all materials are of natural origin and can be found in nature in limited quantities); energy saving (there is no energy consumption in the primary processes, as well as in the transport that accompanies those processes, while additional energy is obtained by burning non-recyclable materials); environmental protection (waste materials degrade the living environment, while recycling protects the environment) and creating green jobs [6].

The consumption of electrical and electronic equipment is strongly related to widespread global economic development. Increasing dependence on technology, expanded industrialization and further industrialization in some parts of the world lead to increase consumption of electrical and electronic equipment (EEO). In addition, electrical and electronic waste (e-waste) contains many toxic and potentially hazardous substances, where if this waste ends up in the environment, it can have an extremely negative impact on the living world and human health. Due to increasingly innovative solutions, rapid technological progress and human needs, electrical and electronic equipment is characterized by a short lifespan, while eco-design of products plays a major role in the prevention of waste generation. In 2019, the world generated a striking 53600 t of e-waste, which is an average of 7.3 kg per inhabitant. The global generation of e-waste grew by 9200 t since 2014 and is projected to grow to 74700 t by 2030 – almost doubling in only 16 years [7]. However, globally in 2019, the formally documented amount of collected and properly recycled e-waste was 17.4%, compared to generated. Increasing levels of e-waste, low collection rates, disposal and non-environmentally friendly treatment of this waste stream pose significant risks to the environment and human health. This waste is considered hazardous waste because it contains toxic additives, potentially hazardous substances such as Pb, Sb, Hg, Cd, Ni, polybrominated diphenyl ethers (PBDEs), and polychlorinated biphenyls (PCBs),
hexavalent chromium, phthalates, bromine-based flame retardants and others [8]. On the other hand, components such as printed circuit boards contain aluminum, copper, platinum, palladium, silver, gold, i.e. economically valuable substances that can be reused [9]. In addition to ferrous and non-ferrous metals, glass and plastics, e-waste contain critical metals (CM) [10] which, if recovered, represent a latent economic opportunity [11]. Most of these materials, due to an inadequate e-waste management system and low collection rate, end up in landfills and remain unused. Pre-treatment is a key step in e-waste management to ensure the efficiency of subsequent processes and the quality of output materials. Currently, conventional recycling methods are largely based on recovering ferrous and non-ferrous metals, plastic and glass, but the majority of critical metals and rare earth elements are lost during the pre-treatment processes [12, 13]. The main task for waste collection companies and local governments is to prepare appropriate waste collection methods acceptable to residents who wish to dispose of this waste. When the percentage of the collection is at a satisfactory level, e-waste will represent a significant resource that can be used for the extraction of metals that are increasingly in deficit. Collection models should be efficient, with low emissions into the environment and thus reducing additional pollution, promoting a circular economy through the use of secondary raw materials.

MATERIAL AND METHODS

The research in this paper is based on data analysis and synthesis of theoretical and empirical facts. The methodological framework is based on desk research methods and includes methods of analysis, synthesis, deduction and induction, as well as general scientific methods, such as description analyzing scientific papers, published texts and documents related to the concept of circular economy at the national level, and documents related to the concept of circular economy at the national level, as well as the systematization of collected information according to research objectives.

The aim of this paper is to identify deficiencies in WEEE management in Serbia and to provide recommendations for overcoming the obstacles that stand in the way of the effective implementation of CE. In addition to the introduction and methods, the work is based on the identification of deficiencies in e-waste management, as well as recommendations for overcoming obstacles in the efficient implementation of the circular economy in Serbia. The author's concluding remarks are also given. The originality of the paper was achieved by the analysis aimed at the set goal of the research, critical evaluation of knowledge and recommendations of the author.

IDENTIFICATION OF SHORTCOMINGS IN E-WASTE MANAGEMENT IN SERBIA

European Union (EU) waste laws have driven major improvements in waste management since the 1970s, supported by EU funds. However, they need to be modernized on an ongoing basis to make them fit for the circular economy. To establish efficient management and control of e-waste, the EU has adopted the Directive on Waste Electrical and Electronic Equipment 2002/96/EC (also known as the WEEE Directive), which was supplemented by Directive 2012/19/EU. The purpose of this Directive is to contribute to sustainable production and consumption by the prevention
of WEEE generation and also by the reuse, recycling, and other forms of recovery of such wastes to reduce the disposal of waste. According to WEEE Directive, this would contribute to the efficient use of resources and the retrieval of valuable secondary raw materials. The WEEE Directive is based on the principle of extended producer responsibility (EPR) to create the link between the production phase and the waste phase of a product. In the first place is the prevention of the generation of waste, by implementing the principle of "Producer's extended responsibility", producers are required to finance the collection, treatment, return (reuse), and ecological disposal of e-waste. Also, the producers bear the greatest responsibility in the context of the composition and properties of the product and its packaging. Taking this into account they are obliged to reduce waste generation, develop products that are recyclable, developing the market for the reuse and recycling of its products.

The European Union defined the electronic waste collection rate as 4 kg/inhabitant/year with the Directive on waste electrical and electronic equipment, which was originally valid until 2008. This was followed by an increase in e-waste management fees and the introduction of more demanding collection targets. The obligation of the member states was to collect 45% of the total amount of e-waste defined as the average amount of Electrical and Electronic Equipment (EEE) placed on the market in the previous three years until 2018, and after that from 2019, the target is 65%. In Serbia, the goal of separate collection of waste e-equipment from the household is 4 kg per inhabitant per year and according to the current legislation, however, the new regulation that should be valid for the period after 2019 has not yet been adopted.

According to [14], only 2.78 kg per inhabitant of WEEE has been collected annually in Serbia. The reason can be found in the lack of an appropriate WEEE collection system for households and small businesses. Moreover, in Serbia WEEE management infrastructure is not yet fully developed or, in rural areas, is entirely absent. Thus, companies that perform treatment and recycling of WEEE, directly or through intermediaries, also have the role of e-waste collectors [15].

Collection and recycling are not organized to a sufficient extent and for the most part their routes lead through the informal sector. Most collection sites are located in cities, while in rural areas establishing a collection system is still a big challenge. In order to adequately manage e-waste, the primary separation of waste and the construction of collection centers are indispensable. No regular collection system for WEEE from households and small businesses exists. Municipalities do not provide collection facilities for separate waste collection from households. Retailers have according to legislation on WEEE the obligation to take back WEEE on a one-for-one basis, however, the indication is given that the option is hardly used by end-users. At irregular time intervals, non-systematic collection campaigns are organized by waste collection and recycling companies, providing large containers for bulky waste and metal scrap. In the business sector, about 500 companies participate in the collection of e-waste through the formal sector, collecting mainly IT and telecommunications equipment. The informal sector that makes up the illegal streams of e-equipment and waste is mainly interested in the recovery of all types of waste containing metals. That is why part of the waste from electrical and electronic equipment is sold as scrap metal.
in the "grey" zone. In addition, collectors often supply local second-hand workshops where the spare parts are removed from the electrical waste and electronic equipment and used for reparation [16]. Also, the treatment of e-waste through the informal sector leads to uncontrolled emissions into the environment, and at the same time gives a different socioeconomic dimension and occupational safety and health risk.

The e-waste recycling chain consists of several steps (collection, pre-processing, end-processing) carried out by specialized operators. After the collection, pre-processing is the first and crucial step of e-waste treatment due to the fact that it determines to which recovery or disposal processes the material is fed [17]. The WEEE management system in Serbia consists of the collection of this waste stream and its pre-treatment, while the final treatment technologies are not represented. Pre-treatment technologies that are currently in use are customized for efficient separation and recovery of “mass relevant” fractions in e-waste, mostly metals (Fe, steel, Ni, Al, Cu) and non-metallic fractions like plastic, rubber, glass and textile, while the majority of CMs are lost as they stay coupled with dominant metal output fractions, or end up in the dust from the process [12, 13].

Moreover, ineffective management of e-waste directly contributes to climate change, due to greenhouse gas emissions for example due to energy consumption during the transport and treatment stages. Also, low material recovery rates have a big impact, which is again a consequence of inadequate recycling techniques or waste export to developing countries for treatment and disposal [18, 19].

Serbia as an EU candidate country, through national legislation, has harmonized and adopted the majority of the Union’s environment policy requirements regarding WEEE. Following the assessment of the systemic integration of the transposed EU acquis on WEEE into the national legislative framework, it can be stated that Serbia has partially transposed the WEEE Directive, but the level of transposition is quite low, with slightly less than half of the provisions fully transposed by national legislation [20]. The legal gap analysis of the harmonization of relevant Serbian legislation showed that out of 248 obligations defined by the WEEE Directive, Serbia has fully transposed 115, partially transposed 30, and 103 have yet to be transposed [21]. Based on this, it is clear that substantial changes are needed in terms of management, financing, and adoption of amendments to the Law on Waste Management and other ministerial orders, which will provide the legal basis for the implementation of newly planned policies.

Among the most significant aspects of the non-compliance of Serbia's national regulations with EU legislation is the lack of a legal framework for the establishment of collective and individual schemes in accordance with the principle of "producer's extended responsibility". While the second most significant deficiency that should be implemented into national legislation is the establishment of a National Register - National Registration Body for producers/importers of electrical and electronic equipment that would provide a financial guarantee that they will finance the management of these products at the end of their life. The main drawback is the absence of a decision on the inclusion of municipalities in the e-waste collection process as key actors in the system that strives to meet the goals of the collection of waste EEE and the circular economy itself.
RECOMMENDATIONS FOR OVERCOMING BARRIERS IN THE EFFECTIVE IMPLEMENTATION OF THE CIRCULAR ECONOMY IN SERBIA

The CE through the "product - waste - product" model promotes the message: Don't think about waste, but about the product, that is, about how the product is designed, how recyclable it is, how it is produced and how good it is for the environment. There is a great need for a CE in the world, where recycling is considered the leading instrument of this economic model [22]. The circular economy model is primarily recognized in the Scandinavian countries, which, in addition to social care, represent an example of a well-planned and developed system of sustainable development. These countries have implemented a system of increasing recycling rates, optimal use of resources with extended product life and their reuse, resulting in CE becoming a daily part of life. In addition, these countries are characterized by primary waste selection, awareness of separation and recycling, wastewater treatment with care for air quality, and advanced technologies with well-used environmental information. On the other hand, in Serbia, this model has not yet been developed, but economic development based on digitization and circular economy, which are presented in the Action Plan for the implementation of the Industrial Policy Strategy in the period from 2021 to 2030, is being pursued [23]. That is why the Ministry of Environmental Protection of the Republic of Serbia (2020) defined the following frameworks: regulatory and institutional, financial and investment, research and development as an industry, waste as raw materials and the framework of green jobs.

Regulatory and institutional framework. In the regulatory sense, the implementation of the circular economy in Serbia requires multi-layered and multi-sector linking of national public policies and regulations that would enable favorable conditions for new investments. Concretely, this implies the definition of priority sectors at the national level, in accordance with the priorities of the Government of the RS, infrastructural development and institutional capacities. This requires the creation and harmonization of national planning documents, amendments to laws (by sector) and technical regulations, promotion of voluntary instruments, the introduction of economic instruments in accordance with budget planning and the development of mechanisms for monitoring the implementation of regulations that contribute to the sustainable use of resources. Capacities at the local level are insufficiently developed, but there are also large differences in economic power in different regions of Serbia. It is necessary to change the resource policy, where the state will influence the preservation of natural resources through various measures and emphasize through public policies the sustainable reuse of already used resources and materials.

Financial and investment framework. The circular economy requires significant financial investments by all actors and a change in the conception of the business model. In addition to this, the fact that the European Commission has announced new funds in the context of supporting the industry for the transition to CE business models is not negligible. In addition, it is necessary for the economy of Serbia to continue the process of development. Accordingly, new competitiveness criteria have been set by
world market leaders, which relate to the type of resources used, product life, pollution reduction and waste prevention.

A framework for research and development as an industry. The research potential of the scientific community is not used sufficiently to contribute to the development of the industry. This means that the awareness of the advantages of circular design in the production process is insufficiently developed. There is a lack of trained staff among industry and business representatives for new business models in CE. It is necessary to support the model of strategic partnership between the academic community to support innovation and development and the manufacturing industry.

Using waste as raw material. The waste management policy is inadequate and outdated, with residual problems from the past and problems for the implementation of regulations in the waste sector. There is a low level of awareness about the potential of waste as a raw material for production, while the market for secondary raw materials is underdeveloped.

Framework of "green" jobs. At the national level and through competent institutions, it is necessary to promote the education of employees in companies who should be trained in new skills and familiarized with new business processes in the global market. Estimates are that the introduction of the circular economy in Serbia can create 30,000 new jobs. One of the main problems in Serbia is the constant increase in waste generated by the economy [24] while the primary separation and collection of special types of waste (packaging, tires, oils, bulky waste, e-waste and others) from the household at a very low level.

The main factors that influence the creation of an increasing amount of waste are frequent innovations and poor product quality because waste is caused by a mismatch between the life of a product and the life of use, that is when the life of use is shorter than the life of use. To avoid this, waste prevention is paramount in CE, which is achieved by designing products to have a longer life, while incorporating environmentally friendly materials that are not harmful and parts that can be easily repaired, replaced or recycled [25]. In addition, a big problem in Serbia is the lack of infrastructure, that is, special containers for separating waste to adequate sanitary landfills. For example, Serbia has only 10 sanitary landfills, more than 120 municipal landfills (which do not meet minimum standards), while there are more than 2,170 illegal landfills (it is estimated that there are more than 3,500 of them) that are near populated areas and watercourses [16].

The application of the principle of "extended producer responsibility" in Serbia would establish a sustainable financing system, because the producers, united in a collective operator, would control each other in the payment of fees for waste management. Such a system would lead to investments in the collection network, where public utility companies would also (JKP) be included. At the same time, the problems in financing the recycling industry would be overcome and the funds in the budget would be increased for financing other environmental protection projects. In addition to this, the introduction of a CE would increase the percentage of collected waste, create new jobs and raise the value of products that are lost when fully or partially functional products are discarded because they cannot be repaired, the battery
cannot be replaced, the software is no longer supported or materials embedded in devices are not returnable.

In order for the circular economy to live in Serbia, policy changes relate to principles, production design and legislative changes, in the area of eco-design, greening, public procurement and the introduction of incentives that are needed to improve production [26], which would have many positive effects [22, 6], (Table 1).

Table 1 Positive effects of the circular economy in Serbia

| Standardization of production by introducing ISO standards (14001, 9001, OSHAS 18000, 30000, 30001), etc.; | Transition from the classic process and processing industry to an innovative industry with far higher value of final products; |
| The transition from a manufacturing to a service economy (higher market value); | Modernization of industrial plants to create conditions for "cleaner production"; |
| Raising social awareness on issues of future development of society; | Opening new markets abroad for marketing products and services; |
| Establishing links with companies that implement the circular economy; | Reduction of negative effects on the environment, preservation of natural resources |
| Introducing the concept of sustainable development as a milestone for new markets; | Higher professional independence (through strengthening education); |
| Promoting the modern strategy and orientation of Serbia in order to rate investments from major world development funds (EU); | Entering the market of modern energy trade, and a potential pioneering position in creating smart grids; |
| Capacity building in Serbia, to become a center of knowledge and experience about CE in the region; | Establishing links with global development partners and organizations such as the UN and the EU to facilitate access to project funding; |
| Creating a knowledge economy and enabling an orientation toward a green economy; | Improving the model of taxes and duties on waste in industry and households; |
| Education of experts for the latest forms of business and social activities; | Savings on modernization of the economy (materials, energy, water, pollution treatment); |
| Reducing the technological gap in relation to developed countries; | Energy independence and sustainable development of society; |

Source: [22, 6]

The main recommendations, as well as the priority actions that need to be implemented in order to effectively implement CE in the field of WEEE management in Serbia, are as follows:
• Legal regulations - align legal regulations with EU directives, define the role of municipalities in the household waste collection system and implement the principle of extended producer responsibility;
• Prevention of waste generation:
  o Ecodesign of products – regulatory measures for electronics and ICT including mobile phones, tablets and laptops under the Ecodesign Directive so that devices are designed for energy efficiency and durability, reparability, upgradability, maintenance, reuse and recycling;
  o Extending the life of products - put emphasis on the production and import of products that can be easily disassembled for repair;
  o Reuse of products - opening more services for product repair or second-hand market;
• Strengthening infrastructure for collection - investments are needed through European funds for planning and building capacity for waste collection and opening green jobs;
• Investment in the recycling industry - subsidies and projects to strengthen capacities for extracting and processing precious and critical metals;
• Inclusion of the informal sector in the system regulated by regulations and legal norms;
• Education programs for citizens and employees on the importance of proper waste disposal.

CONCLUSION

By signing the Sofia Declaration on the "Green Agenda for the Western Balkans" (2020), Serbia accepted the European Green Deal as a new growth strategy, with the goal of a modern, climate-neutral and competitive economy that uses resources efficiently. One of the priorities relates to the circular economy. The circular economy (product - waste - product) is an opposed thesis to the linear model of the economy (take - make/use - dispose), which implies the ideology of uncontrolled exploitation of natural resources and the flow of materials, from the stage of production, use and finally inadequate disposal in landfills. Prevention of waste generation, treatment or recycling represents a step forward in the way of thinking and orientation of society because saving raw resources, saving energy, protecting the environment and opening green jobs are achieved.

Taking into account that WEEE is one of the fastest-growing waste stream that includes potentially hazardous substances, it has been classified as a priority waste stream by the European Union. WEEE Directive aims at the prevention of WEEE by promoting re-use, recycling and other forms of recovery of such wastes in order to reduce the landfill scenario, as also to focus on sustainable management of resources and subsequent recovery of valuable secondary raw materials.

Environmentally sound WEEE management should include economical, social and environmental criteria along with strong legislation which enhances the citizens’ environmental conscience. In this light, stakeholders like local authorities; nonprofit companies, producers, customers, etc. are responsible for contributing to the environmental end-of-life take-back system. In parallel, adequate infrastructures, as
well as recycling facilities, are required in order to develop a sustainable WEEE treatment system at a national level that will be in line with the principles of the circular economy.

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Energy security as one of the strategic objectives of the EU Green Deal
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KEYWORDS - Energy security, Measurement methodologies; Decision making

ABSTRACT
This paper defines three fundamental strategic priorities of sustainable energy management: exploitation of renewable energy sources, energy efficiency, and risk management. Basic information is presented on energy production from renewable sources with basic technical and technological solutions, and a proposition for managing and economic evaluation of energy production from renewable sources is given. The chapter defines fundamental assumptions of energy efficiency, audits and possibility for improvement of energy efficiency in particular business areas. There is a detailed overview of the risk estimation process which is related to the energy exploitation of a particular company. Finally, the chapter defines fundamental assumptions in the process of risk management in plants in all exploitation phases of energy resources. The chapter presents the basic model of the risk management process in this field.

1 ENERGY SECURITY

The concept of energy security
Energy security is one of the development priorities of each country. Therefore, each national economy strives to provide a satisfactory level of energy security and to conceptualize, plan, and implement it following its own needs and specifics (Filipović, Radovanović and Golušin, 2018).

Initial reflections on energy security arose in the 1970s as a result of oil crises. In October 1973, the first oil crisis began with members of the Organization of Arab Petroleum Exporting Countries (OAPEC) imposing an embargo on oil exports to the Netherlands, the United Kingdom, Portugal, Japan, Canada, the United States of America (USA), Rhodesia, and South Africa. The reason for the embargo was the Yom Kippur War, which was not energy related. Nevertheless, this event marked a new era in which oil started being used as an oil weapon, i.e., this event started the practice of using oil as leverage for political gains (Akins, 1973). Consequently, the price of a barrel of oil rose from USD 3 to USD 12 globally. As the sudden rise in the price of oil endangered the security of supply as well as the economic development of the countries, in 1974, the International Energy Agency (IEA) was formed with the initial goal of responding to physical oil supply disruptions. Over time, the IEA has become an international source for energy statistics, an advisor on energy policymaking along with issues of energy security (Paravantis et all, 2018). The problem of energy security
became commonplace, as the second oil shock in 1979 followed very quickly, which was politically motivated by the escalation of the Iranian Revolution and resulted in a double rise in prices over one year.

Although energy security issues were initially raised due to the oil crises, energy security was later linked to the Gulf War as well as to other crises (terrorist attack on September 11, 2001, in the US), natural disasters (Hurricane Katrina in 2005) and conflict situations (the Russia-Ukraine gas dispute in 2005–2006). Today, energy security is a matter of national security, and due to the different availability of energy resources, different political systems, economic welfare, ideologies, geographical locations, and international relations, energy security can mean different things and the priorities may vary.

Thus, the term energy security is of a relatively recent date and has undergone an upgrade over the last few decades. Initially, the term energy security meant, above all, technical security of supply, i.e., the provision of all necessary technical preconditions for the supply of sufficient quantities of energy (Sovacool and Mukherjee, 2011). During the 1970s and early 1980s, during several oil crises, oil price volatility directly affected energy security, so in addition to the technical dimension, the economic prerequisites for providing imported energy were pointed out. In the early 1990s, after the war in the Persian Gulf region, energy became an unavoidable subject of geopolitical changes. Hence, energy security gained a geopolitical component. The transition to the 21st century, brought the need for environmental protection so that the concept of energy security has gained its ecological dimension. At the same time, there is a growing belief that access to energy is the right of every human being and one of the essential preconditions for an adequate quality of life.

In defining energy security, the IEA has developed a short-term and long-term approach to energy security. It views the short-term approach of energy security exclusively as the ability of a country’s energy system to respond immediately and in the best possible way to changes in the balance between supply and demand for energy. On the other hand, the long-term approach to energy security focuses on finding and implementing supplies that are in line with economic development, with the need to preserve the quality of the environment. The IEA defines energy security as the uninterrupted availability of energy sources for all needs, at an affordable price (Ang, BW, Chong, WL, Ng, TS., 2015).

The Asia Pacific Energy Research Centre (APERC) formulates the same ideas with further focus stating that energy security is the ability of an economy to guarantee the availability of energy resource supply in a sustainable and timely manner with the energy price being at a level that will not adversely affect the economic performance of the economy. Whereas environmental sustainability was not directly incorporated in IEA’s definition except for its related long-term dimension, the APERC explicitly mentions it (A quest for energy security in the 21st century, 2007).

The European Commission agrees as it defines energy security as the uninterrupted physical availability of energy products on the market, at a price which is affordable for all consumers (private and industrial), while respecting environmental concerns and looking towards sustainable development (Radovanović, Filipović and Golušin, 2018).
On the other hand, the United Nations Development Program (UNDP) defines energy security as "part of national security, which implies a continuous supply of energy in various forms, in sufficient quantities, and at an affordable price" (World Energy Assessment: Energy and the Challenge of Sustainability, 2015).

The IEA, APERC, UNDP, and European Commission’s views on energy security are thus focused on the following three elements:

1. The physical availability and accessibility of supply sources,
2. The economic affordability and
3. The long-term environmental sustainability.

This approach is complex because it encompasses three basic dimensions: availability, reliability, and acceptability. The availability of energy goods and services implies the physical disposal of the required quantities of energy, by type (with adequate stocks), assuming the functioning of an adequate world energy market (Cherp and Jewell, 2014). Reliability shows how resistant the energy system is to disruption because the uninterrupted flow of energy can be interrupted due to technical problems and accidents, natural disasters, pandemics, changes in the world energy market, changes in the geopolitical sphere, actions of hostile groups or individuals, high-tech crime and other challenges, risks, and threats. Acceptability depends on the complex relationships that exist in the world energy market and is reflected in national energy security, even in countries that have large natural energy reserves.

There is a clear division on the acceptability of short-term and long-term definitions of energy security. Proponents of the short-term approach believe that energy security is a matter of the ability of the energy sector (and all relevant systems) to provide enough energy for the needs of one country (Augustis et al, 2017). Security of supply is in the focus of observation. Although there is clear evidence that energy security is not just security of supply, most modern measurement methods are based precisely on determining the degree of security of supply, without considering environmental, social, and other aspects. Of course, the security of supply is highly important. However, it is only one aspect of energy security, which in no way measures the related environmental parameters and the welfare of citizens (Narula et al, 2017).

In addition to these four institutions, some other authors have contributed to the most comprehensive definition of energy security. Yergin (1988) for the first time expanded the concept by introducing a geopolitical dimension, that is, defining energy security as “assurance of an adequate, reliable supply of energy at a reasonable price and in ways that do not jeopardize major national values and objectives”.

Based on this, we can say that the broader concept of energy security implies the country's ability to provide enough energy (by type, quantity, and quality), in the necessary place, at the required time, which will be sufficient to meet the needs of the economy and society, without endangering the environment, at an acceptable price, and with the provision of adequate reserves.

2 ENERGY SECURITY AND ENERGY RISK

Although there is no single accepted definition of energy security, it is evident that energy security depends on a large number of environmental factors that affect the
energy supply chain. Due to the difficulty in measuring all these risks simultaneously, the concept of energy security is mainly reduced to the analysis of one or several dimensions in the literature.

Risk as the probability that a particular event will occur, is a complex phenomenon and can be studied and observed from several points of view. Thus, depending on the criteria, we classify risks according to the source of risk, the extent of impact, and various aspects of risk such as speed, size, endurance, spread, singularity, or certainty of impact (Akhtaruzzaman et al, 2021).

If the source of risk is observed, then a rough classification into three risk categories can be made: technical risks, human risks, and natural risk sources. Technical risk refers to various infrastructure problems and constraints such as dilapidated and outdated infrastructure capacities that in themselves jeopardize the process of energy production, transmission, and distribution, and can also result in high losses in the transmission and distribution network (Boyko et al, 2017). Besides, technical risk may relate to inadequate network of oil and gas pipelines, inadequate protection of plants, insufficiently developed infrastructure, etc. Human risk can refer to various types of human error and negligence, but also high fluctuations in energy demand, underinvestment in energy capacities, various forms of sabotage and terrorism, political and geopolitical instability, wars, embargoes on exports and imports of energy. Natural risk sources refer to the problem of depletion of fossil fuels, the problem of insufficient availability of renewable energy sources, the occurrence of natural disasters, etc. Natural and human risk sources are often viewed in the context of security of supply and are associated with the ‘availability’ and ‘accessibility’ of energy resources (Aven, 2016).

If the scope of the impact measure is observed, i.e., how energy security is viewed, one of the important aspects is to consider the risk of sudden changes in the availability of supply concerning demand. Continuity in energy supply can refer to different phases of the process of transformation of primary energy, i.e., supply to the final consumer, and it can depend on the price and availability of oil, gas, coal, or electricity. Another risk may relate to continuity in supply services, i.e., prices, and availability of heating, transmission, distribution services, etc (Thorbecke, 2019). Also, if the scope of the impact measure is observed, human safety and environmental sustainability should be taken into account.

Many authors further restrict the concept of energy security by introducing subjective severity filters to distinguish between secure and insecure levels of continuity. The severity of a threat increases with the speed, size, sustention, and spread as well as with decreasing singularity and sureness of the impacts. Speed refers to the time frame during which risk can materialize. Accordingly, there is a constant scarcity - e.g., potency in renewable energy sources), and fast shocks: supply disruption due to war, technical disasters, or natural disasters (Murshed, and Tanha, 2021).

The size of threat impacts refers to the extent of changes in scarcity within the affected area. In that sense, there are impeding changes (indicating the probability of a negative impact without a direct impact on consumers), small changes (affecting consumers, but not the system), and phase changes (affecting consumers, but also the
A good example of phase changes could be physical barriers to energy supply or global warming (Kester, 2021).

Depending on the spread of threat impacts, risks differ at the local, national, and global levels. Endangered energy security due to technical problems is an example of local risk. At the national level, an example of endangered energy security is political risk or an embargo in energy trade. Since global warming occurs at the supranational level and has effects on the whole world, the risk of global warming is an example of the risk of the highest rank.

The singularity of threats refers to the frequency of occurrence of the risk. In that sense, we make a distinction between unique (e.g., nuclear catastrophe), infrequent (political conflicts, natural disasters), and frequent (technical problems) threats. As a result, the literature states operational and strategic risks, where the former include frequent threats, whereas strategic risk refers to infrequent/rare treats (Wang and Zhou, 2017).

Risks are also classified according to the level of predictability (Hammoudeh et al., 2021). Accordingly, there are four types of risk: predictable (example of energy resource depletion), probabilistic (example of a technical constraint), heuristic (possibility of political conflict or terrorist attack), and completely unpredictable (anthropogenic global warming).

Based on all mentioned, it can conclude that energy management that implies achieving the desired level of energy security is a complicated and time-consuming process. This process is under the influence of a lot of different factors, and at its centre is the energy sector (exploitation, transport, and energy consumption). The energy sector operates in an environment that is more or less unstable, whereby the environment that affects the processes of obtaining, distributing, and consuming energy in the world is especially variable and difficult to predict (Matsumoto and Shiraki, 2018). Namely, there are numerous possibilities for predicting the movements on the global energy market but the specifics and significance that energy has for the whole of humanity necessarily leads to problems and events that are difficult to manage. Due to all the above, energy management is a process that is associated with increased risk, and therefore must be planned and implemented with special attention (Tian et al., 2017).

Sustainable energy management is, in essence, an additional complication of the energy management process, and therefore necessarily becomes an even more complex process when it comes to risk assessment that accompanies and affects it. In the process of sustainable energy management, risk is a separate process, but one which nevertheless takes place integrated with the process of sustainable energy management, intending to achieve and maintain the desired level of energy security (Malkova and Malkov, 2018).

When assessing the risk in the process of sustainable energy management, it is necessary to take into account and analyse a large number of internal and external factors. Also, it is essential to analyse economic and non-economic risk factors that may affect the success of the implementation of sustainable energy management in a particular business system.
**Internal risk factors** include a large group of events that may occur in the economic environment, which primarily include (Spada and Burgherr, 2020):

- **procurement market** – where it is necessary to assess all factors of energy supply, their availability, purchase price, distribution conditions, quality, specifics, with a particular analysis of the possibility of supplying energy produced from alternative sources. Also, it is necessary to analyse the options for energy production from own sources.
- **competition** - every company operates in an environment where there is competition. It is necessary to consider the strength and quality of competition, its number, geographical distribution, and market segments it covers. Modern companies are fighting for consumers, among other things, by influencing the increase in the level of energy security of the country, so that the acquisition of a strong competitive position largely depends on the behaviour towards the use of energy resources.
- **legal regulations** - in each country certain legal regulations determine the rules of business so that any change can lead to significant problems for the security of the state. Modern legislation mostly supports sustainable energy management, but the risks of change in this area are still possible and
- **technical and technological innovations** - are of great importance in the process of security energy management. All changes in the technology market have to be specifically anticipated. Also, it is necessary to take into account the quality, prices, availability, specifics of delivery, and installation of a particular technology, as well as all other factors of this type.

**External risk factors** include a range of diverse factors that can positively or negatively affect the energy sector to a large extent. These factors need to be analyzed as accurately as possible due to the specificity of the global distribution and the importance of energy in the development of all humankind (Franc-Dąbrowska, Mądra-Sawicka, and Milewska, 2021):

- **availability of energy resources** - uneven distribution of energy resources put a large number of economies in the world in an unequal position because many countries have to import energy. Therefore, each country strives to provide sufficient amounts of energy for its functioning but is highly dependent on the rules dictated by countries that have energy resources.
- **conditions of natural disasters** - energy resources are products of a country which have a high possibility of being exposed to natural disasters, which can jeopardize the ability to supply the world market to a great extent.
- **the conditions for the occurrence of disasters due to human activities** - energy production and processing plants, as well as facilities and means of distribution, are inherently complex and as such may be particularly susceptible to industrial disasters of smaller or larger scale.
- **political factors** - are factors that largely determine the functioning of the world today, especially in the sphere of energy distribution, which is a limited resource. We must consider all political changes with special attention to political predictions to minimize the risk of their occurrence.
state of war and other armed conflicts - the risk of armed action is always present in regions with large energy reserves, which poses a constant risk to the availability of energy for all those who depend on energy imports.

Only the basic factors that need to be taken into account when assessing the risk of operation of power plants are listed. Their analysis is complex but necessary because the transition from the traditional to the safe way of energy management is a kind of strategic change that necessarily leads to large and long-term changes. Risk assessment involves performing a series of evaluations that are exceptionally complex when it comes to activities related to energy production and consumption because there is a high possibility of environmental incidents with major consequences (Sýkora, Marková and Diamantidis, 2018).

In addition to the harmful consequences for the environment, the negative consequences for the energy sector and the country as a whole should certainly be considered, because all adverse events in the energy sector can have an impact on the broader social, economic or political environment. Plants that deal with the production and transportation of energy conventionally are plants that carry a high-security risk. A particular problem for risk assessment is producing energy in nuclear plants.

Risk analysis, as part of the risk management process, involves the analysis of each critical point identified. During this phase, it is necessary to determine all the parameters of the observed risk (Azzuni and Breyer, 2018):
- the origin of the risk, where it is necessary to determine why a critical point occurs at a certain place in the technological process, that is, why pollution occurs. Proper assessment of the origin of pollution is very important because it can provide valuable information that can immediately offer adequate solutions. The situation is different if it turns out that the cause of harmful effects is a human factor, malfunctions in the installation of the plant, weak technological solution, and the like.
- type of pollution, implies the detection of the nature of pollution, that is, its physical, chemical, or biological nature.
- direction of action, represent different pollutants directed to diverse natural systems, some pollute the air, some water, some directly endanger human health, and most often act in a complex manner.
- intensity of action implies defining the strength of the impact of pollutant emissions because it certainly does matter whether it is a small or mass contamination.
- hazard as a final analysis that indicates the real danger of the polluting factor to the environment.

After assessing the characteristics of the risk event itself, a list of priorities is determined. Energy consumption is often associated with risks of varying intensity but is essentially the cause of a large number of risks that exist in performing a particular activity. Energy consumption is a process that necessarily causes pollution and therefore requires special attention (Papież, Śmiech and Frodyma, 2019).

Risk assessment, where all previously determined parameters are considered together and a judgment is made as to whether an individual critical point of high, medium or low risk is present. Further procedures depend on this assessment. High-risk impacts should be eliminated as soon as possible, while low-risk impacts can in
most cases be eliminated more simply. Experience shows that goals must be ranked according to the degree of urgency and ability to be solved and that they must then be approached individually. Only when one security problem that arises in the energy sector is solved, another problem can be solved (Wieczorek-Kosmala, 2020).

Risk management involves a series of activities (implementation of protection measures, employee training, strict and constant control) that are carried out to properly deal with critical points that have been detected in previous procedures. Some technologies and procedures are associated with risks, but with proper management, the possibility of incidents is minimized.

The risk assessment may establish that a particular technology has a large number of critical points and surpassing them is extremely expensive and therefore unprofitable. In such a case, it is indicative to think about changes in the technological process or about a change of the entire technology. Modern technologies are, as a rule, energy-efficient and safe, and energy consumption is controlled. However, in many parts of the world, modern technologies are not available, and the problem of transport, which is necessary for performing most human activities, still exists as an activity that consumes fossil fuels and replacements are not yet sufficient or adequate (Wang et al, 2018).

Today, the assessment of the risk of performing a certain activity is a necessary parameter when evaluating future investment activities that is, making decisions on starting a new activity. Every business plan or investment project in the energy sector must provide information on possible environmental risks, as well as offer information on how the company intends to keep risks under control.

Risk is an event that can be different and intense. Risk assessment is essentially a complex and multifactorial analysis that is related to all aspects of business and is especially analyzed to assess the economic feasibility of business and security of energy infrastructure as a whole. Namely, certain risks can be so high as to jeopardize the survival of the company itself or require investments that are so large that they impose the need for a strategic turn in business, which is an important decision with far-reaching consequences. Modern business rules require an assessment of work risk, especially when it comes to energy consumption, both in existing companies and when investing in new activities. There are three fundamental issues to consider before considering ranking energy projects (Ioannou, Angus and Brennan, 2017).

- It is first necessary to assess the strategic scope of the analysed project or endeavour, that is, to evaluate how strategic and how opportunistic the project should be. Surely, projects with a significant strategic character should be the subject of a more detailed analysis. Most projects related to energy consumption can be considered as projects of this type because energy is a strategic resource and all activities in this field are of importance.

- Secondly, it is necessary to analyze the type of risks that exist. In conventional management, it is understandable that all investments, regardless of whether they are potentially profitable, can carry a significant risk of failure. That is especially true in the case of investments in the energy sector whose potential profitability may depend on uncontrolled risks that are not evenly distributed in the observed area.
• Thirdly, the economic implications of the project need to be taken into account. Regardless of the priority given to sustainable energy management, ways to achieve equality or equity in balancing resources on condition to achieve maximum profitability per unit of money spent should be explored. It is necessary to assess whether the indicators should be adjusted to justify forced projects to achieve goals that are not narrowly economically oriented and safe. Energy production and energy resource management is an issue of strategic importance for each country, so these types of projects cannot be viewed solely as economic ventures.

• Finally, it is especially important to take into account the sensitivity of the energy sector to cyber-attacks.

Assessing the potential risk posed by the implementation of a particular project is an exceptionally complex undertaking and evaluating energy risk makes it even more complicated. The issue is complicated further by global problems that deepen the risk in this sector. Namely, the problems of uneven distribution of energy resources, conditioning of energy supply, uncertain market, and price fluctuations are just one of the risk factors that should be taken into account. An overview of the factors to consider are the following:

• Exposure - it is necessary to assess how much and which type of uncontrolled risk factors can affect potential results.

• Timelines - it is necessary to consider whether there is a trend for important risk factors to become more or less favourable. If the time factor is misjudged, the project may fail due to premature investment or become profitable over too long a period. Most projects in the energy sector are expensive, and the demands in this direction are expected to be even stronger.

• Volatility - it is necessary to assess the probability of the expected result if all uncontrolled risk factors act. In the case of analysis of this factor, it is essential to have an adequate risk management plan because this factor has an extremely devastating effect if all types of risk occur at the same or in a short time. When it comes to energy projects, a relatively high level of these impacts can be expected, which is a consequence of the instability in the global energy market, therefore, it is advisable to perform this type of analysis with special attention.

• Safety - regardless of the number of risks, it is necessary to consider whether there is a way to minimize or mitigate the impact of uncontrolled risk factors. That most often refers to a step in the risk management process when making a decision.

• Persistence - projects in the energy sector are usually long-term, so it is necessary to assess how long uncontrolled risk factors will affect the success of the project. In this way, the possibility of terminating the observed risks during the project can be considered. Also, it is necessary to predict whether the effect of uncontrolled risk factors will continue after the end of the project life.

Only the fundamental factors that should be taken into account are listed, e.g., when planning investments and operations in the energy sector. As energy investments represent capital investments, risk analysis is a key phase of the strategic decision-making process with extraordinary emphasis on risk management in the field of

3 ENERGY SECURITY MEASUREMENT METHODOLOGIES

Following different energy security definitions and respecting risks, decision-makers need to be able to derive effective policies for their countries. Hence, as a first step, they need to be able to quantify the energy security of their country to situate their performance and compare it to the one from other countries. Given the multiple dimensions of energy security, to quantify energy security, indicator-based approaches that include several indicators at the same time are most commonly used to provide a multidisciplinary approach. The Multi-Criteria Decision Analysis method is used, based on which several individual indicators are combined into an overall score, usually called an index or composite indicator, which exhibits the performance of the alternatives. Thanks to the effective communication tool for policymaking that indices offer, their popularity has been increasing recently. Numerous methods to combine individual indicators into an index are reported in the literature, as a consequence, several different indices have been developed (Gasseer, 2020).

After 2000, several approaches for measuring energy security were developed to quantify energy security, which would enable more efficient monitoring, comparison, and prediction. Currently, the most commonly used methods for quantifying energy security are:

- Shannon-Wiener Index,
- Energy Security Index,
- Supply/Demand Index for long term security of supply,
- Oil Vulnerability Index,
- Vulnerability index,
- Risky External Energy Supply,
- Socio-economic Energy Risk,
- The US/International Energy Security Risk Index,
- MOSES - The IEA Model of Short-term Energy Security,

4 CONCLUSION

From a practical point of view, energy security is becoming an increasingly important issue for each country, but understanding and practical monitoring of energy security are often insufficiently methodologically based, and the estimates thus obtained can be potentially dangerous. Also, from previous research on the essence of energy security, it becomes quite clear that it cannot be viewed separately from the specific characteristics of each country and the moment in which it is determined. Thus, determined national approach to defining, conceiving, and planning an energy secure future creates certain differences between countries while losing a unified approach to energy policy, which is especially evident in the example of EU countries. Every country in the EU (and beyond) is striving to find a way to ensure an energy-secure
present and future while leaving less and less room to respect the previously accepted
general directions of development. Each country individually strives to be as energy
dependent as possible, because this clearly leads to the development of all other forms
of dependence, which are usually unfavourable in the long run, and often lead to the
development of geopolitically conflict situations.

Consideration of energy security is completely inseparable from the consideration
of national security as a whole. Namely, achieving the country's energy security
without undermining its national security as a whole is certainly in the focus of interest.

There are several reasons why the issue of energy security is a concept that
depends on the specifics of each country. First, there is an uneven distribution of energy
resources in the world and within one country. Also, there is unequal access to energy
resources, unequal demand in different periods and seasons. Furthermore, countries
have different visions of their own economic, environmental, and social future,
different geopolitical priorities, and plans for the future. In such a situation, any
methodology for measuring energy security can only give an approximate insight into
the situation in a given country at a given moment. Finally, the large and different
impact of changes in energy prices on energy security is very clear. Namely, high
energy prices certainly have a direct impact on economic development, but even in
these cases, a country's economy does not reduce energy consumption proportionally.
On the other hand, low energy prices affect the increase of consumption, and especially
the reduction of investments in renewable energy sources and energy-efficient
technologies.

Therefore, regardless of the definition used, energy security today is defined at
the national level, following one's vision of the present and plans for the future. The
efforts of each country to achieve and maintain energy self-sufficiency, as well as the
development and preservation of an energy system that is resistant to disturbances - are
becoming an imperative of energy policy in all countries that strive to preserve national
security as a whole. Therefore, the stability of the energy system, its vulnerability,
resilience, and self-sufficiency should be the basic parameters of energy security. In
addition, it is necessary to take into account the fact that energy security is a dynamic
category, because at different times there can be different priorities in the same country.
Based on all that has been previously said, we can conclude that stability in the field of
energy security is much more significant than the measured size itself, as well as the
economic and environmental costs that arise in this regard.

In addition, the relationship that exists between the parameters that affect energy
security has been clearly defined in a large number of studies as more important than
the quantities in which the values of these parameters are expressed. Therefore,
knowing the relationship between economic growth, sustainable development, and
energy security is of great importance for the future. Most of the previous research cites
as one of the conclusions the need for continuous review of existing definitions and
proposals for new solutions. Namely, energy security is not a new concept, but it
certainly requires a new way of observing, defining, and measuring.

A high degree of uncertainty is a problem faced by all decision-makers in the
modern world, especially when it comes to energy policy. When a large amount of data
is added to the equation, it is absolutely clear that a large number of challenges open
up for decision-makers. There is a lot of data, but their accuracy and credibility are often questionable. Modern information technologies enable the application of numerous methods and techniques; however, all the advantages simultaneously carry significant deception and can lead to making some intentional or accidental decisions with far-reaching consequences. All of the above points to caution, multidisciplinary, and objectivity, with a realistic view of the data and modern processing methods, in the process of energy security modelling.

In such a complex equation with too many unknowns, it is difficult to make decisions. However, due to the high importance of energy security in the modern world, decisions must be made in the given circumstances, with the data available to decision-makers. Energy decisions often have to be made relatively quickly and in line with geopolitical changes, changes in financial markets and with the clear knowledge that these decisions are far-reaching and can sometimes lead to serious unintended consequences, most notably internal unrest, diplomatic and armed conflicts.

Energy security is part of the national security system. The issue of energy security and national stability is complex and exposed to a large number of influences, many of which are geopolitical, with a high degree of unpredictability and variability. The problem of decision-making is further complicated by the unclear nature of the variables that must be taken into account in strategic planning, the undefined direction and intensity of their impact, their complexity and the impossibility of exact quantification.

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Institutional and Social Setting – Preconditions for Green Growth for Western Balkan Countries: A Systematic Literature Review

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ABSTRACT

Green growth has gradually attracted increasing research attention as the problem of sustainability of the economies receives greater and threatening dimensions. Indeed, favourable institutional and social environment contributes to green growth from the perspective of new growth economics. However, rare studies, mostly focused on developed countries, have systematically and empirically explained the connection between the institutional and social environment and green growth. The exploration of Western Balkan Countries that have begun to modestly modify their environmental and economic policies in order to transition to green economy is at its initial phase of implementation and research. In this paper, the literature review is performed with the accent on two dimensions, institutional and social environment and their impact on green growth. The discussion indicates that there is a strong relationship between institutional and social environment and green growth identified in the literature. That is, the institutional and social environment can promote countries’ green growth, or it can hinder it, depending on their peculiar characteristics within the country. Furthermore, literature review suggests that weak institutions, non-functioning rule of law, high level of corruption and distrust in the society can be detrimental for economic and green growth in particular. In the course of transition, all those deviations developed in the Western Balkan Countries, affecting the environment and deteriorating the living standards. In the effort to reconcile the reality with the requirements of green economy and EU accession criteria, institutional and social setting in Balkan economies needs to develop much further in order to accommodate the requirements of structural and economic changes, but also green economy principles. Offering the systematic literature review, the paper gives the avenues for further research and pinpoints the necessity of data needed for the empirical analyses for the case of Balkan countries. Finally, the analysis on the institutional and social environments highlighted that the role of the corruption in green growth, that sometimes can have greater impact than those of the governmental and legal aspects. This seems to be especially relevant point of future research for the case of Balkan countries.

INTRODUCTION

Under the pressure of environmental pollution and the energy crisis in recent years especially, as well as through the pursuit of EU accession criteria, Western
Balkan Countries (WBCs) have begun the process of modification of their environmental policies in order to enable for a transition from a brown economy, characterised with high consumption and emissions to a green economy that is economically sustainable and environmentally friendly. In general, green economy aims to change production and consumption by improving resource efficiency and reducing pollution, hence promoting sustainability and congruence between the environment and the economy. Notably, this is a demanding goal even for the developed economies.

This process is even more challenging for WBCs that are already in a process of continuous transformation, starting with the transition from planned to market economy in the past three decades and the process of adjusting to the EU accession criteria. Generally, transition was a unique process of transformation of the former socialist countries from a system of central planning to the institutional arrangements of a free market economy [1]. This fundamental change in favour of a market economy was expected to improve productivity, resource allocation and efficiency, but also to improve the living standards, green economy standards included, in all transition economies (TEs) [2]. It was anticipated that after some short period of adjustment and contraction of economic activity the new system should lead to recovery and sustained growth. However, for a number of reasons these aims and “wishes” have not been realized equally in all former TEs. While some were successful and managed to recover very rapidly, like Central Eastern European Countries (CEECs), others, like WBCs experienced prolonged transitional recession that lasted much longer than expected, accompanied by deeper contraction and recovery which has not been as smooth as predicted. Instead of rapid recovery and robust growth, the prolonged recession turned out to be ecologically detrimental, especially for WBCs. Notably, Western Balkans countries CO2 emissions (kg per 2017 PPP $ of GDP) were almost four times higher than the EU standard in 2019[3]. In particular, most of that emission is due to electricity production, suggesting that the region is far from implementing the circular economy principles. WBCs usually record bad air quality, lower productivity of used natural resources (especially water and non-renewable resources), and high greenhouse gas emissions, driven by heavy use of lignite, compared to other countries, while it is at the same time they are relatively vulnerable to a changing climate and not well prepared for a greener world [4, 5, 6, 7, 8]. The WBCs have high exposure to climate change and high probability to climate-induced economic damages due to high dependence on agriculture. In addition, their capacity to adapt is limited by institutional weaknesses, high inequality and a relatively low income and high level of corruption. In addition, WBCs’ economies are not sufficiently flexible to benefit easily from going green. The business environment faces many challenges such as poorly functioning labour markets, low competitiveness and non-diversified exports, which additionally complicates technology transfer. Lastly, WBCs’ transfer of knowledge and preparedness for innovations (even copying the leaders) are deficient to assist green technological change.

At the same time, WBCs are trying to achieve international commitments, such as the Paris Agreement and to initiate a green economic development model, adjusted to their needs and opportunities. In addition, the EU stipulated that the European Green
Deal would apply to the countries in the WB region as well, through so called “Green Agenda for the Western Balkans” with targets to be agreed both by 2030 and 2050. Green Agenda plans many aspects such as: improving environmental protection and nature conservation, enhancing biodiversity in the region and significantly reducing pollution, and introducing a circular economy and environmentally sustainable agriculture as well as achieving carbon neutrality by 2050 [9]. Having the green economy as one of its incentives, WBCs’ governments, together with the people and businesses started to work on “greener” and more sustainable ways of doing business and living. Over the last year, several countries have improved their regulatory environments in the areas of climate change and energy efficiency. For example, in 2020 Albania adopted a law on climate change, which shall create a legal framework for combating climate change. That law encompasses the integration of climate change mitigation and adaptation issues into other legislation and strategies, the submission of the country’s NDCs and the strengthening of emission control regulations. In Serbia, four new laws on renewable energy sources, energy, energy efficiency and mining were adopted in April 2021. Those laws bring about a number of notable changes, including the introduction of auctions for the allocation of market premiums and feed-in tariffs, and various incentives for adopting renewable energy technologies and energy efficiency measures, as well as simplifying the issuance of permits and approvals in the sector. In North Macedonia, a new energy efficiency law was adopted in beginning of 2022, which introduced several important changes, including much easier requirements for the photovoltaic systems installations in the effort to replace the coal-intensive electricity production technologies. Several countries in the region have also submitted updated Nationally Determined Contributions\textsuperscript{10} in the last year.

Pressured by the international environmental regulations, as well as by the EU accession criteria, WBCs are compelled to develop accompanied institutional infrastructure and to build social capital within the society that shall reconcile the economic motives to the green economy principles. However, due to weakness of the institutional setting and its slow development in the course of transition, as well as due to the deteriorated social capital and prevailing distrust in the society, this task remains difficult and sometimes impossible mission, especially in the contexts of high level of corruption and weak or non-existent controlling mechanisms. Our paper brings a modest contribution into the literature of green economy. Firstly, as the impact of the institutional environment on green growth is often ignored by Western Balkans countries, we utilized exactly those as an example to conduct the analysis, which brings new perspective for theoretical research that focuses on the institutional and social environment and green growth in former transition countries. Second, the context of the analysis shall provide a reference for improving the research on institutional and social environment and furthermore, for the creation of the relevent economic policies through promoting green growth in WBCs.

\textsuperscript{10} Nationally determined contributions (NDCs) are at the core of the Paris Agreement and the achievement of its goals. NDCs embody efforts by each country to reduce national emissions and adapt to the impacts of climate change. The Paris Agreement (Article 4, paragraph 2) requires each Party to prepare, communicate and maintain successive nationally determined contributions (NDCs) that it intends to achieve. Parties shall pursue domestic mitigation measures, with the aim of achieving the objectives of such contributions (https://unfccc.int/process-and-meetings/the-paris-agreement/nationally-determined-contributions-ndcs/nationally-determined-contributions-ndcs).
Hereafter, the systematic literature review is presented. Firstly, after defining the green growth, the review on literature that relates institutions and green growth is given, followed by the literature review on WBCs. Then, the literature reviewing social capital and relation to green growth is provided, followed by the discussion on it in the case of WBCs. Finally, recommendations for future research avenues are given.

1 INSTITUTIONAL AND SOCIAL SETTING AND GREEN GROWTH

Green growth

Green economy, also known as green growth, has attracted great attention from the research community but also from governments and businesses as the problems of pollution and sustainability became more urgent across the World. Green growth is usually considered as growth that has positive impact on the economy, environment, resources and energy. Broadly, green growth, or green economy, in brief encompasses the principles of the environmentally sustainable economic growth, suggesting that the economy should be focused on sustainable natural systems, infrastructure knowledge and education for all, creating a decent and green livelihood, build on a collective action but also on individual choices and providing wealth - financial, human, social and natural [10]. The World Bank defines green growth as efficient, clean and resilient, that is efficient in the use of natural resources, that minimizes pollution and environmental impacts, and it manages the natural risks” [11]. In addition, green growth means achieving many objectives favourable to sustainable development: restricting the greenhouse gas emissions, building resilience to climate change disasters, using resources more efficiently, especially the natural ones that have been treated as economically invisible in the past, and providing sustainable and equally distributed increases in GDP and standards of living [12].

Huberty et al. [13] provides a review of different international approaches to green growth and classifies weak, moderate and strong versions of green growth. Depending on the intensity of the actions and measures, various countries can be classified in three distinctive groups: weak green growth, where the “no harm” approach is applied, encompassing emissions reductions and environmental regulations adoption. Natural resources and their efficient use are considered as a growth driver. Moderate green growth is the second level where green growth actually creates jobs in new green sectors. For example, investments in new low carbon technology and infrastructure create employment opportunities or green jobs. Finally, strong green growth encompasses countries where green behaviour and mentality becomes a transformative force across the whole economy over the mid to long term. Sweden and other Scandinavian countries are countries that belong to this category, where the green transformation is engine for the whole economy through the effects of widespread technology investments and productivity improvements across all economic sectors.

2 INSTITUTIONAL SETTING - THEORETICAL AND EMPIRICAL REVIEW OF LITERATURE

Many factors affect green growth, among which institutional setting, environmental regulations, fiscal expenditure, process of clean energy transition, innovation and
research and development investment have been discussed in the literature. However, the influence of government institutions was mostly ignored as only few studies have provided evidence on the role of institutions in enhancing green growth.

Dabrowski et al. [14] give a wide definition of institutions specifying them as “formal rules and institutions (legal codes, court systems), and also rules of behaviour, expected even from those with unknown reputation”. In general, institutions create the economic environment in which economic agents function that in turn makes them an important ingredient for sustainable growth [15]. Better institutions with less weaknesses and limitations are an important precondition for sustainable growth [16]. Institutions are even more important in defending green economy principles, where they have to accommodate the economic logic to the need of green economy principles.

Salman et al. [17] investigated the relationship between institutional quality and economic growth and carbon emissions, suggesting that efficient and impartial domestic institutions are very important to increase economic growth and decrease carbon emissions. They argue that institutional quality, together with energy use and factors stimulate economic growth and decrease carbon emissions, but also there is a reverse relation from green growth to the factors, meaning that the relationship is reinforcing itself, resulting in virtuous circle. Hence they conclude that it is necessary to regulate and strengthen the role and effectiveness of local institutions with the aim of lowering carbon emissions if one economy does not want to fall into vicious circle of weak institutions and heavy carbon emissions. Sun et al [18] suggested that adopting green technology can be a sustainable way to achieve green growth within a low/free-carbon environment, but this strategy needs strong backing and funding of reliable government institutions to shift the country’s paradigm. They based their conclusions on a sample of over seventy developed, but also developing countries for the period between 1990 and 2014. Overall, these studies agree that a country with a good institutional environment stimulates economic subjects to absorb and use green economy rules, stimulates investments, domestic and foreign, sustainable use of resources and so on. Furthermore, improving institutional quality is advantageous to avoid resource curse [19]. They classified institutional variables into three categories such as degree of market resource allocation, market openness, and property rights diversification and hence empirically analysed the relationship between economic growth, natural resources, and institutions quality. On the data set of China provinces, they found out that the low-quality institutions such as bad market resource allocation system and property rights system limit the advantages of natural resources to promote economic development. This is so called “resource curse” effect, where bad institutions offset the benefits of owning resources. Under the effect of the causal cycle mechanism, the lower the quality of the system, the more severe “resource curse” effect is according to them. In similar vein, Zhang et al. [20] pursue the idea of institutional dimensions such as green logistics, which is essential for the promotion of green growth. Adopting grounded theory method and in-depth interviews, they conclude that among other major factors, the green governance capacity of the government and the level of social supervision influence the effectiveness of green logistics policies.

It becomes widely recognized that development of institutions plays a specific role in a country’s growth and implementation of green economy principles. The state’s
institutional capacities are important indicators of government power to enforce the formal order, its rules and regulations and this is especially important for lagging transition countries, such as WBCs [21]. Furthermore, institutional development is an important component for a country’s growth, as it ensures greater legal protection, enforcement of contracts, enforceable property rights and a climate hospitable to business and environment [22, 23]. Many studies have suggested that the relationship among economic growth and institutions is robust and positive in the case of WBCs [23]. However, rare studies have assessed the multidimensional institutional environment and examined the effect of the institutional environment on green economy. This is especially rare for the case of WBCs, where to our knowledge these types of academic studies have not been found, possibly due to novelty of the research but also due to lack of data. Mainly, the studies on green economy for the case of WBCs are conducted by the World Bank international teams or EU teams, and mainly on observation and description on many green economy indicators.

Evidently, Western Balkans countries that had to build new institutions, laws and social norms in such a short period were prone to more institutional shortcomings, some far more serious than the institutional weaknesses identified in developed countries. In that context, Stiglitz [24] suggested that new institutions should have been built on old inherited institutions in a gradual transition process, as China managed to do so. He stated that only gradual introduction of laws that correspond to existing norms are likely to succeed. Conversely, Dabrovski et al. [14] disagreed suggesting that old social norms relating to economic activity, which had existed under socialism, expired even before the collapse of communism. In that situation, governments were faced with a peculiar situation of absence of appropriate norms and urgent need for introduction of new laws and institutions.

Indeed, introduction of laws, institutions and norms in many Western Balkans countries proved to have incoherent and uncoordinated paces. Clearly, under these circumstances many deviant processes developed, such as corruption, weak rule of law, increased number of economic and ecological crimes, which in economic literature are taken to be measures of the degree to which institutions are not suited to the needs of a market and green economy, too [25].

3 SOCIAL CAPITAL AND GREEN GROWTH - THEORETICAL AND EMPIRICAL REVIEW OF LITERATURE

Concept “social capital” is taken from sociology, and it is further conceptualized into the economic context in order explain the relation between social environment and economic performances. The complex nature of social capital is captured by wide range of definitions in the literature, with no consensus on how it is measured. According to Healy and Côté [26], social capital is consisted of network, containing norms, values, and understandings that upholds cooperation within and among groups. Pretty and Ward [27] define social capital as relations of trust, reciprocity, common rules, norms and sanctions, and connectedness in institutions. World Bank [28] defines rather organisational dimension of social capital that encompasses collective actions taken by the government institutions and peoplein the organizations. In general, social capital
includes all the relations between individuals and groups. It involves social networks, reciprocal norms, and resulting trust among people.

In the empirical literature, many scholars have found positive correlation between social capital and economic phenomena. Using the data of 29 market economies, Knack and Keefer [29] presented evidence, that “social capital” influences the economic performance. Using indicators of trust and civic norms they found that social capital is stronger and more important in the economies with stronger institutions that practice better rule of law and have less discriminating informal order, and less inequality, and with better-educated and ethnically homogeneous populations. In the context of green growth, Pretty and Ward [27] pay attention to how social and human capital affects environmental outcomes, suggesting that social capital can increase cooperation of people in various groups, which on the other side increases inclination to protect natural resources. On the other side, Jones [30] argues that the social capital may significantly influence environmentally responsible behaviour of people, thus influencing the effectiveness of environmental policy. In particular, he argues that the social costs and benefits, influenced by the social capital may influence the decision of individuals to cooperate and thus they can be a significant indicator for environmental behaviour. Moreover, Halkos and Jones [31] show that social factors (expressed as social and institutional trust social norms, and social networks) influence individuals’ decisions to pay for improvement of environmental protection. Using the data from Greece, in the empirical model they show that social capital variables, especially social norms and social trust, have a strong positive influence both on the willingness of the individuals to pay and on the level of specific amount stated. With adequate social capital and trust, citizens are more inclined to protect their environment and are more willing to pay, as they believe that all the group members will contribute the same. Hence, Halkos and Jones [31] introduced the non-selectivity of rules and laws, as an important ingredient for social trust, which seems also relevant for the WBCs. In similar line, Polyzou et al. [32] identified that socio-economic and environmental elements, that is individual social capital is among the determinants of willingness to pay of people when it comes to improvement of water quality. Exploring the community based eco-tourism, Liu et al. [41] suggested that high levels of social capital encourage peoples’ pro-environmental behaviours, with them valuing economic benefits of ecotourism especially. Further, they argue that there is reciprocal relationship between community members as beneficiaries and the nature of ecotourism. Namely, when people are aware of the benefits, it can have a direct impact on their willingness to preserve nature even when running a business. Czajkowski et al. [33] explored the moral and social incentives that determine pro-environmental behaviours in individuals in respect to waste contracts and recycling actions in Poland. They found out that costs but also the aspiration for a positive social image determines the recycling behaviour. Hence, they conclude that social capital plays an important role in determining eco-friendly behaviour of people.

Bjørnskov and Mèon [34] suggest that social trust affects total factor productivity (TFP) in the economy, on its level, but also on its growth. Using both development and growth accounting, they suggest that the positive effect of social trust on TFP runs through good functioning economic-judicial institutions, but not through political
institutions. In addition, the authors claim that social capital impact environmental behaviours depending on the degree of corruption in one society. Indeed, sociocultural norms and practices impact the corrupt behaviour in one society, because culture as a dynamic social construct is determined and affects the political and economic environment. In general, scholars found that corruption leads to worsened environmental outcomes, such as higher rates of deforestations, increased pollution in various forms, increased misuse or depletion of natural resources [35]. Furthermore, through literature review Menocal & Taxell [35] suggest that the strength and especially the enforcement of environmental regulations and the adoption of international environment rules is likely to be weaker as corruption grows. In addition, they argue that the corruption leads to situation where firms use corruption and bribing for obtaining licences that allow them to extract fast and high quantities of a natural resource or to use natural resource harming the nature, thus sometimes completely depleting the natural resource and the environment. Examples of this can be seen in WBCs, where corruption has led to overuse of natural resources such as marble or varied types of ores or misuse of water from rivers for hydro centrals.

Morse [36] explains that corruption leads to poor governance in several steps, firstly when policies are defined, then in their management and enforcement. Finally, the effects of various policies can be environmentally destructive, as the environment considerations are not included in the process of creation of policies at all. Damania [37] analyses the interactions between monitoring, prosecution rates and fines in order to gauge the impact of corruption on environmental behaviour. According to the findings, the more environmental regulations create a reverse effect on corruption, creating more and more space for the officials to extract bribes. Furthermore, findings suggest that corruption and inadequate penalties for violations are among main factors contributing to non-compliance when it comes to environmental regulations [37]. Interestingly, Damania [37, p.409] will conclude that

Environmental issues are representative of a larger class of problems where the government delegates powers to self-interested bureaucrats... hence, the interaction between environmental controls and corruption is of some relevance for environmental policy purposes.”

The conventional wisdom is that trust is an important ingredient of social capital that facilities the functioning of the economy. The Life in Transition [38] provides insights into this issue categorizing trust measures into “generalized trust”,11 “group trust” and “institutional” trust. Interestingly, the general trust which in 2006 in all transition countries on average as a group was 30% of respondents having some or complete trust did not change significantly. It rose only to 34% of respondents, while at the same time for developed countries this percentage was 42%. With respect to “group” trust, the results are much higher (around 60% of people showing trust in their families, relatives, neighbours and so on.). Yet most interesting for this research is the

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11 Generalised trust is measured by asking the respondents to answer to the question: Would you say that most people can be trusted, or that you cannot be too careful with people? The answers are scaled using five-point scale: completely trusted, some trust, neither trust neither distrust, some distrust, complete distrust.
“institutional” trust which have been very low across WBCs, as a result of high corruption, and weak rule of law.

Having malfunctioning formal institutions, many countries created specific informal institutions or private order that acted in place of the inadequate legal system [23]. In general, private order exists in every country, developed market economies included, and it is a complement to the legal system, articulated through norms, values and reputation assessment [39]. However, in the case of some of transition countries, private order, which consist of “social networks and informal rules and gossip that substituted for the formal legal system”, gained the primary role to rule social life, the economy included [39]. As McMillan and Woodruff [39] show, to some extent, private order had played a positive role in the course of transition, creating side-mechanisms that supported the economy in the absence of institutions, such as: trustworthiness of bilateral relationships, communal norms and trade associations and market intermediaries. However, in WBCs private order overtook the whole control power, overflowing into criminal violence; hence, deterring overall productivity by excluding new entrants in sectors or by expropriation of profits. Additionally, it is argued that private order is strongly interwoven with “ethnic” segregation, which is especially relevant for transition countries that experienced fragmentation, war or conflicts [39].

One particular form of social capital is so called “organizational capital” that Dabrowski et al. [14] define as the value of a productive organization over and above the value of its assets that is due to existence of habits, formal rules and trust. From green economy perspective, organizational capital is a name for maximal efficiency that enables elimination of the inefficiencies within the firm or broader system, however with respect to the green economy rules.

Having in mind the definitions, it becomes clear that it is difficult to assess organizational capital formation in WBCs. Various authors take different stands towards this issue. According to Stiglitz [24], organizational capital existed in socialism, and it should be preserved as very valuable under conditions of transition because, once dissipated, it cannot be easily reassembled, particularly in environments with little entrepreneurial experience. Havrylyshyn et al. [40] agreed, partly stating that organizational capital started to deteriorate before transition that is at the eve of socialist period when huge inefficiencies in firms were recorded. In their view, transition was supposed to eliminate those inefficiencies and create appropriate organizational capital. However, Dabrowski et al. [14] strongly rejected the hypothesis that old inherited organizational capital can be put to use during transition. Instead, the authors suggest development of a new private sector that is flexible and fast reactive towards the changes in the environment. However, having a difficult task to adjust the human and also organisational capital to the new market economy environment, business in WBCs did not seem to have enough finances, knowledge and innovation capacity to adapt to the green economy rules too. The evidence for the former proposition is the fact that, in transition economies, de novo private firms have been found to be far more efficient than all other categories of firm – both privatized and state owned – with the exception of firms run by foreign direct investors [39, 40].
4 CONCLUSION

By reviewing previous literature, this paper investigates the theoretical and empirical relationship between institutional and social environment and green growth. In general, the scholars agree that strong institutions and appropriate social infrastructure are conducive to green growth, although various studies use different aspects for assessing the relation and also different measures for institutional quality or green economy indicators. Nonetheless, using various methodologies they confirm the positive relation among institutions and strong social capital and green economy indicators. By reviewing many papers, we outline general directions for future research in this field that can be applied in the case of WBCs. The given review offers guidance of relevant and interesting topics, which can already be recognized as problems in Western Balkans.

While there is a significant body of these sorts of research for developing countries, research on the case of WBCs is still in its infant phase. Furthermore, while existing research is focused on highly diversified and specific, individualized environmental factors, based on the use of various data sets, in the case of WBCs green growth is predominantly researched by institutional organisations with scarce data sets and mainly descriptively and in general context.

Having in mind, that this sort of research is relatively novel for the region, the lack of data shall be emphasized at this instance. Obviously, the data collection in WBCs shall be adjusted and detailed in order to be able to measure various environmental or green aspects that can be of interest for research. In addition, the reliability and relevance of data that can be sensitive shall be provided.

In general, the WBCs are yet to realize and comprehend the importance of institutions and social capital for solving environmental problems. Starting from the unique perspective of institutions and social capital, therefore, this paper addresses it with respect to the characteristics of Balkans’ society. Based on original data from future possibly joint Social Survey the elements of institutional setting and social capital can be observed that are in line with countries’ national conditions. On the basis of such data, the effect of institutions and social capital on environmental performance and behaviour can be studied. The results of the research highlight the heterogeneity of definitions of institutional quality and social capital and demonstrate how different types of institutions and social capital contribute to green economy principles. The results can provide a more powerful and Balkan-oriented basis for the formulation of future policies. In addition, through the article the need of exploring institutional quality and social capital prior to environmental policy implementation is underlined along with the need of creating institutional and social capital assessment techniques adjusted to Western Balkans Countries.

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Historical review of the evolution of energy efficiency observed through the prism of the construction of residential buildings in the EU

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ABSTRACT

The goal of this paper is to reflect the intention of the authors to point out the importance and conservation of energy during the construction of residential buildings, as well as the evolution of energy use in buildings during previous centuries in the area of today's EU. Energy has always been important for people and the progress of humanity, but one gets the impression that it is most pronounced in the 21st century, which we are all witnessing. The energy crisis leads the world's strongest economies into recession and affects the life of every individual. Earth, water, fire and air have long been considered elements that are the foundation on which the entire cosmos rests, and we now call three of the four elements renewable energy sources. Energy conservation by building residential buildings that will be energetically self-sustaining is possible, and thanks to scientific progress in the construction of new materials, such buildings should become the standard, not the exception, in the future.

1. INTRODUCTION - ABOUT ENERGY IN GENERAL

In physics, energy is defined as "the ability of a body to do work". The more complex definition of energy, that we find in Lerman’s article, describes energy as a feature, i.e. a feature of a body that must be transferred to an object in order for it to do work, or for it to heat up. That feature can be converted into another form, but it cannot be destroyed.12 The word energy comes from the Greek language (ένεργεια) with the meaning "lively, cheery", and we meet it for the first time in the works of Aristotle in the 4th century BC. During the development of human society, different forms of energy were used. What they have in common is the human aspiration to get the most energy by using the minimum amount of work. The idea of "Perpetuum mobile" has motivated the greatest scientists for centuries, who aspired to construct a mechanism that would produce more energy than is invested in it, without the system remaining

unchanged. Such a mechanism has not been created yet because it is against the fundamental laws of physics: Newton's first law and the laws of thermodynamics.

The first form of energy that man encountered was thermal energy, necessary for the survival of the human species in harsh prehistoric conditions. The discovery of fire and the power to control it created the prerequisites for the progress of human civilization. That is why the discovery of fire and the wheel are considered the most important inventions that changed the course of history. However, thermal energy is only one of the forms in which energy can manifest itself. With the improvement of knowledge about nature and the progress of natural sciences, a whole spectrum of different types and forms of energy was discovered, which explained the human environment, natural phenomena and consequences, and until then were inexplicable and attributed to the "divine". Although the first records of the existence of electricity are attributed to Thales of Miletus in the 6th century BC, the discovery of electricity and its scientific explanation took place almost two millennia later. The first scientific-empirical explanations of electricity and the discovery of positively and negatively charged particles began in the 18th century. From Benjamin Franklin (Benjamin Franklin, 1706 - 1790), who developed the model of electric current as a fluid, explaining that electricity is nothing more than the movement of charged particles, through Alessandro Volta (Alessandro Giuseppe Antonio Anastasio Gerolamo Umberto Volta, 1745 - 1827) from the creator of the first battery, up to Thomas Edison (Thomas Alva Edison, 1847 - 1931) and Nikola Tesla (1856 - 1943), the inventor of alternating current, among other things, electricity has become the main generator of the progress of human civilization and the conditio sine qua non of every person's daily life in the twenty first century. It is almost certain that life today without electric energy would lead to the collapse of civilization. The conditionality of satisfying elementary needs, such as running water and preservation of foodstuffs, with electricity is worrying, and one gets the impression that never in human history has man been more dependent on energy, and at the same time more distant from nature.

Due to everyday use, the word "energy" began to be used in a contradictory sense. The basic law of physics on the conservation of energy states: "Energy cannot be created or destroyed. Energy can only be transformed from one form to another." That's why terms such as: "energy production" or "renewable energy" are in themselves contradictory, confusing and scientifically unfounded.

Advances in science and new discoveries in the field of energetics have also revealed new forms of energy. In addition to the thermal energy that occurs as a result of body heating and electrical energy that is a consequence of the electrification of objects, the following were discovered:

- kinetic energy - arises as a result of the movement of the objects;
- chemical energy - as a result of chemical bonds between atoms;
- nuclear energy - which arises as a result of the instability of the object's atomic nuclei
- electromagnetic energy or radiation energy - and it occurs in the form of light, radio waves or other manifestations of the same phenomenon of electromagnetic radiation;
- potential energy - arises as a consequence of the position of the object in relation to other objects.
- sound energy – as the energy of mechanical air waves.

Each of these forms of energy has benefits that can, if used correctly, bring benefits to man and the community. The way humanity has used different forms of energy is a crucial characteristic and essence of the modern economy. The progress from cart power to steam power, then the internal combustion engine and finally electric power are essential elements and parameters of the progress of civilization. The development of energy in the future emphasizes and emphasizes renewable energy and energy efficiency as the key to preserving fossil energy sources and avoiding the greenhouse effect, i.e. global warming.

2. THE CONCEPT OF ENERGY EFFICIENCY VIEWED THROUGH THE PRISM OF THE CONSTRUCTION OF RESIDENTIAL BUILDINGS THROUGHOUT HISTORY

According to some estimates by the European Commission\textsuperscript{13}, today in Europe the construction sector is responsible for about 40% of the total consumption of primary energy, so there is significant potential in reducing energy consumption in that area. In this sense, current analyzes and interventions are related to energy saving while ensuring adequate comfort conditions, which is defined as "building energy efficiency". This principle achieves two important goals of sustainable development while reducing the demand for energy, namely the economy of primary resources and the reduction of emissions into the environment.

In order to develop new technologies and strategies for improving energy efficiency in buildings, it is very important to know their evolution through history. Only on the basis of previous experiences and knowledge of the problems encountered in the past, progress can be made. Without understanding the evolution of energy efficient buildings, it will be difficult to imagine new concepts and new solutions to reduce energy consumption in the construction sector.

Studying the historical evolution of energy-efficient buildings is necessary for a better understanding of the changes that have occurred over time with the aim of improving comfort and optimizing energy consumption. People are aware of the need to apply new concepts, standards and laws when they are presented in the light of improving the existing situation and for the general welfare. Scientists quickly accept new concepts and solutions if they are based on the results of specific calculations or experiments. Citizens accept them because the current standard or law offers a solution or simply because they are current and promoted in the public media. On the other hand, a person who thinks with common sense, regardless of his profession, will always want to understand the way of thinking of others and will not accept the concept as an axiom. Such a person will explore the evolution of technology over time to get to the root of a concept or phenomenon.

Demands for more energy-efficient buildings are not recent. They only represent the result of the evolution of science and human needs throughout history, with the

accelerated development of innovations and changes that have occurred since the 19th century. Concern for energy efficiency has always existed in a certain latent form, but awareness of this issue emerged only in the 19th century, parallel to development and scientific achievements. During the 20th century, through the media, standardization and legal regulations, the idea of the importance and necessity of energy efficiency was latently implemented in the consciousness of the population. In the 21st century, we are faced with widespread energy problems that are being solved by scientific and technological progress and innovation.

Energy efficiency of buildings mainly refers to two components:

a) passive properties - obtained by thermal insulation, accepted and converted solar radiation and natural ventilation;

b) active properties - provided by equipment for absorbing, converting and using energy (renewable energy).

Since ancient times, man has sought and found ways to use and transform natural mechanisms to improve conditions for a better and more comfortable life. One of them was the technique of building residential buildings. Although energy efficiency was not a common concept and term in use as it is today, before the 20th century, people created and passed down codes of good practice from generation to generation. Therefore, the method used to build the house was based on previous experiments. At the time, it was a satisfactory way to improve and preserve certain construction techniques.

Each age and epoch during civilization brought something new or improved existing construction techniques, but it is fascinating that the principles based on renewable energy sources that are used today have ancient predecessors. “It was determined that in the 6th century BC (around 5,500 BC), in the Carpathian region, people used the solution of partially buried houses, thus achieving a more stable internal temperature, which was later used in the construction of houses by the human communities of the Essenes from the Middle East and the American Indians. The evolution of that design can also be seen in the Persian buildings called badghir (wind tower) where the energy of the wind and the ground were used purposefully to ensure indoor comfort. A similar technique, but only using wind energy, can be found in the Egyptian malqaf (wind catchers).”

Improving thermal comfort by designing walls was achieved by the Egyptians using thick brick or tile walls (which also have special acoustic properties), and later by the Greeks and Romans who used hollow walls as a special form of insulation. The Romans also used heating with burning gases flowing through cavities in the floor or walls. These objects with a large thermal mass can actively maintain the internal temperature at a comfortable level for a long time. The Romans covered the windows with plates made of the mica mineral in order to actively preserve pleasant internal temperatures by retaining solar radiation.

Ancient times were characterized by the traditional and standardized construction of residential and sacred buildings, which expressed aspects of national identity, and as such was preserved throughout the centuries, including the Middle Ages. Renaissance further emphasized the values of the ancient era and marked

different social areas from culture to science, architecture and technology. Classicism marked the 19th century in science, so progress also took place in the field of construction. This was one of the most important eras of scientific discoveries in the classical sense. Scientists not only materialized technical innovations but also created a fundamental scientific base based on various discussions, books, dissertations, etc.

Towards the end of the 19th century, scientific articles were widely published that dealt with the effect of thermal insulation in the field of heat transfer, formation and transport of moisture in walls, multi-layered window configurations, etc. Heating the air in the service room located in the basement became a common method of heating the rooms, which initiated the process of ventilation by air circulation towards the upper floors.

At the beginning of the 20th century, researchers already had the theoretical and technological foundations to realize the desire for a future energy-efficient house. In the 1930s, the "House of Tomorrow"\(^{15}\) was built, which proved that the energy of the Sun can be used through solar collectors to heat buildings. Due to the Second World War, the following decades were marked by stagnation in the field of energy efficiency, so that this idea would become relevant at the end of the 1950s due to the actualization of the idea of energy storage in the field of construction. As a result, the first long-term storage of thermal energy was built in Germany in 1984.\(^{16}\)

The oil crisis of 1973 determined the increase of interest in the energy efficiency of buildings. People are becoming more and more interested in super insulation and heat recovery in the ventilation system, using three-layer windows and passive technologies that were mainly oriented towards using the heat energy of the Sun. After the energy crisis, the concept of sustainable development was gradually defined in science. The field of construction adopted the principles of sustainability, which were very important in defining new design strategies. Later, buildings that took into account these principles were called "sustainable buildings", where the design includes an orientation towards integration into the landscape and community acceptance of its appearance. "Sustainable building" has become a branch of the more general term "sustainable development".

The first energy-autonomous house in the world was created in 1992 as a result of the design of the Fraunhofer Institute for Solar Energy from Freiburg (Germany). Thanks to excellent insulation and solar energy technology, the house was able to cover its own energy needs without the help of external energy sources.\(^{17}\) In 1994, a new standard called "Minergie" was created. Specially developed for new and renovated buildings, "Minergie" is the Swiss quality label for buildings with low energy consumption.\(^{18}\) The first two houses according to this standard were built in 1994. In the same year, the first house of positive energy (Plus Energie Haus) named Heliotrope


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(Heliotrope) was put into operation. The house built in Freiburg was designed by architect Rolf Disch, German architect, solar energy pioneer and environmental activist. This was the first house in which the amount of energy produced was greater than the amount consumed. The technologies implemented in the building used energy provided entirely from renewable sources.\(^{19}\)

The concept of an intelligent building began to emerge in the 1980s, when several buildings gradually integrated the control of various equipment and systems. Initially, the automated systems implemented in buildings were dedicated to each machine or device, and later their complexity was capable of controlling multiple systems. Today, one system integrates the ability to monitor and control security, heating, air conditioning and electrical energy systems. The latest developments in technology have led to the implementation of monitoring and control through wireless systems and the Internet.

Wang (Shengwei Wang) singled out five phases in the age of intelligent construction: from 1980 to 1985 with integrated single-functional/purpose systems; from 1985 to 1990 with integrated multifunctional systems; from 1990 to 1995 with integrated systems at the building level; from 1995 to 2002 with a computer-integrated building and the last fifth phase, which lasts from 2002 to the present day, with network systems for remote control via the Internet.\(^{20}\)

Accelerated technological progress, which is also transmitted in construction techniques, allows energy saving ideas to be easily integrated into building design to improve comfort, energy efficiency, utility or even aesthetics. In recent decades, researchers involved in the design of low-energy houses have constantly come up with creative solutions and rules for thermal design. While the specific options and style may vary, energy-efficient houses have some basic elements in common as a result of an established design pattern: superinsulation of walls, windows and doors, complex configuration and tightness of the envelope, ventilation with heat recovery units, high-efficiency heating and cooling systems, solar equipment and energy efficient devices. Theoretically, in order to achieve the requirements for an energy efficient building, there are several ways to reduce the high cost. There are many relatively cheap insulation materials available on the market. However, it is important to use appropriate materials, equipment and solutions for each aspect that the building needs to fulfill. A problem that seems contradictory for passive houses is related to their impermeability. High air tightness reduces heat losses, but leads to very low natural air exchange between the interior and exterior spaces, causing a slow refresh cycle. Ventilation is provided by a mechanical ventilation system with a high heat recovery rate that works continuously and ensures minimal heat loss.

One of the ways to achieve greater energy efficiency in buildings, where science has made a key contribution, are low-emission "Low-E" glasses that are installed on glass surfaces. The so-called thermopane glasses are made of two or three glass panels, the inside of which is coated with a coating of precious metals (silver, zinc, metal oxide). The panels are separated from each other by a space usually filled with noble

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gases argon, krypton and xenon. In this way, a low-emissivity glass is created that allows light to pass through the glass, but that UV radiation and summer heat from the Sun are reflected outside, while the internal heat remains in the room. In the summer, when the outside air temperature is higher than the inside, the outer layer does not allow the passage of thermal radiation and, by reflecting it, reduces the gain of solar heat. In winter, the coating on the opposite side reflects heat radiation, reducing heat loss to the outside (in this way, the inner surface of the glass has a higher temperature than normal glass). Depending on the orientation of the building, i.e. the angle of incidence of radiation, some optical properties can be attributed to the glass layer. The global reduction of CO₂ emissions plays a vital role in reducing climate change. Reducing energy consumption in the most important areas is the main solution for directly reducing greenhouse gas emissions. The European directive adopted in 2007 set three goals, taking 1990 as a reference year: reduce emissions by 20%, increase energy production from renewable sources by 20% and improve energy efficiency by 20%.

The evolution of the concept of an energy-efficient building throughout history is evident, especially in the last few decades when it fully matured as a concept at the end of the 20th century. Today, standards and technology cover all the necessary criteria in order for housing systems to be safe, energy efficient, with reduced emissions of pollutants during exploitation and adjusted to the optimal point for the defined life cycle of use. Modern society has faced major environmental problems in the last two decades. A special economic instrument provided by the Law on Environmental Protection of the Republic of Serbia aimed at environmental protection is compensation for environmental pollution, based on a special principle of environmental protection called "the polluter pays". Every new innovation mainly involves human perception related to the concepts of "environmentally friendly", "sustainability" and "ergonomics". Currently, buildings are seen as an "organism in constant evolution", which should be treated, rehabilitated and modernized over time in order to meet the demands set by users. Standards exist to help human needs and they also change over time in accordance with new discoveries, new expectations and requirements. There are several standards of energy-efficient design and construction certification in the world, and the trend is towards a cost-optimal aspect that gives efficient options to people who invest in building houses.

The question arises, what will energy efficient buildings look like in the future. Also, the evolution of building construction can be viewed through their design in the context of progress in general science and technology. Today, energy efficiency in construction is a high priority on the political front as governments strive to reduce wasteful energy consumption, strengthen energy security and reduce emissions of gases that contribute to the greenhouse effect. There are only a few countries in the world that have not set goals for reducing energy consumption and reducing CO2 emissions. In order to avoid a temperature increase of 5 to 6°C by the end of this

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century, humanity needs to adopt ambitious energy efficiency programs in all sectors, especially in construction.

EU policy makers have long recognized the importance of energy efficient buildings in mitigating climate change. This concern is reflected in the Energy Efficiency of Buildings Directive of 2002 (revised in 2010) and the Energy Efficiency Directive of 2012. Although the efficiency of new buildings has improved over time, the majority of the existing building stock in Europe (over 90% of the total stock) has yet to be influenced by energy efficiency requirements. Therefore, based on the experience gained over time, it is necessary to develop new technologies and strategies for improving energy efficiency in buildings.

3. CONCLUSION

The importance of energy and its rational use are not topics that arose in the 20th and 21st centuries. The ancient Greeks, ancient Indian and Chinese sages and philosophers emphasized the importance and structure of nature through the use of its basic elements: earth, water, fire and air. Not only on planet Earth, these elements are designated as the foundation on which the entire cosmos rests, and we call three of the four elements listed today as renewable energy sources. In the last three centuries, civilization has decided to base its progress on non-renewable energy sources (fossil fuels (oil, coal, natural gas and oil shale) and nuclear fuel) due to the economic profitability and low cost of production and processing, however, apart from their non-renewable and limited in quantity, another big problem regarding non-renewable energy sources is environmental pollution caused by their use. The progress of mankind is directly conditioned by the amount of energy used and it is becoming more and more evident that if we want this progress to continue, there will not be enough non-renewable sources of energy, i.e. renewable sources must become primary, and this requires the reorientation of entire industrial branches. "Increasing energy efficiency in residential buildings, transport, industry and services is an important strategy that would reduce the demand for energy services to a level that enables a significant reduction of gases with the greenhouse effect and a complete switch of energy systems to a renewable basis"

In Serbia, "the energy potential of renewable energy sources is significant and according to experts' estimates, equal to almost half of the country's annual energy needs." As seen within the European framework, we have greater potential than Malta, but on the other hand, in the field of wind use, we are significantly behind Denmark or Spain. The greatest potential is shown by the use of biomass and it is estimated at around 2.7 million tons of oil equivalent." The European Union has obliged its members with Directives that by 2020 20% of total energy consumption comes from renewable sources, which is an invaluable step towards healthy and clean energy.

The energy that is clean, healthy (in the sense that it does not harm human health and the environment) and comes from renewable sources is the energy of the future. Throughout history, it has been shown that life without energy and progress is not possible, but also that adaptability to situations, which are often unfavorable, characterizes people as an intelligent species that is ready to do everything in order to
survive. To change her habits, behavior, demands and give up the benefits of a comfortable life in order to survive, and the reason is essentially simple - survival and life have no alternative.

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Prospects for the use of green solutions in the water and energy complex of the Central Asian region

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ABSTRACT
The paper presents the results of a study of the prospects for the use of "green" and smart technologies in the water and energy complex of Central Asia. An analysis of the current situation in the water and energy complex was made, solutions were proposed to restore the functioning of the unified energy system and restore water and energy regimes. The possibilities of introducing a number of new "green" solutions and smart technologies into the energy complex are considered, taking into account the characteristics of the countries of Central Asia. An assessment is given of the prospects and timing of the implementation of these technologies with the justification of the necessary financial investments in their integration into the existing energy system.

INTRODUCTION
Today, in the context of climate change issues and the current energy deficit, we can talk about the aggravation of the situation around the limited water resources in the Central Asian region. In the current situation, it is necessary to determine rational approaches to the use of new green technologies to regulate the watercourses of the largest transboundary river basins in the region - the Syrdarya and Amudarya water systems.

For the downstream countries - Uzbekistan, Kazakhstan, Turkmenistan, most of the surface watercourses are transboundary. This applies to both the Amudarya river basin and the Syrdarya basin. On the territory of Uzbekistan, for example, only about 10-12% of the river runoff of the Central Asian region is formed. At the same time, Uzbekistan consumes more than 50% of the water resources of the Aral Basin, and the southern regions of Kazakhstan consume more than 20% of the water resources of the Syrdarya (G.N. Petrov et. al., 2019) (Fig. 1, 2).
Figure 1. Syrdarya river basin (source: zen.yandex.ru/media)

Figure 2. Amudarya river basin (source: zen.yandex.ru/media)
In the Syrdarya river basin, according to the regime of operation of the Toktogul reservoir, the dead level of the water volume in it should not decrease to 9 billion m$^3$ and below. The reservoir has already reached this level under the current regime of electricity consumption in Kyrgyzstan (Fig. 3, 4).

Rice. 3 Volume of water in the Toktogul reservoir (source: www.energo-es.kg)

Figure 4. Water inflow and outflow in the Toktogul reservoir during the winter energy regime (source: www.energo-es.kg)

In Kazakhstan, at the end of 2021, there is a shortage of electricity, which is covered by flows from the Russian system. Especially problematic is the south of Kazakhstan, where there is a long-term shortage of electricity.
Electricity shortages also continue in Uzbekistan, resulting in short-term power outages. The reason for this is the lack of generation at hydroelectric power plants (about 20%) and thermal power plants of the Republic. HPPs in Uzbekistan generate about 6.5 billion kWh per year, or less than 10% of electricity. There is a reduction in the regulated capacities of the domestic energy system. Thus, due to the limited water resources at the moment, the possibility of electricity flows from neighboring countries, as well as the regulatory balance, are limited. One should also take into account the tension in the autumn-winter period in the gas balance. The above facts reduce the ability of the Republic to increase electricity generation at the expense of thermal stations, as well as the declared capacities of renewable energy stations (minenergy.uz).

There is also a shortage of electricity in Tajikistan and Turkmenistan, as well as in the region as a whole. Although Tajikistan officially states that in the first three quarters of 2021, about 15.9 billion kWh of electricity was produced, which is 7.4% more than in the corresponding period of 2020. Barki Tojik attributes the power outages to repairs being carried out at the Nurek, Sarband and Kairakkum hydroelectric power plants, transmission and distribution grids, although at the same time there is a shortage in the regions of the country, and the export of electricity from the country to Uzbekistan and Afghanistan continues grow. Turkmenistan has its own peculiarities of energy supply to local consumers, where there is a shortage of electricity and interruptions are not uncommon. At the same time, the Republic has a good potential for regional trade in energy resources and can play one of the key roles in the development of regional energy cooperation. The necessary power generating capacities have been created in the country to supply energy to domestic demand and increase exports to neighboring countries.

1 ISSUES OF REGULATION OF ELECTRICITY FLOWS IN THE INTEGRATED POWER SYSTEM OF CENTRAL ASIA

At present, the energy systems of the southern part of Kazakhstan, Kyrgyzstan and Uzbekistan operate as part of the IPS CA, which work through the energy system of Kazakhstan in parallel with the Unified Energy System of Russia and the CIS (Fig. 5).
The CA IPS has its own technical regulations that are specific to this system, which must be taken into account when supplying electricity. The incompletely functioning IPS CA operates in parallel with the UES of Russia, having an indirect connection with the UES of Russia through the Kazakh energy system.

Since 1991, the parallel operation of the energy systems of the Republic of Kazakhstan, the Kyrgyz Republic, the Republic of Tajikistan, Turkmenistan and the Republic of Uzbekistan has been coordinated, the enterprise "Unified Dispatch Control of Energy Systems of Central Asia" (the current CDC "Energy") was established.

In CA IPS, a parallel operation mode should be run, implemented by the joint operation of power systems with a single frequency and ensuring, within acceptable limits, the voltage level at the nodal points of power systems and power flows along intersystem lines. There are three types of technical regulation - frequency regulation, voltage regulation, regulation of power flows along the lines (Shamsiev Kh.A., 2019).

As changeable RES plants are introduced, the problem of managing imbalances will only grow. In addition, Uzbekistan is expanding the introduction of CCGTs, which are designed to operate in the basic mode. The integration of solar power plants in Uzbekistan, the construction of wind turbines in Kazakhstan in large volumes will lead to the need to maintain a large amount of replacement reserves. The introduction of PVP in Uzbekistan in the declared volumes will require an increase in the purchase of regulatory services at times. At the same time, there are restrictions on the passage of the necessary capacities in cross-border nodes. In this regard, there are limits to the
integration of PVP. Increasing the volume of PV integration is possible with the use of energy storage technologies.

2 CCGT TECHNOLOGIES FOR WATER CONSUMPTION COMPENSATION

Today, the regulation of the flow of the Naryn River is carried out immediately for the Toktogul hydroelectric complex on the basis of the energy regime, while the interests of downstream countries, the volumes of regulating reservoirs are partially taken into account. Uzbekistan and Kazakhstan have to build counter-regulating reservoirs, the volume of which is often not enough to regulate the flow. At the same time, the agreements on compensatory fuel supplies are not observed. Kyrgyzstan has to provide its own needs for fuel for thermal power plants and gas supply.

We propose a method that is devoid of many of the shortcomings of the methods prescribed in the agreements and allows you to effectively solve the existing problems with the supply of water during the growing season to Uzbekistan and Kazakhstan, the export of electricity from Kyrgyzstan in the summer to these countries or transit to Afghanistan and Pakistan, and compensation in form of fuel resources to Kyrgyzstan and the necessary additional electricity generation in Kyrgyzstan in the autumn-winter period.

Such a solution for the interchange of water and energy resources is proposed to implement a joint integrated investment project, which consists in the construction of energy generating facilities of thermal power plants in Kyrgyzstan using relatively environmentally friendly CCGT technology. Thermal stations are proposed for construction in the southern and northern parts of the country.

In Kyrgyzstan, projects for the construction of thermal power plants using environmentally friendly CCGT technology can be implemented. In the southern part of the country, a thermal power plant can have a capacity of about 250-300 MW, with such a capacity, additional generation of 2 billion kWh per year can be obtained. According to the compensation scheme, gas supplies can be carried out by Uzbekistan. Such stations are built in blocks and can be further expanded with an increase in capacity. The station can be located near the Datka substation with the prospect of connection and transmission via the Datka-Kemin line to the north of the country.

The same station in the north of the country can be built on the basis of a departmental boiler house in the city of Kara-Balta, located near the border with Kazakhstan. According to a similar compensation scheme, fuel supplies can be carried out from Kazakhstan. It can be a gas-fired plant or a combined gas-oil plant. Initially, the capacity can also be 250-300 MW, which can be of great help for the scarce northern Kyrgyzstan and close the existing deficit and increase the limit indicators of consumers.

3 ISSUES OF IMPLEMENTATION OF "GREEN" TECHNOLOGIES FOR THE COUNTRIES OF THE CENTRAL ASIAN REGION

Today, the countries of Central Asia are actively implementing renewable energy technologies to increase generation and cover the existing deficit. Possibilities
of implementing NPP projects are being considered. At the same time, both directions require the creation of certain conditions for the operation of the energy systems of the countries and the recovering IPS CA. So, when large nuclear power plants are included in the work of the energy systems of Kazakhstan and Uzbekistan, it will be necessary to have capacities for their reservation of equivalent capacity. Within countries, such reservations will fall on existing and newly built thermal plants that carry the base load. Another solution could be the construction of a hydroelectric power station (or pumped storage power plant) in the southeast of Kazakhstan and the Tashkent region of Uzbekistan. Such projects are already planned for implementation in the near future. A more rational solution would be to build and bring to full capacity the Kambar-Ata HPPs in Kyrgyzstan, as well as other projects upstream of the Naryn River. At the same time, in addition to the issues of energy supply, redundancy, expanding the capabilities of the IPS, the issues of regulating the flow of the Syrdarya River, which is of crucial importance in the region, would also be addressed. This issue is already on the agenda of negotiations between the countries and certain steps have been taken towards each other. However, these projects have a rather long implementation period and will be considered as solutions for the medium term. Also in the medium term is the issue of involving projects of large hydroelectric power plants in Tajikistan in connection with the timing of the restoration of the country’s entry into the CA IPS.

In this regard, in addition to large-scale energy projects, the Central Asian countries should also develop small-scale energy. In Kyrgyzstan and Tajikistan, these are small hydropower plants, as well as in the south of Kazakhstan and the east of Uzbekistan. Countries should create conditions and actively involve small projects of RES, PPV and wind turbines of small capacities, micro-grid systems. At the same time, in parallel, it is necessary to introduce intelligent grid management technologies on a large scale. Such a combination will effectively regulate electricity flows, replace generation, and locally solve the problems of energy losses and shortages (Omuraliev AM, 2021).

Conditions for the introduction and development of smart and micro-grid technologies should be created in all countries. Today, their development in Central Asia is at the initial stage and is limited to 20% implementation of AMI systems; there are only separate projects for micro-grids. AMI technologies in some cases allowed to solve the problems of large power losses in grids (cases with 50-60% power losses), reducing them to 10% or less. A transition to the next steps in the implementation of smart grid technologies is required, this should be accompanied by a parallel transition to a micro-grid solution. Such a combination will make it possible to gradually make an energy transition to smart grids with distributed generation, which will allow unloading large stations, thermal power plants and hydroelectric power plants, and saving water and energy resources. The potential for implementing these technologies is enormous, in Central Asia, smart grid systems can cover more than 12 million consumers, and micro-grid generation can reach more than 20 billion kWh per year. Such transition is carried out in the countries of Europe and North America.

It is rational to develop biogas technologies in Kazakhstan and Kyrgyzstan in areas with concentrated livestock farming. The development of this direction will solve many issues related to the energy supply of remote rural areas. The potential for the
introduction of these technologies in these countries is 12 million consumers. Biogas technologies are widely introduced in China, Southeast Asia, Europe and the USA. First of all, the introduction of biogas will solve the problem of energy shortage in rural areas (Obozov A.Dj., 2018).

PSP projects need to be implemented in Kyrgyzstan, Tajikistan and to a lesser extent in Kazakhstan. The implementation of HPS projects for the CA IPS will be critical due to their ability to provide backup of base capacities, variable RES and balancing fluctuations in grids. In combination with existing and planned hydropower plants in the region, they will ensure the optimization of energy flow regulation and the use of water resources, and will increase the capacity of renewable energy projects. The potential of the PSP in the region is tentatively estimated at more than 3 GW in terms of capacity. Consideration of PSP projects by experts is recommended as a matter of urgency, as the first steps it is necessary to carry out design and survey work on the basis of design institutes in Central Asia and Russia, and with the involvement of foreign consultants. PSP projects are actively implemented in Scotland, Switzerland, Austria, China, USA. PSPs are highly efficient solutions for accumulating and backing up growing RES capacities.

Hydrogen technologies have the potential to be introduced in all CA countries. Kyrgyzstan and Tajikistan have special conditions for their development. In the medium and long term, hydrogen technologies can be an effective solution for storing and redistributing energy seasonally. With the construction of hydroelectric power plants and pumped storage power plants in the region, the ability to regulate flows, a combination of hydropower and hydrogen technologies can be an ideal solution to provide Kyrgyzstan and Tajikistan with energy in the winter. In addition, hydrogen technologies can solve the issues of storing and reserving energy at renewable energy facilities, there is also a great potential for the consumption of hydrogen itself both within the countries of Central Asia, and the potential for its export to countries neighboring the region. In the medium term, the potential for hydrogen production in the region is estimated at more than 1 billion tons per year. For the same period, the potential for introducing hydrogen technologies as energy storage and power backup is estimated at more than 4 GW.

4 PROSPECTS OF INTRODUCING NEW TECHNOLOGIES IN THE WATER AND ENERGY COMPLEX OF CENTRAL ASIA ASSESSMENT OF INVESTMENT OPPORTUNITIES

Energy mix model for the countries of Central Asia and the IPS, taking into account the trends in the use of water resources in the region. The energy balance modeling was carried out for the countries of Central Asia - Kazakhstan, Uzbekistan, Kyrgyzstan, Tajikistan, Turkmenistan, taking into account the interconnections of the countries within the CA IPS and possible changes in the long term in the use and regulation of the region's waterways for energy purposes.

A predictive balance has been built in the medium and long term, which makes it possible to determine possible scenarios for the generation and consumption of energy.
Current indicators, forecast data for the medium term up to 2030-35 were used as initial data for current and medium-term indicators of electricity. For long-term indicators up to 2050, data approximation methods based on medium-term energy indicators were applied.

According to the forecast data, the countries have a great potential for establishing cooperation within the framework of the CA IPS. To realize this potential, it is necessary to solve a number of infrastructure network issues. It is necessary to restore the parallel operation of the energy system of Uzbekistan and Tajikistan. In particular, to implement a connection scheme for the transit line 500 kV Regar-Surkhan, restoration of the line L-507 Regar-Guzar. To increase the capacity of the transit overhead line 500 kV L-514 Shu-Frunze with an increase in the capacity of the substation and the creation of a second parallel circuit. Create an inner ring 500 kV in Kyrgyzstan Frunze-Kemin. Create 500 kV ring circuits between the Turkmen and Uzbek power systems. Create a 500 kV ring in the Samarkand-Bukhara part of Uzbekistan (CDC Energy).

It is necessary to address the growing issues of regulating imbalances as the massive introduction of changeable renewable energy sources by increasing the capacity of hydroelectric power plants, pumped storage power plants and storage facilities. It is also necessary to solve the problems associated with the mass construction of CCGT.

These issues can be resolved as part of the creation of the Central Asian electricity market, which can operate in parallel with the Russian energy system through the energy system of northern Kazakhstan (USAID, Energy for Future Project).

The main directions for creating the Central Asian electricity market and expanding regional electricity trade in Central Asia should be:
- Modernization of cross-border networks;
- Solution of water and energy problems;
- Solving the issues of electricity transit;
- Expansion of the market of ancillary services in IPS CA;
- Creation of additional power reserves in IPS CA.

5 CONCLUSION

The water and energy complex of Central Asia has significant resources, and their combination makes it possible to effectively resolve the issue of interaction between countries. However, in practice the situation is different. Uzbekistan, along with increasing generating capacity through thermal power plants and renewable energy sources, is striving to use internal hydro resources to increase control capacities and increase system flexibility through hydroelectric power plants and pumped storage power plants. Kazakhstan also, after the introduction of renewable energy capacities, began to consider the use of its hydro resources in the southeast of the country with the attraction of investments from China.

At the same time, problems in the irrigation and water regime of the main water arteries of Central Asia are only intensifying. With the shortening of dry periods and
the deterioration of flow regulation, a shortage of water resources for the region is expected. Moreover, in this regard, the upstream countries are expected to experience a significant shortage of electricity in the coming years. The deficit will also increase in downstream countries. In such a situation, the possibilities of restoring the functioning of the CA IPS will only move away. At the same time, the possibilities of supporting the unified system to support its regulation are reduced.

It is possible for the countries of the region to gradually establish cooperation in the water and energy sector and quickly restore the functioning of the unified system. The volumes of compensation with water and fuel resources can be agreed upon according to new schemes for the supply of electricity or the construction of generating facilities. In winter, the upstream countries can be provided with electricity and supply water resources at the required time for the downstream countries. In this case, the functions of primary and secondary regulation and support of system stability can be restored.

New smart green technologies should be developed in parallel with renewable energy, including traditional hydroelectric power plants, pumped storage power plants, and new solutions for distributed generation and energy storage, such as BESS, hydrogen technologies. New technologies can provide new opportunities in the development of the energy system of the Central Asian countries. Such an impetus can be given by the implementation of the project of the CA RES Development Center. The centralized implementation of smart solutions in synergy with the development of renewable energy sources in the Central Asian countries will make it possible to accelerate the energy transition. Building a new energy infrastructure will allow testing and implementing future technologies based on digital solutions.

The Central Asian countries need to adapt their plans and goals in accordance with current global trends. There is good potential, the region has rich resources, their unique distribution and combination for organizing effective interaction between countries. The development of new technologies makes it possible to solve the above-mentioned issues, and in order to achieve high performance in the water and energy sector, our countries do not have the right to fully realize the existing potential.

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Clean energy transition in the Western Balkan countries – Trap or chance for development?

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ABSTRACT

The Western Balkans countries (countries succeeding former Yugoslavia plus Albania) have a high level of carbon intensity. In comparison with the European member states, the Western Balkan countries in order to generate the same amount of gross domestic product will emit four times more carbon emission. Carbon footprint is in a direct correlation with a usage of coal as the dominant energy source in these countries. Coal is not only predominantly used for electricity production, but it is also used for individual heating of households. The operation of 16 coal-fired power plants in the Western Balkans represents a great environmental, health and economic burden not only for the region, but for the whole of Europe. Contrary to the rules of the European Energy Community, coal production in the countries of the region is subsidized. Despite the fact that the region has a lot of untapped potential in renewable energy sources, investments in thermal power plants still has lead.

As signatories to the Energy Community Treaty, the Western Balkan countries are obliged to comply with all obligations under the Stabilization and Association Agreement and the Energy Community Treaty. The highest challenges for the Western Balkan region are requirements for reduction of emissions, increase of renewable energy resources (except for Albania) and improvement of energy efficiency. By and large, energy sector needs investments but there are many obstacles mainly due to limited regional integration and low electricity prices.

As part of the European Green Deal, a Green Agenda for the Western Balkans was prepared together with the IPA investment fund of EUR 9 billion for the period 2021-2027. By signing the Green Agenda in November 2020, the Western Balkan countries have committed themselves to work with the European Union to make Europe a climate-neutral continent by 2050, which means defining and implementing a strict national climate policy and reforming the energy and transport sectors. This includes a number of specific actions, such as the introduction of a tax on carbon dioxide emissions, phasing out of subsidies for coal, etc. The measures will be implemented in five areas: climate, energy and mobility, circular economy, pollution prevention, sustainable agriculture and food production, and biodiversity. For each of these five areas, the most important initiatives were defined.
A clean energy transition, based on more efficient use of raw materials and energy, expansion of green industries and technologies, and promotion of a more energy-efficient economy that produces less pollution, can help the Western Balkan countries to build an environmentally clean and resilient economy. Analysing energy transition indicators and commitment of the Western Balkan countries in their EU integration process, the aim of this paper is to evaluate if these countries prepare to undertake necessary actions toward clean energy transition. At the moment, it seems that both governments and energy companies as key partners in energy transition have reactive approach, which is not adequate if they want to succeed in this long lasting race for sustainable development.

1. INTRODUCTION

Energy transition considers the replacement of fossil fuels based systems (including primarily coal and oil) in energy production and consumption with renewable energy sources in order to reduce carbon emissions. In other words, energy transition considers a set of policy instruments that can be effective in achieving of carbon neutralization.

The European Union is implementing the energy transition with a commitment to reduce greenhouse gases for 55% by 2030 compared to 1990. In this way, the European Union should become the first carbon neutral region by 2050. The European Union defined carbon neutralisation as a strategic goal within the Green Deal [1], which is a long-term development strategy adopted in December 2019. Achieving this strategic goal means that adequate financial resources must be available and legislative framework must be adopted. Although at some point it seemed that the Covid crisis would have the effect on delay of carbon neutralization, the European Union showed that it is firmly determined in implementing the Green Deal. First, the Investment Plan [2] was defined, which specifies the financial framework, financial mechanisms and financial institutions that will be involved in the implementation process of the Green Deal. Second, the Climate Law was adopted as the first European Climate Law [3] and in that way climate neutrality became obligatory for member states. In July 2021, the European Commission adopted a regulatory framework ("Fit for 55 package"), which includes revision on existing regulation where [4, 5, 6] and adoption of new laws [7, 8].

Although the energy transition is in its early stages, it is planned to gradually close fossil fuels-based thermal power plants. A coal phase-out before 2030 is expected in 11 Member States (Denmark, Ireland, Greece, Spain, France, Italy, Hungary, the Netherlands, Portugal, Slovakia and Finland), leaving coal power plants operational in only seven of the European Union member states (Bulgaria, Czech Republic, Germany, Croatia, Poland, Romania and Slovenia). It should be noted that within the European Union, Estonia and Finland have not ruled out the use of peat and oil shale after 2030. Between half and two-thirds of active coal power plants in the European Union will be retired by 2030 and their retirement will affect between 54,000 and 112,000 employees in the power sector and coal mines. In order to provide support to regions whose energy sectors are based on fossil fuels, as well as regions with energy intensive industries, the European Union has provided a special Just Transition Mechanism [9] consisting of:
Just Transition Fund, a dedicated just transition scheme under InvestEU, and a new public sector loan for additional investments that will be supported by the European Investment Bank.

Mitigating the socio-economic consequences of the transition, primarily for the regions, industries and workers directly affected by the transition, requires significant funding of at least EUR 100 billion. The envisaged Just Transition Mechanism should provide assistance to all Member States that have an energy intensive industry and a large number of coal mines. To access to the mechanism, Member States have to draw up territorial plans and define the direct effects of transition in socio-economic terms. These plans should determine the best ways to solve social, economic and environmental problems.

The countries of the Western Balkans (Albania, Bosnia and Herzegovina, Kosovo*, Montenegro, North Macedonia and Serbia), as members of the Energy Community, have commitment to adopt core EU energy legislation and prepare strategic documents, among others National Energy and Climate Plans. Among the Western Balkan countries, Montenegro, Serbia, North Macedonia and Albania are official EU candidates, which means that they have to harmonize their legislation with the regulations of the European Union. Until now, the accession negotiations have been started only with Montenegro and Serbia, while Bosnia and Herzegovina and Kosovo* are still just potential candidates.

Given the characteristics of the energy sector of the Western Balkan countries, the energy transition will be extremely challenging since electricity production in this region rests on thermal power plants that predominantly use coal as a fuel. In addition, productivity in coal mines is 4 times below the average of mines at the level of the European Union. The transition in the Western Balkans will be hampered by the fact that a large number of employees work in the coal, electricity and energy-intensive industries. With all this in mind, the European Union adopted the Green Agenda for the Western Balkans [10]. The Guidelines for the Implementation of the Green Agenda for the Western Balkans were fully endorsed in the Sofia Declaration at the Western Balkans Summit of 2020, committing the region to working towards the 2050 target of a carbon-neutral continent together with the European Union.

Analysing energy transition indicators and commitment of the Western Balkan countries in their EU integration process, the aim of this paper is to evaluate readiness of these countries to undertake necessary actions towards the clean energy transition. The paper is structured so that the second chapter points out the main characteristics of the energy sector in the Western Balkans, and above all, the electricity sector. The third chapter points out the number of employees in the coal sector and energy-intensive industries who will be directly affected by energy transition. The fourth chapter presents the Green Agenda for the Western Balkans. In the end, based on analysis the concluding marks are presented.

2. CHARACTERISTICS OF ENERGY SECTOR IN THE WESTERN BALKAN COUNTRIES

The Western Balkan region have installed electrical capacity of 18,000 MW, where the thermal power plants (TPPs) are dominant. Almost 100 per cent of installed
capacities in Kosovo are based on coal-fired power plants, two-thirds in Serbia and half in Bosnia and Herzegovina. Coal-fired plants have a significant role in power systems of North Macedonia and Montenegro, while Albania is the only country in the region whose electricity capacities are based on hydro power plants. Serbia has six plants whose total capacity is 4.3 GW, Bosnia and Herzegovina reaches 2 GW with five plants. Kosovo* and North Macedonia have two plants each with total capacity of 1.2 GW and 0.8 GW, respectively. There is one 0.2 GW coal power plant in Montenegro. Structure of electricity net generation capacity in the Western Balkan region is presented in the Figure 1.

Figure 1. Electricity net generation capacity (MW) and net generation (TWh), % of total Source: [11]

In comparison with the European Union, where only 20% of electricity was generated from thermal power plants based on coal in 2018, it is evident that the Western Balkan region is highly dependent on coal. In the European Union there are 166 operating coal power plants with a total installed capacity of 112 GW, while in the Western Balkans there are 16 coal-fired power plants with a total installed capacity of 8.3 GW. Kosovo* has the power generation with the highest dependence on coal (95%), followed by Serbia (67%), Bosnia and Herzegovina (65%), North Macedonia (51%), and Montenegro (41%). It should be noted that installed thermal power capacities has remained constant since 2016, however, the share of fossil fuels in total installed capacity decreased from 52% in 2016 to 48% in 2020 as a result of newly installed capacities into energy renewables sources.

The largest coal producer in the region is Serbia (38 Mt in 2018), while the rest of the countries together produce less than Serbian alone. The dominant type of coal is lignite, and the region has 18 mines, where eleven are in Bosnia and Herzegovina, three in North Macedonia, two in Serbia and one in Montenegro and Kosovo*. The two largest lignite mines are in Serbia, with coal production of 28.4 and 8.6 Mt, followed by the mine in Kosovo*, producing 7.7 Mt of lignite per year. This is similar to the European Union, where the three largest mines in Germany and Poland produce 30 Mt
Domestic production of coal almost matches demand of the region. Bosnia and Herzegovina and Serbia were the largest coal importers, with 1.6 Mt and 1.4 Mt in 2018, respectively, whereas their production in the same year was 14.5Mt and 37.6Mt. Here it is important to point out on the problem of low productivity in coal mines, given that the data show that in coal mines in the European Union an average productivity of 4,730 tons per full-time equivalent employee (t / FTE), whereas the average productivity in the region is a 1,632 t/FTE. The main factors driving this spread in productivity are ‘volumes, operating technology, logistics costs, degree of ‘outsourcing’, type of mine and geological characteristics, skills and equipment of miners’.

Regarding the power sector, the plant fleet analysed is older than that of the EU. While the EU fleet averages 35 years old, that of the Western Balkans is 44 years old. In terms of productivity, while EU plants average an employment intensity of 0.4 jobs/MW, plants identified in the Western Balkans is 1 job/MW for the Western Balkans. In 2018, close to 23 Mt of solid fossil fuels were used in energy-intensive industries in the Western Balkans, of which the vast majority - 20 Mt (89%) - were used in the production of iron and steel. Another 2 Mt (9% of the total) were used in the non-metallic minerals sector.

On the other hand, it is important to note that the price of electricity does not include carbon emission costs. According to the latest Eurostat data for 2021, the electricity price for household consumers (consumption from 2500 to 5000 kWh) for the European Union is 21.92 euro cents / kWh, while the average electricity price for households consumers in the Western Balkan is 6.67 euro cents / kWh (Figure 2). What can be concluded from the chart is that the share of taxes in the price for industry into the final electricity price is significantly lower (18%) than in the European Union countries, where taxes have a share of almost 40% in the total electricity price.

![Figure 2: Electricity prices for households, eurocent per kWh](https://appsso.eurostat.ec.europa.eu/)

Note: data for Albania are not available.
According to the latest Eurostat data for 2021, the price of electricity for non-household consumers (500-2000 MWh) is 15.73 euro cents / kWh for the European Union, while the average price in the Western Balkan region (apart from) is 8.97 euro cents / kWh (Figure 3).

![Figure 3. Electricity prices for industry, eurocent per kWh](https://appsso.eurostat.ec.europa.eu)

Note: data for Albania are not available. Source: [12] Eurostat database

As a result of all the mentioned above, all the Western Balkan countries are facing the problem of high CO2 emissions. According to International Energy Agency, the latest available data for 2020 [13] showed that CO2 emission per unit of GDP (base USD 2015) were highest in Bosnia and Herzegovina and Kosovo (both 1.30 tCO2), followed by Serbia (1), Northern Macedonia (0.7), Montenegro (0.5) and Albania (0.3). On the other hand, CO2 emission per capita were highest in Serbia (6.6) and Bosnia and Herzegovina (6.3), followed by Montenegro (4.20), North Macedonia (3.5), and Albania (1.2).

All Western Balkans countries (apart from Kosovo, which is not a recognised the United Nation member) have signed the Paris Agreement, thus committing to lower carbon emissions. At the moment, the amount of carbon that is emitted into the atmosphere, adjusted for the size of the economy (measured through CO2/GDP at PPP), is up to four times the EU average. Air quality might be improved if old plants are upgraded or if the new plants are more efficient and environmentally-friendly than the old ones.

As signatories of the Energy Community Treaty, the Western Balkan countries have pledged to harmonize their national legislation and adopt European Union standards. On 1 January 2018, Directive 2001/80 / EC took effect in the Energy Community that requires significant reductions in emissions from large combustion plants. This means, among other things, the abolition of subsidies for fossil fuels and the reduction of their participation in electricity production.

Until now, only North Macedonia adopted its National Energy and Climate Plan (NECP) where it is defined that coal power plants will have been closed by 2030 [14].
Serbia plans to decommission all coal power plants below 300 MW by 2024 because they are on average more than 45 years old, with an efficiency below 30% [15], but this would only account for six of a total of 14 coal-fired units in Serbia. According to Energy Strategy 2017 [16], Bosnia and Herzegovina developed four different scenarios for minimum and maximum decommissioning share is based on expected coal-fired power plant closures until 2030 in these scenarios. Kosovo* in its Energy Strategy [17] has three scenarios for existing two power plants (Kosovo A, Kosovo B) and possible new power plant ranging from 0% decommissioning if Kosovo A is refurbished to 47% if it is closed. According to Montenegro’s energy strategy [18], the shutdown of power plant Pljevlja is planned for the end of 2030. The exact date for coal phase-out, however, would be defined in the Montenegrin NECP.

3. CONSEQUENCES OF ENERGY TRANSITION ON EMPLOYED IN COAL AND RELATED SECTORS

The energy transition has direct effects on the number of employees in the coal sector. There are almost 41,510 direct employees in the coal sector in the Western Balkans [19]. Close to 33,782 employees work in coal mining (ranging from 750 jobs in Montenegro to 12,331 jobs in Serbia) and 7,782 employees work in coal-based power plants (ranging from 171 jobs in Montenegro to 2,931 in Serbia). Seen as a proportion of the total workforce, these employment levels range from 0.4% in Montenegro to 1.4% in Kosovo*, with North Macedonia (0.5%), Serbia (0.6%) and Bosnia and Herzegovina (1.3%) in between. For comparison purposes, the EU’s largest coal sector is in Poland constitutes 0.7% of its national labour force.

Besides direct employees in coal and thermo power sector, there are and an additional indirect jobs that support that sector. Assuming levels of employment in related sector to the coal activities, it is possible to develop model which predict number of indirect jobs related to coal sector [20, 21]. These are mostly concentrated in Serbia (almost 38,000 jobs) and Bosnia and Herzegovina (13,000 jobs). An additional 5,000 indirect jobs are to be found in Kosovo*, almost 4,000 indirect jobs in North Macedonia and 1,000 indirect jobs in Montenegro. Just a limited number of mines in Bosnia and Herzegovina and in Serbia get close to the productivity range seen in the EU.

Table 1 Number of employees in mines, TPPs and indirect jobs

<table>
<thead>
<tr>
<th></th>
<th>Mining jobs</th>
<th>Power plant jobs</th>
<th>Overall jobs</th>
<th>Indirect jobs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bosnia and Herzegovina</td>
<td>14,472</td>
<td>2,466</td>
<td>16,938</td>
<td>13,250</td>
</tr>
<tr>
<td>Serbia</td>
<td>12,331</td>
<td>2,931</td>
<td>15,262</td>
<td>37,708</td>
</tr>
<tr>
<td>Kosovo*</td>
<td>3,249</td>
<td>1,482</td>
<td>4,731</td>
<td>4,967</td>
</tr>
<tr>
<td>North Macedonia</td>
<td>2,980</td>
<td>678</td>
<td>3,658</td>
<td>3,927</td>
</tr>
<tr>
<td>Montenegro</td>
<td>750</td>
<td>171</td>
<td>921</td>
<td>1,061</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>33,782</strong></td>
<td><strong>7,728</strong></td>
<td><strong>41,510</strong></td>
<td><strong>60,914</strong></td>
</tr>
</tbody>
</table>

Source: [19]
Additionally, employees working in the energy intensive industry sectors such as steel and iron production, chemical industry, pulp, etc. may be at risk. Serbia’s industry consumed the largest amount of solid fossil fuels, followed by Bosnia and Herzegovina, Albania and North Macedonia. Kosovo * and Montenegro used negligible amounts of solid fossil fuels in industry.

Table 2 Solid fossil fuel use in energy-intensive industry, 2018

<table>
<thead>
<tr>
<th></th>
<th>Iron and steel</th>
<th>Non-metallic minerals</th>
<th>Nonferrous metals</th>
<th>Chemicals</th>
<th>Pulp and paper</th>
<th>Total energy intensive industry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serbia</td>
<td>958</td>
<td>300</td>
<td>109</td>
<td>22</td>
<td>1</td>
<td>389</td>
</tr>
<tr>
<td>Bosnia and Herzegovina</td>
<td>620</td>
<td>162</td>
<td>150</td>
<td>932</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Albania</td>
<td>408</td>
<td></td>
<td></td>
<td></td>
<td>408</td>
<td></td>
</tr>
<tr>
<td>North Macedonia</td>
<td>103</td>
<td>107</td>
<td></td>
<td>210</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kosovo*</td>
<td>25</td>
<td></td>
<td></td>
<td>25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Montenegro</td>
<td>6</td>
<td></td>
<td></td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1712</strong></td>
<td><strong>977</strong></td>
<td><strong>259</strong></td>
<td><strong>22</strong></td>
<td><strong>1</strong></td>
<td><strong>1970</strong></td>
</tr>
</tbody>
</table>

Source: [19]

4. GREEN AGENDA FOR THE WESTERN BALKAN

The Green Agenda for the Western Balkans was adopted at the Summit of the region’s leaders in November 2020 in Sofia. By adopting European standards and defining development priorities that can be funded by the EU funds, the Green Agenda aims to help countries in the region to prepare more easily for EU accession. Besides, in October 2020 the Economic and Investment Plan for the Western Balkans was adopted. The European Union is ready to invest EUR 9 billion from it’s budget through the Instruments for Pre-Accession Assistance (IPA III) for the period 2021-2027. The funds are intended to support the development of competition, sustainable growth, green and digital transition.

On their way to joining the European Union, the Western Balkan countries have an obligation to transpose the acquis communautaire into their national legislation, as well as to adopt the standards applicable in EU countries. The Green Agenda envisages the implementation of a series of actions in order to achieve the ultimate goal, which is the creation of a climate-neutral continent by 2050 and a competitive economy that uses resources efficiently. This goal can be achieved together with the European Union, the introduction of a strict climate policy and the reform of the energy and transport sectors.

With population of 18 million inhabitants, the Western Balkan countries have good preconditions to achieve green growth in an efficient way, through the application of the circular economy concept, increase of use of renewable energy sources, energy saving, production optimization, circular design promotion, green public procurement,
etc. With the Green Agenda for the Western Balkans, the parties undertook to implement actions in five key areas:
1. Climate, energy and mobility;
2. Circular economy;
3. Reduction of pollution (air, water and soil);
4. Sustainable agriculture and food production;
5. Biodiversity.

For each of the five areas, activities have been defined, the implementation of which will achieve the set goals of green development, in order to achieve sustainable development and reduce climate challenges. Some of the most important actions defined through the mentioned areas, which should be taken in the coming period are:
- Alignment with the European Climate Law with a vision of achieving climate neutrality by 2050;
- Setting energy and climate change targets by 2030 in line with the Energy Community framework and the EU acquis, as well as developing and implementing integrated energy and climate plans with clear measures designed to reduce greenhouse gas emissions for all relevant sector policies;
- Continue alignment with the EU Emissions Trading Scheme, as well as work on the introduction of other carbon pricing instruments to promote decarbonisation in the region;
- Prioritizing energy efficiency and improvement in all sectors;
- Increasing the share of renewable energy sources and providing the necessary conditions for investment, in line with the EU and the objectives of the Energy Community;
- Integrating the Western Balkans into the EU's industrial supply chains through decisive action to improve the sustainability of primary raw material production;
- Implement an industrial ecosystem approach to achieve an environmentally sustainable and balanced economic recovery across the region;
- Development of a circular economy strategy, considering the entire product life cycle, waste prevention, modern waste management and waste recycling, reuse, repair and re-production;
- Making further progress in building and maintaining waste management infrastructure for cities and regions;
- Designing and implementing a consumer-oriented initiative to raise citizens' awareness of waste, separate collection and sustainable consumption, etc.

In order to achieve the set goals in a coordinated, sustainable and efficient way, it is necessary to improve cross-sectoral governance and support the integration of green low-carbon transition, including public administration reform, public financial management, economic reform agenda and resource mobilization.

It is of great importance to increase administrative capacities in the region in order to implement Green Agenda. It necessarz to provide a help in monitoring and improvement of all activities, as well as in enforcement of environmental commitments. There is a lack of public participation of all interested stakeholders (industry, civil society, etc.) into the process. Besides, access to statistical data and relevant information is real problem which is crucial for fair reporting of environmental
conditions. An economy-specific and regional awareness-raising plan needs to be developed in all five areas, including the reflection of the Green Agenda for the Western Balkans in education system reforms [22].

5. CONCLUSION

Analysing energy transition indicators and commitment of the Western Balkan countries in their EU integration process, the aim of this paper is to evaluate are these countries prepare to undertake necessary actions toward clean energy transition. As signatories of the Energy Community Treaty, all the Western Balkan countries and Kosovo* are obliged to harmonize their regulatory framework with the EU regulations. Among others, this considers Directive 2001/80 / EC that requires significant reductions in emissions from large combustion plants. This means, among other things, the abolition of subsidies for fossil fuels and the reduction of their participation in electricity production.

The biggest challenge for the Western Balkan countries is transformation of the electricity sector due to the structure of electricity production is heavily based on thermal power plants, which are more than 40 years old and more than two times lower level of productivity compared to the average of the European Union countries. A special challenge of the energy transition is the demand to close thermal power plants, which would leave not only employees in power plans but also those working at coal mines. Besides, green transition will consider a substantial transformation of industry.

In line with the Green Deal, the Green Agenda for the Western Balkan region was adopted in November 2020. The European Union is ready to invest EUR 9 billion from it’s budget through the Instruments for Pre-Accession Assistance (IPA III) for the period 2021-2027. The funds are intended to support the development of competition, sustainable growth, green and digital transition.

Energy transformation is facing with huge challenges and many obstacles in the Western Balkan region. At the moment, it seems that both governments and energy companies as key partners in energy transition have reactive approach, which is not adequate if they want to succeed in this long lasting race for sustainable development.

ACKNOWLEDGEMENTS

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Circular Economy – Examples from Sweden and experience of the Stockholm Environment Institute

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KEYWORDS – Circular economy, circular cities, social impact

ABSTRACT

The circular economy is gaining momentum in Sweden, and it is seen as a powerful tool to contribute to the ambitious climate neutrality goals. This paper provides an overview of recent initiatives contributing to a circular economy in Sweden, and how the Stockholm Environment Institute is supporting those efforts with the research. It also highlights the need for further analyses, and a holistic approach toward a circular economy, including integration of the social aspects.

1. INTRODUCTION

In 2021, the European Union (EU) made climate neutrality, the goal of zero net emissions by 2050, legally binding in the EU, with an interim target of 55% emission reduction by 2030 [1]. The European Green deal is the roadmap for the EU to achieve these goals. The European circular economy (CE) action plan from 2020 is envisioned to make a “decisive contribution to achieving climate neutrality by 2050 and decoupling economic growth from resource use while ensuring the long-term competitiveness of the EU and leaving no one behind”.

On one side, Sweden is a country with a high climate and environmental ambitions, that are in line with the EU Green Deal. The Government has adopted a national strategy for a circular economy that sets out the direction and ambition for a long-term and sustainable transition of Swedish society, which is already underway but needs to be intensified further. The main priorities of the strategy are product design, sustainable consumption, nontoxic and circular flows, innovation, and circular business models [2]. In line with that, Sweden is already acknowledged as ambitious, with a target to achieve a net zero until 2045²³, including accounting for the consumption-based emissions within its targets, something no other country has pledged.

On the other side, Sweden's economy was only 3.4% [3] circulatory in 2021, considerably less that the world average of 8%[4]. According to Statistics Sweden environmental accounts, natural resource extraction is on the rise since 1998, and in 2020 more than 260 million tons of natural resources were extracted, out of which are sand and gravel (101 million tons) timber (40 million tonnes), iron ore (48 million tonnes), and copper (31 million tonnes)²⁴. In 2020, material consumption per person

²³ Please see (In Swedish): https://www.naturvardsverket.se/amusomraden/klimatomstallningen/sveriges-klimatarbete/nar-sverige-de-nationella-klimatmalen/, accessed 31 August 2022
was 24.9 tonnes, almost double of the 13.4 EU average. Material consumption per person (see Figure 1) of fossil fuels in Sweden is significantly lower than in the EU (1.7 tonnes compared to the EU average of 2.5 tonnes), while material consumption of metals is five times higher than the EU average (5.8 tonnes compared to the 0.7 tonnes).

![Figure 1: Domestic material consumption by material category, Sweden and EU 2020, tonnes per capita](https://example.com/figure1.png)

In Innovations, research, and development play a very prominent role in Sweden. The country tops the European Innovation Scoreboard\(^\text{25}\), an index published by the European Commission. When it comes to research and development (R&D), the country is investing, as a rule, more than 3 percent of the country’s growth domestic product (GDP) in R&D. According to Statistics Sweden, in 2021 expenditure on intramural research and development (R&D) amounted to SEK 184.4 billion\(^\text{26}\). The business sector accounts for most of R&D expenditure, while the government agency Vinnova plays a central role in promoting and funding research projects in a wide range of fields.

Stockholm Environment Institute (SEI), a research institute established in 1988, has been ranked among the top think tanks in the world working on environmental policy and practice\(^\text{27}\), with the main aim to connect science and decision-making to develop solutions for a sustainable future for all.

This paper aims to provide an overview of the relevant initiatives supporting the circular economy in Sweden, including the relevant SEI research in the area.

2. OVERVIEW OF RELEVANT INITIATIVES SUPPORTING CIRCULAR ECONOMY IN SWEDEN

There are many initiatives supporting the circular economy in Sweden, both legislative and non-legislative measures, that promote circular economy processes, encourage sustainable consumption, and aim to ensure that waste is prevented, and the resources used are kept in the economy.

Waste prevention is an integral part of the comprehensive transformation toward a circular economy, and one of the measures to support the reuse of products is VAT reduction from 25 to 6%\(^{28}\) for repair, refurbishment, and reuse. Goods that can be repaired with a lower tax rate are bicycles, shoes, leader goods, clothing, and household linens. Encouraging the reuse of products is also supported through the so-called pop reuse centers, small shops or malls located right next to a recycling center, where the visitors can drop off their items. One of the most famous opened in 2015 in Eskilstuna, ReTuna\(^{29}\). Even Ikea opened its first world’s first second-hand pop-up store in the ReTuna Shopping Centre, where all products sold, reused, or recycled.

Some aspects of the collaborative economy are gaining momentum. Analysis of sharing economy in EU countries showed that the collaborative finance sector provided 4,477 jobs and generated revenue of EUR 1.2 billion in 2016, in Sweden\(^{[5]}\), making it the biggest and most important sector in Sweden’s collaborative economy, placing Stockholm as the second most important FinTech hub, after London\(^{[6]}\).

Car sharing services are also on the rise. In the City of Stockholm, there are more than 2200 cars\(^{[7]}\), that belong to three categories (fixed carpool, flexible carpool, and private car sharing). Private car sharing has the largest number of vehicles in Stockholm in 2021, 1234, followed by fixed carpool, 878 cars\(^{[7]}\). In December 2021, 55 live percent of Stockholm's residents within a 400-meter radius of a fixed carpool space, an increase from 52% in November 2020\(^{[7]}\). Volvo Car Mobility, self-reported that their services in 2020 in Sweden, saved 8,200 tonnes of CO2 emission, stating that carpool is a cheaper option than owning a car up to a traveled distance of 7,000-9,000 km/year\(^{[8]}\).

Viable Cities\(^{30}\) is a strategic innovation programme (2017-2030) focusing on the transition to climate-neutral and sustainable cities. The programme is implemented with support in a concerted effort by Vinnova, the Swedish Energy Agency and the Swedish Research Council for Sustainable Development (Formas), where the Swedish Energy Agency is the responsible authority, while the Royal Institute of Technology (KTH) in Stockholm is the host organization for Viable Cities. The main programme tool is Climate Contract 2030 and the Viable Cities Transition Lab is a central strategic venture by Viable Cities, and it is funding the research and innovation initiatives.

Circular business models for energy intense industries are supported through the Industrial Leap (Sw: Industriklivet), a long-term initiative run by the Swedish Energy Agency, that is making it less risky for the industry to test new technology and achieve the technological leap needed for change. Since 2021, the Industrial Leap is part of the

\(^{28}\) Please see (In Swedish): https://www4.skatteverket.se/rattsligvagledning/edition/2022.9/355538.html#update_20220518104314

\(^{29}\) Please see: https://www.retuna.se/english/, accessed 31 August 2022

\(^{30}\) Please see: https://en.viablecities.se/om-viable-cities, accessed 31 August 2022
green restart for a climate-smart society after the Covid-19 pandemic and is part of the EU’s Recovery and Resilience Facility (RRF), which is also an element of NextGenerationEU, to support the EU member states to recover from the COVID-19 pandemic. The Industrial Leap is established for the 2018-2040 period, to significantly reduce process-related emissions in the Swedish industry. It covers a total of approximately SEK 909 million in 2022 and can finance projects that run until 2029, and the annual budget is decided in connection with the budget bill. Types of projects supported are feasibility studies, demonstration projects and full-scale investments.

With the help of the Industrial Leap, many projects have already progressed from the idea stage to the investment. One interesting example is support to Northvolt, Swedish battery developer and manufacturer, specializing in lithium-ion technology for electric vehicles. Among other things through support for a preliminary study, for business development, followed by demonstration support of SEK 146 million (20% of the value) to build the pilot plant in Västerås. The facility started developing, testing and industrializing lithium-ion batteries in 2019, making it a major step toward the lithium-ion battery Giga factory in Skellefteå (factory is called Northvolt Ett), which assembled its first battery at the end of 2021, continuing in 2022, to deliver the first commercial deliveries. Northvolt is part of the joint venture that opened the first electric vehicle European battery recycling plant in Norway.

Another interesting example of Industrial Leap support projects is a new methodology for the chemical recycling of plastic. A feasibility study is underway, carried out with project partner Stena Recycling, for a chemical recycling unit to be established at the Borealis production location (planned for 2024).

Support to company Ovako to invest in an electrolyzer that will produce fossil-free hydrogen in Hofors, expected to be in operation as early as 2022. This will have positive effects for the production of fossil-free steel and will be an important part of a future hydrogen infrastructure in the region, at the same time as it can act as a stabilizer for the electricity grid.

2.1 THE STOCKHOLM ENVIRONMENT INSTITUTE (SEI)

Stockholm Environment Institute (SEI) is an international non-profit research and policy organization that tackles environmental and development challenges. The institute was founded in 1989 and is named after the Stockholm Declaration of 1972, that is seen as the origin of the SEI’s mandate. The mission of the institute is to support decision-making and induce change towards sustainable development around the world by providing integrative knowledge that bridges science, policy and practice in the field of environment and development.

31 Please see: https://www.energimyndigheten.se/en/innovations-r--d/energyintensive-industry/the-industrial-leap/, accessed 31 August 2022
34 Please see (In Swedish): https://www.energimyndigheten.se/nyhetsarkiv/2021/nu-utreds-forutsattningarna-for-ett-plastretturraffinaderi/, accessed 31 August 2022
The centers are located on five continents, Latin America, East Africa, North America (US), Western and Central-Eastern Europe, and Southeast Asia. This unique center structure also enables North-South, South-South, and South-North learning. Crucially, the work of the centers builds on and connects to SEI’s expertise globally.

SEI focuses on environmental dimensions of human development and well-being and aims to contribute to better living conditions around the world, including for poor and vulnerable groups, through better “policies, technologies and related management techniques and strategies for an environmentally sustainable development of society”.

### 2.1.1 SEI Relevant Research

At the end of 2021, SEI numbered approximately 320 employees worldwide [9]. SEI’s researchers published more than 155 peer-reviewed articles with a citation rate of 14,811 [9]. The research is organized around 11 cross-disciplinary research teams in SEI Head Quarters in Stockholm.

SEI is a secretariat of the Leadership Group for Industry Transition (LeadIT37), that gathers countries and companies that are committed to reaching net-zero carbon emissions from industry by 2050. The initiative supported the preparation of roadmaps for member countries and companies (roadmaps refer to strategic long-term decarbonization plans, visions, and pathways that include decarbonization targets) and it developed two tools – the industry tracker38 and the green steel tracker39, to facilitate analysis of and research into the decarbonization of hard-to-abate industry sectors.

The circular economy is just one of the topics SEI is engaged in. Within the last decade SEI carried out 57 projects related to CE, which mainly address three key areas of expertise: circular bioeconomy, circular solid waste management, and circular water management, in Europe and Asia. Recently published report that analysis the of SEI-wide engagement on the circular economy concluded that the future directions for establishing an impactful and actionable CE research agenda should focus on at higher R Strategies – such as rethinking, repurposing and refusing consumption – and linking CE with the concept of sustainable consumption [10].

SEI is supporting Swedish local governments in their efforts to be more sustainable and circular through several projects and networks. One of them, the Urban circularity assessment Project (UCAF)40 project aims to provide an adaptable city level circularity assessment framework that will assist cities in transitioning to a circular economy. This framework will allow cities to measure their level and potential for circularity and can be tailored to different decision-making contexts and sector specific demands.

Despite urban circularity becoming a policy priority, there is currently no city level assessment framework that addresses both the technical and sociopolitical aspects. Recently published a scoping review of the scientific and grey literature concerning the social impacts of urban transitions toward a CE concluded that the social dimension of CE is underrepresented [11]. Also, there is a narrow interpretation

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37 Please see: [https://www.industrytransition.org/who-we-are/](https://www.industrytransition.org/who-we-are/), accessed 31 August 2022
of the social impact discussions centered around employment opportunities for informal sector workers in low and middle-income countries. Looking from the sectoral level, CE is analyzed through waste management, both in Europe and middle-income countries [11]. Additional output prepared is a searchable database “Circular cities: an evidence map of research between 2010 and 2020”[41], comprising of 178 reviewed publications, showing which cities have been discussed, what CE strategy they are focusing on, and the sectors under review.

Moreover, an assessment of the 15 indicator-based frameworks applicable to measure circularity at the city-level showed that they largely focus on the environmental perspective, missing the qualitative lens [12]. This means that cities can understand which sectors have circularity potential, but they do not have the tools to assess this in a qualitative manner, making this the first gap cities face in transitioning to circularity.

SEI is also supporting Sweden’s municipalities to map and reduce emissions generated by consumption in their local areas by using the newly developed tool - the Consumption Compass[42] which analyses, visualizes and maps household emissions from consumption (see Figure 2). The consumption compass contributes to the development of new initiatives and activities within the municipalities to address climate-affecting emissions.

The Viable Cities’ Finance project assesses what climate neutrality means for nine cities in Sweden, how much achieving this goal would cost, and how it can be funded. Initial calculations came to the amount of neutrality in nine selected Swedish cities is at least 19 271 SEK per capita per year until 2030[43], with an estimation of the 200 billion SEK per year for the entire Sweden.

[42] The tool is available here: https://seiorp.sharepoint.com/sites/Municipal-Footprints/Delade%20dokument/Forms/AllItems.aspx?id%2Fsites%2FMunicipal%2DFootprints%2FDelade%20dokument%2FGeneric%2FKonsumtionskompassen%5FPUBLIC&p=true&ga=1, accessed 31 August 2022
The Viable Cities’ Finance project assesses what climate neutrality means for nine cities in Sweden, how much achieving this goal would cost, and how it can be funded. Initial calculations came to the amount of neutrality in nine selected Swedish cities is at least 19 271 SEK per capita per year until 2030[^44], with an estimation of the 200 billion SEK per year for the entire Sweden.

3. CONCLUSION

High material consumption, import of the embodied carbon, and high domestic rates of extraction are very important challenges hindering the CE progress in Sweden, despite that some of them are put in the function of the climate actions and CE. There is a need for regulations that reflect a holistic approach to circularity throughout product life cycles, the creation of mandatory targets for secondary material use, and basing policies on material use, not just emissions [3]. As most supply chains are highly international, circularity goals in Europe and Sweden cannot be met without large-scale changes also taking place in low and middle-income countries [13].

The circular economy is seen as an important tool to support countries to climate neutrality. However, there is a need for holistic scientific research and empirical evidence regarding the circular economy, especially going beyond environmental and technological benefits. Understanding how CE strategies affect people allows governments to develop redistributive policies that would address imbalances and result in a more just society [11]. If established correctly, the CE has the potential to

unlock not only environmental benefits but also provide a myriad of opportunities for all stakeholders [11].

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Greening the cities – Improving micro-scale thermal conditions and enhancing sustainable urban environments

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KEYWORDS - Cities, microclimate, thermal conditions, green infrastructure, NBS.

ABSTRACT

Due to the intensive growth of the city population, and thus the very intensive process of urbanization, in the last few decades, there is a need to establish a concept that would enable further development of society, but on the principles of sustainability and in accordance with nature-based solutions. High environmental pressure in urban areas is not only characteristic of large cities with multi-million inhabitants, but also of medium-sized cities (such as Novi Sad and Osijek), as well as smaller cities between 10,000 and 50,000 inhabitants. Therefore, Novi Sad and Osijek are cities that are today under the pressure of intensive urbanization, modified climate, which is expressed due to climate change, intensification of traffic and constant reduction of green areas. As a consequence of these processes, there is a threat to the urban ecosystem, additional energy consumption, increased thermal risk, as well as threats to the economy and public health. In order to contributing in prevention of the current environmental threats, from 2019 to 2022 was realized the project in coordination of institutions from Serbia and Croatia.

The GReENERGY project is an international/cross-border project implemented in Europe, with the aim of helping to improve the environment in cities, i.e., in this case urban areas of Novi Sad (Serbia) and Osijek (Croatia). Therefore, the activities of GReENERGY project seeks to: a) encourage the production and consumption of green energy (through the installation of new solar power plants in public buildings), and reduce energy consumption from conventional sources that are major emitters of CO₂; b) to emphasize the installation of green roofs and green walls on public facilities as one of the Nature-based solution (NBS) that provide additional energy efficiency of the facilities; and c) to help preserve the urban ecosystem and improve the conditions of outdoor thermal comfort at the microscale.

1. INTRODUCTION

Due to the intensive growth of the city population, and thus the very intensive process of urbanization, in the last few decades [1], there is a need to establish a concept that would enable further development of society, but on the principles of sustainability and in accordance with the NBS. High environmental pressure in urban areas is not
only characteristic of large cities with multi-million inhabitants, but also of medium-sized cities, as well as smaller cities between 10,000 and 50,000 inhabitants [2,3,4]. Therefore, today cities are under the pressure of intensive urbanization, modified climate, which is expressed due to climate change, intensification of traffic and constant reduction of green areas. As a consequence of these processes, there is a threat to the urban ecosystem, additional energy consumption, increased thermal risk, as well as threats to the economy and public health.

The importance of research and initiatives whose focus is on the environment of cities, green energy and greening of cities, speaks of the CORDIS database, which shows a total of 2169 projects dealing with those topics. Some of the most important projects funded by the European Union are: a) ThinkNature - where the main goal is to develop a multi-stakeholder communication platform that provides support and promotion of NBS at the local, regional and international levels; b) Nature4Cities - develops complementary and interactive modules (N4C platform) for engaging stakeholders in the process of collective education on urban greening, development and circulation of new businesses, financial and management models for nature-based projects; c) UnaLaB - seeks to, in cooperation with stakeholders and the implementation of demonstration areas, the so-called. “Living laboratories”, develops a comprehensive base of examples and a European framework of innovative, replicable and locally oriented NBS to improve cities’ resilience to climate and hydrological change; d) URBAN GreenUP - where the aim is to establish an adaptable methodology that will support the development of urban greening plans focused on climate change adaptation and efficient water management; e) CONNECTING Nature - aims to position Europe as a leader in innovation and implementation of NBS [5]. It is interesting to say that projects that bring sustainable solutions to urban environments in Europe significantly contribute to the improvement of the environment and even more intensive research is expected in the future, financially supported by European Union funds, with new green solutions and innovations.

The main goal of this study is to: a) present the main outcomes of the EU project entitled „Greening the cities - Development and promotion of energy efficiency and sustainable urban environment in the cities of Croatia-Serbia cross-border region“ (GReENERGY); and b) present the analyzed microclimate conditions in Novi Sad using the urban monitoring network that was developed by the contribution of the GReENERGY project.

2. THE BACKGROUND OF THIS RESEARCH

The GReENERGY project is an international/cross-border project implemented in Europe, with the aim of helping to improve the environment of urban areas, in this case the urban areas of Novi Sad (Serbia) and Osijek (Croatia). The main idea of the project is to encourage the production and consumption of green energy (through the installation of new solar power plants in two selected public buildings – one in Novi Sad and one in Osijek), and reduce energy consumption from conventional sources that are major emitters of CO₂, then emphasize the installation of green roofs and green walls on public facilities as one of the NBS that provide additional energy efficiency
of the facility, help preserve the urban ecosystem and improve the conditions of outdoor thermal comfort at the micro level (for more info follow the project website\textsuperscript{45}). The installation of green roofs (a total of 640 m\(^2\)) and a green wall (a total of 80 m\(^2\)) in both selected buildings in Novi Sad and Osijek was aimed to improve the energy efficiency of public buildings and reducing energy consumption. The project was particularly focused on the production of 213 kW of additional renewable energy through the solar power plants. Therefore, the installation of solar power plants on the roofs of selected buildings was aimed at promoting the production and use of renewable energy, i.e., green energy, for the operation and maintenance of green roofs and wall, air conditioning in buildings, lighting in buildings, hot water preparation, and generally promoting the principle of circular economy (Figure 1). Planned achievements through the project are likely to have a positive impact on target groups, such as: local and regional administration, environmental agencies, NGOs, private sector, experts and students, construction companies, as well as the wider population of both cities numbering about 400,000 people.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{solar_green_roofs.png}
\caption{Installed solar power plants and green roofs in a) School for primary and secondary education “Milan Petrović” in Novi Sad; b) sport and recreational complex of the High school playground in Osijek}
\end{figure}

The link between the intensity of urbanization and the process of climate change has important implications for ecological sustainability. Climate change (Figure 2a) can accelerate environmental stresses in urbanized environments, as well as intensify already existing urban environmental, economic, and social stresses [6,7]. Also, during urbanization, there is a modification of the land surface, i.e., in general, the ecologically intact land is reduced and the remaining land is fragmented, which reduces the capacity for habitats of various animal species, and increases the probability of further ecological degradation [8]. By investigating the intra-urban relations of the air temperature in Novi Sad (using data from the Novi Sad Urban Network system - NSUNET), i.e., by defining the differences between various built-up types (various local climate zones - LCZs), the obtained results showed the greatest differences during the night times and during heat waves periods (Figure 2b). For instance, in Novi Sad, the differences between the most urbanized parts of the city, such as LCZs 2, 5 and 8,

\textsuperscript{45} The project website: www.greenenergy.rs
and LCZ A (forest area around the city) reach from 3-4 °C to 6-7 °C. Therefore, projects that are focused on adaptation measures of the urban environment, thermal conditions and public health can be of great importance for the cities in the 21st century.

Figure 2: a) average annual air temperature in Serbia for the period 1901-2019 (source: https://showyourstripes.info/); b) differences in average daily air temperature values (in °C) between the most urbanized part of the city (Grbavica district) and the natural environment (highway-Kać forest complex) for the period 2004-2017; y-axis – UTC time; x-axis – days of the year.

3. RESEARCH LOCATION AND DATASETS

Novi Sad is the second largest city in the Republic of Serbia, with 102 km2 of built-up and urban green/blue areas and a population of 330,000 people. The city is located on the Pannonian Plain in Central Europe (45°16’N, 19°50’E), thus most of the urban area is flat with an absolute elevation between 72 m and 80 m [9]. Furthermore, the implementation of green infrastructures, solar power plant and microclimate monitoring system were performed on the School for Primary and Secondary Education (SPSE) "Milan Petrović" in Novi Sad (Figure 3). The SPSE "Milan Petrović" in Novi Sad was built in 2010, as a detached building on a rectangular plot with a total area of 11,538 m². The area of the building is gross 7,244.64 m² and net 6,034.15 m², where the ground floor area of the building is 4,175 m², and the total heating area of the building is 5,719 m². The size of the building and its multiple purpose required complex solutions during construction, that is, division into several parts, different purposes and functionalities and thus different thermal zones.
For monitoring of the microclimate and outdoor thermal comfort conditions, four static Davis Vantage Pro2 automatic weather stations (AWS) were used. Static AWSs are located around the building of the SPSE "Milan Petrović". The selection of sites was based on the best location for data acquisition, availability of electricity and security requirements. All stations are mounted on building walls (Figure 4). Each station is equipped with Davis Vantage Pro2 sensor set, together with included sensors for measuring air temperature, air humidity, wind speed and direction and solar radiation, as well as with the Testo Globe sensor. AWSs provide a new data every 10 minutes and station’s time was set up based on the UTC. For this study we used datasets from four AWSs: station 301 – roof/street side; station 302 – schoolyard/solar panels; station 303 – green roof; and station 304 – schoolyard/garages (Figure 4). Also, we selected heatwaves (June 27th-July 1st; July 21st-26th) from the summer 2022, for further analysis and presentation of thermal conditions on the microscale. For spatial and temporal analysis were used air temperatures (Ta), globe temperatures (Tg) and relative humidity (RH) datasets.
4. RESULTS AND DISCUSSION

In this chapter we present the climate conditions on the microscale, with the focus on thermal conditions. The monitoring contains the four AWSs located in different sites around the school building (see Figure 4). Based on previous studies, it is well known that different thermal conditions are driven by various urban designs, both on local- and micro-scales [10,11]. Therefore, our stations are located with purpose to recognize the influence of walls, concrete, solar cells or green surface on thermal characteristics during the extreme events, such as heatwaves. For detailed analysis we selected two heatwave periods that occurred in June and July 2022 (Table 1). Analysis of Ta (air temperature) present very similar values from all four stations/locations (particularly during the first heatwave period). However, some differences are noticeable between locations 301/302 and 303/304 in maximum values (about 2 °C of difference). Very similar values among locations are visible for RH (relative humidity), i.e., the differences are not higher than 2-3%. Some obvious differences are visible in Tg (globe temperature) values among stations, particularly between site 303 and sites 302/304. The Tg values in the site 303 are 4-5 °C lower (in average and max) than on other stations, and the highest differences are occurred during the intensive heatwave in July (Table 1). Obviously, that extensive green roof with low vegetation (sedum mix) has some impact on microclimate conditions,
particularly in reducing thermal discomfort and minimally lowering the humidity based on more intensive water absorption.

Table 1 Main statistical characteristics of Ta, RH and Tg during the selected heatwave periods

<table>
<thead>
<tr>
<th>Heatwave: June 27\textsuperscript{th} – July 1\textsuperscript{st} 2022</th>
<th>Ta</th>
<th>RH</th>
<th>Tg</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>301</td>
<td>302</td>
<td>303</td>
</tr>
<tr>
<td>average</td>
<td>29.6</td>
<td>29.4</td>
<td>29.7</td>
</tr>
<tr>
<td>max</td>
<td>37.8</td>
<td>37.8</td>
<td>37.8</td>
</tr>
<tr>
<td>min</td>
<td>20.0</td>
<td>20.6</td>
<td>20.6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Heatwave: July 21\textsuperscript{st} – 26\textsuperscript{th} 2022</th>
<th>Ta</th>
<th>RH</th>
<th>Tg</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>301</td>
<td>302</td>
<td>303</td>
</tr>
<tr>
<td>average</td>
<td>29.5</td>
<td>29.8</td>
<td>28.7</td>
</tr>
<tr>
<td>max</td>
<td>40.6</td>
<td>41.1</td>
<td>39.4</td>
</tr>
<tr>
<td>min</td>
<td>20.0</td>
<td>20.0</td>
<td>20.0</td>
</tr>
</tbody>
</table>

Urbanization with artificial materials directly affects temperature (air and surface), air humidity, wind speed, solar radiation, and other meteorological parameters, creating a city-specific urban climate. Also, based on the modified pervious natural surfaces and the artificialization processes, thermoradiative and energetic processes are altered in cities [12]. Therefore, because of combination of global changes in climate and intensive urbanization, making cities climate-proof is becoming increasingly critical [13]. Based on previous microclimate monitoring campaigns in Banja Luka [14] and Belgrade [15], it was confirmed that apparent thermal differences are occur between short distance sites but with various urbanization environments, in the same hot summer day. Therefore, we made more detailed analysis (Table 2, Figure 5) and selected the hottest daytime and night-time during the intensive heatwave in July. In Table 2 is presented the differences in daytime of July 23\textsuperscript{rd} from 9 am to 5 pm UTC and in night-time of July 23\textsuperscript{rd}/24\textsuperscript{th} from 7 pm to 5 am UTC.

Generally, more pronounced differences are visible among measurement sites, comparing to results from the Table 1. Based on the Table 2 and Figure 5, the differences between stations are directly connected with the fact is the measurement site is currently under the sunlight or in shadow. During the daytime, stations 301/302 are under sunlight from the morning until late afternoon, and stations 303/304 are under shadow during the morning hours. Therefore, Tg values on the station 302 are higher from 2 °C to 10 °C than in stations 303/304. Also, the station 302 is under the influence of wall, glass, concrete and solar cells. During the late morning and early afternoon, all locations are under the sunlight and thermal values constantly rise. After 2 pm UTC, i.e., 3.20 pm UTC, the stations 302 and 304 are under shadow by trees and buildings from the south. The station 303 is still under sunlight until the sunrise. Therefore, in late afternoon time the Tg is 6 °C to 10 °C higher on the location 303 (Figure 5a). During the night-time (Figure 5b) the Tg values in the location 303 are lower from 0.5
°C to 4 °C comparing to stations 302/304. Obviously, that green areas (in our case extensive green roof) in the location 303 have influence in lowering the thermal conditions and contributing to improvements of outdoor thermal comfort. The positive impacts of vertical and horizontal green infrastructures on thermal comfort conditions are also confirmed in other studies [16,17]. Furthermore, some previous studies that were focused on urban area of Novi Sad, confirm that green infrastructures, but also building shadows could contribute in preventing the outdoor thermal discomfort conditions [18,19,20].

Table 2 Main statistical characteristics of Ta, RH and Tg in the hottest daytime and night-time during the heatwave in July 2022

<table>
<thead>
<tr>
<th>July 23rd 2022 – daytime from 9 am to 5 pm UTC (from 11 am to 7 pm CEST, local time)</th>
<th>Ta (°C)</th>
<th>RH (%)</th>
<th>Tg (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>301</td>
<td>302</td>
<td>303</td>
</tr>
<tr>
<td>average</td>
<td>38.9</td>
<td>39.0</td>
<td>38.1</td>
</tr>
<tr>
<td>max</td>
<td>40.6</td>
<td>41.1</td>
<td>39.4</td>
</tr>
<tr>
<td>min</td>
<td>36.7</td>
<td>36.7</td>
<td>36.1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>July 23rd/24th 2022 – night-time from 7 pm to 5 am UTC (from 9 pm to 7 am CEST, local time)</th>
<th>Ta (°C)</th>
<th>RH (%)</th>
<th>Tg (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>301</td>
<td>302</td>
<td>303</td>
</tr>
<tr>
<td>average</td>
<td>26.5</td>
<td>26.8</td>
<td>26.5</td>
</tr>
<tr>
<td>max</td>
<td>31.7</td>
<td>31.7</td>
<td>31.7</td>
</tr>
<tr>
<td>min</td>
<td>23.9</td>
<td>23.9</td>
<td>23.9</td>
</tr>
</tbody>
</table>
CONCLUSION

The European Green Deal is an integral part of the European Commission's strategy for implementing the United Nations Agenda 2030 and the Sustainable Development Goals (SDGs) [20]. Given that urban areas are recognized as the primary development drivers, special attention is paid to strategic and planning documents that relate specifically to cities and their future sustainable development. In support of that, one study [21] showed that the total percent of green areas in Novi Sad is about 7.6%; it ranges from 5% in the most urbanized areas to 15% in the outskirts. Unfortunately, over the last 40 years, no additional urban parks and green spaces have been created within city boundaries. Despite urban planning recommendations, local authorities have not focused on the implementation of vertical/horizontal greenery on buildings (green walls and roofs) or added vegetation in inter-block buildings. In combination of climate change and urbanization, making cities climate-proof is becoming increasingly critical, and therefore, in situ and mobile measurements of climate elements are necessary approaches to assess the local and micro-climate conditions in diverse urban or natural areas.

ACKNOWLEDGEMENT

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An overview of the Turkey's energy sector and biofuel industry
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KEYWORDS – Energy, renewable energy, biofuel industry, energy policy, Turkey

ABSTRACT
This article analyses the present situation of the energy sector and biofuel industry in Turkey and provides the information and tools to enable policymakers to build a framework for the development of a sustainable energy sector. It is recommended that agricultural practices must be improved to achieve a sustainable biofuel sector. Turkey should allocate more spending on investments in innovation, services to farmers, education, and training. Additionally, Turkey should focus primarily on improving productivity and efficiency in the context of the environment rather than targeting production levels. Moreover, Turkey should meet its reducing emissions targets under the Paris Agreement by 2030, and renewable energy investment should continue to be supported. These findings can be a guide for further research in Turkey. This paper provides an insight into the Turkish energy sectors and biofuel industry current situation and discusses the strengths and weaknesses of the sectors involved in the biofuels.

1. INTRODUCTION

As a result of population growth, energy demands, and environmental problems are increasing dramatically. The world population is expected to reach 9.8 billion by 2050. Correspondingly, food production should increase by 60% compared to the current amount to meet the food needs of the rising world population [1]. Also, it is envisioned that 30% more freshwater is required to meet the needs [2]. On the other hand, energy is the backbone of the modern world in terms of economic growth. In 2019, primary energy consumption growth slowed by 1.3% compared to the previous year. However, today’s world economies are still based on oil, natural gas, and coal, which affect both environment and humans. For example, coal consumption continues to increase in the emerging economies, and coal production globally increased by 1.5% in primary energy. Nevertheless, there is a positive trend where 3.2 EJ the consumption of renewable energy increased, recording the largest increment among energy sources in 2019. It was the first time the share of renewables surpassed nuclear to generate power, where the share of renewables increased from 9.3% to 10.4%. Moreover, the average carbon emissions growth of the last 10 years is 1.1% per year; in 2019, the growth is only 0.5%, which is a good case [3]. Thus, the transformation of energy systems from fossil-based to renewable become mandatory. The biofuels are rising as an alternative and is expected to be a key solution to the fossil fuel economy.

Turkey is a rapidly developing country and became the seventeenth-largest economy globally in terms of GDP (USD 761 billion) in 2019 [4]. It supports this growth by allocating a share of 1.1% of GDP to research and development (R&D) [5].
The country’s economy relies primarily on agriculture, iron steel industry, manufacturing industry, textiles industry, motor vehicles and automotive industry, shipbuilding industry, defense industry, construction sector, tourism sector, and others [6]. Also, Turkey is the second largest country in Europe for the agricultural economy (2018), the second largest agricultural economy among OECD countries (World Bank), and the ninth largest country in the world for the agricultural economy in 2018 [7]. While in 2019, agriculture contributed 6.43% of GDP [8], in the fourth quarter of 2020, the share of agriculture in the GDP of Turkey is 5.6% [9]. However, the share of agriculture, forestry, and fishing, value-added in GDP declined from 9.0% in 2010 to 6.4% in 2019 [10]. In 2020, Turkey had 37,753 ha of total utilized agricultural land, and 61.3% was the total arable land and land under permanent crops. Nevertheless, agriculture is one of the most critical sectors of the country’s economy that accounted for 6% of the country’s GDP and 17.6% of the country’s employment. In addition, Turkey is a net exporter of agricultural products contributing more than 10% of total exports [11; 12].

2. TURKEY'S ENERGY SECTOR

Turkey had 95,890 MW electric installed capacity in 2020, and 22.53% of the electricity production was obtained from natural gas, 20.45% from coal, 32.31% from hydropower, 9.21% from wind, 1.68% from geothermal, 6.95% from solar energy, and 6.87% from other sources [13]. As of 2020, 51.72% of electricity production was met from renewable sources. According to the 2019–2023 Strategic Plan of the Turkey Ministry of Energy and Natural Resources, it’s aimed to increase the electricity installed power ratio based on domestic and renewable energy resources to the total installed power from 59% to 65% [14]. Furthermore, the target set out under the Eleventh Development Plan (2019–2023), 38.8% of power generation from renewables, has already been reached. Also, in 2017-2027, it is aimed to continue to promote the expansion of renewable energy resources, and it is expected to commission 10 gigawatts (GW) of each of solar and wind capacity. Thus, the Turkish government has encouraged the development of renewable power plants, including wind, solar, biomass, hydro, and geothermal, with the Renewable Energy Resources Support Mechanism (YEKDEM) by offering feed-in tariffs. On the other hand, the dependence on fossil fuels causes an increase in greenhouse gas emissions (GHG). According to United Nations Climate Change, the biggest share in GHG belongs to the energy sector. Energy consumption reduction by improving energy efficiency was evaluated under the National Energy Efficiency Action Plan, covering 2017-2023. The main policy targets have outlined a 14% reduction of Turkey’s primary energy consumption across several sectors, including buildings and services, power and heat, transport, industry and technology, agriculture, and cross-cutting areas [15]. Also, in Turkey, to achieve country's targets for CO₂ emission reduction in the next years, transforming biomass from by-products and biowaste from primary production into energy has an essential role. In the short-term, it is recommended that agricultural residues that are already collected in the field or at the agro-processing plant should be employed to increase bioenergy production. These residues have advantages, such as high accessibility and low mobilization costs. Moreover, in the medium and long term, required policies and
mechanisms should develop to ensure a sustainable supply residues value chain. This should cover cooperatives, intermediaries, energy producers, and biomass owners. Furthermore, these mechanisms should provide information exchange between energy producers and biomass owners, and these mechanisms should involve equipment policies for the collection, pretreatment, and storage of biomass.

The world agrees on shifting of raw materials from fossil to renewable resources to be largely completed by 2050 to protect of climate. At this point, the biofuels contribute to environmental regeneration, spurs economic growth, and supports jobs in rural, coastal, and abandoned industrial areas, leveraging local contexts, and traditions [16]. Overall, it is easy to see that the interest in biofuels in the world is increasing and Turkey has positive developments in this area, as well. On the other hand, Turkey faced a period of macroeconomic uncertainty. Inevitably, this situation affected agricultural production and industry. Especially in recent years, there has been a significant decrease in the income of agricultural producers due to the increase in gasoline and fertilizer prices and the low base prices of products. This situation has resulted in the cessation of agricultural activities and the abandonment of rural areas. Also, the division of agricultural lands by inheritance reduces agricultural activities. However, Turkey needs to determine its biofuels strategy as soon as possible and adapt to this paradigm shift globally. The analysis was carried out across the country level, using country-specific data and conditions. This article analyses the current situation of the biofuels in Turkey and provides the information and tools to enable policymakers to build a framework for the development of a sustainable energy sectors. Also, the study aims to trigger further discussions that would influence the Turkish energy sectors in the coming decade.

3. BIOFUEL INDUSTRY

The development of the biofuel industry relies on biomass availability. When considering biomass use, a critical discussion arises about food and feed production. Several foresight studies emphasize the assuring food and energy security problem will arise and the world will simultaneously face the challenges [17]. However, the efficiency of the food and feed chain could increase by innovative technological applications in agricultural productivity, smart land management, improving logistics and storage; thus, available agricultural land or more land can be used for non-food. On the other hand, oilseed production is essential for biofuel industry. Figure 1 shows the oilseed production from 2015 to 2020.
As shown from the figure, sunflower is the most produced oilseed crop in Turkey. The use of marginal areas for oilseed production in Turkey should be supported by incentives because oilseed production is directly related to the biofuel sector. On the other hand, Turkey has signed the protocol to the United Nations Framework Convention on Climate Change to reduce greenhouse gases emissions due to global warming; thus, alternative fuels became more prominent in Turkey. According to Turkey Biomass Energy Atlas (BEPA), 100 power plants registered in the energy atlas consist of 28 landfill gas, 33 biogas, nine waste heat, 28 biomass, and two pyrolytic oil power plants. The total installed capacity of these power plants is 1,092 MWe. Approximately 2,353 GWh of electricity is produced by these plants annually. Furthermore, eight biodiesel and five bioethanol companies have processing licenses and 199 biomass-based power plants [19]. It is predicted that biomass energy capacity will increase with new regulations and investments.

4. BIODIESEL

In Turkey, 5% of biodiesel blending with diesel became obligatory in 2018 [20]. Figure 2 shows that the amount of blended biodiesel has constantly increased.

Figure 1 The oilseed production from 2015 to 2020 [18].

Figure 2. The blended biodiesel by years in Turkey [21].
The vast majority of commercial vehicles and passenger cars are vehicles that consume diesel. Thus, in 2018, 108,609 million tons of biodiesel were blended into diesel, while in the previous years, biodiesel blending in Turkey was 60,000 million tons in total with voluntary blending [22]. Figure 3 shows that cotton oil has the largest share in biodiesel production, followed by waste vegetable oil and rapeseed oil.

![Raw Material Utilization in Biodiesel Production](image)

Figure 3. Raw material utilization in biodiesel production [21].

Furthermore, biodiesel production has a positive effect on agriculture. Figure 4 shows that rapeseed production tends to increase in general.

![The rapeseed production by years](image)

Figure 4. The rapeseed production by years [23].

On the other hand, Turkey has eight licensed waste vegetable recycling plants. The amount of vegetable waste oil collected in 2016 was 27.57 tons. As of October
2017, vegetable waste oil collection reached 32 tons [24]. However, Turkey has only 5% of diesel is biodiesel, while 20% in the United States. Table 1 shows the amount of Biodiesel- Biofuel Delivery Quantities in 2020.

Table 1 The amount of Biodiesel- Biofuel Delivery Quantities in 2020 [25].

<table>
<thead>
<tr>
<th>Factory/Corporation</th>
<th>Type of Biofuel</th>
<th>Production (ton/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DB TARIMSAL ENERJİ SANAYİ VE TİCARET A.Ş.</td>
<td>biodiesel</td>
<td>58,678.421</td>
</tr>
<tr>
<td>AVES ENERJİ YAĞ VE GIDA SANAYİ A.Ş.</td>
<td>biodiesel</td>
<td>14,805.316</td>
</tr>
<tr>
<td>ÖMER BUCAK İNŞAAT TAAHHÜT SANAYİ VE TİCARET LİMİTED ŞİRKETİ</td>
<td>biodiesel</td>
<td>650.000</td>
</tr>
<tr>
<td>MAYSA YAĞ SANAYİ A.Ş.</td>
<td>biodiesel</td>
<td>442.015</td>
</tr>
</tbody>
</table>

As seen from the table, this production amount is insufficient, considering the diesel consumption amount. Turkey needs to use marginal areas for oilseed production and start growing local energy plants instead of using imported seeds to increase these rates. Therefore, there are studies on biodiesel and glycerin production from Cephalaria syriaca, Camelina sativa, and Mustard leaf. There is over 4 million ha of fallow land in Turkey every year, and the necessary legal permissions are being sought to cultivate new oilseeds in these marginal agricultural areas [26].

5. BIOETHANOL

Bioethanol is produced from corn, sugar beet, and barley in Turkey [27]. While there are 12 plants producing bioethanol in Turkey, only eight produce biofuels. Moreover, only three of them still produce bioethanol as fuel; the others use ethanol for beverages. Table 2 shows the amount of Bioethanol- Biofuel Delivery Quantities in 2020.

Table 2 The amount of Bioethanol- Biofuel Delivery Quantities in 2020 [25].

<table>
<thead>
<tr>
<th>Factory/Corporation</th>
<th>Type of Bioethanol</th>
<th>Production (ton/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TARIMSAL KİMYA A.Ş.</td>
<td>Fuel bioethanol</td>
<td>20,094.630</td>
</tr>
<tr>
<td>KONYA ŞEKER A.Ş.</td>
<td>Fuel bioethanol</td>
<td>16,198.486</td>
</tr>
<tr>
<td>TEZKİM TARIMSAL KİMYA A.Ş.</td>
<td>Fuel bioethanol</td>
<td>15,974.916</td>
</tr>
</tbody>
</table>
Turkey has only 3% of the gasoline used today is bioethanol, while 85% is in the United States. As mentioned above, to increase these rates, Turkey needs to use marginal areas for oilseed production and start growing local energy plants instead of using imported seeds. However, in 2008, the “Alcohol Dewatering Facility” with a capacity of 15 million liters/year at the Eskişehir Sugar Plant was established by obtaining the necessary permissions from the Tobacco, Tobacco Products, and Alcoholic Beverages Market Regulatory Authority (TAPDK) to produce bioethanol. This bioethanol could not be sold due to the lack of a suitable market, was converted into food alcohol by distillation in 2014 with the permission of TAPDK. Bioethanol production started again in 2018 at the bioethanol facility, which has been idle for 10 years. Apart from Türkşeker, Tarkim, Tezkim, and Konya Şeker companies received a Distribution Authorization Certificate to produce fuel bioethanol. Tarkim and Tezkim produce bioethanol from corn and wheat and Konya Şeker from beet sugar molasses [28].

6. BIOGAS
According to BIOGAZDER, there are 61 biogas plants supported by Renewable Energy Resources Support Mechanism (YEKDEM). While the licensing power of these biogas plants is 229 MW, the commissioned power is 192 MW. This means that these facilities operate at 84% capacity [29]. On the other hand, according to the report by Izmir Development Agency, the number of active biogas plants in Turkey is 54, and the total installed capacity is around 135 MW. Also, there are approximately 20 biogas plants, which use agricultural sources. Most of these companies are based abroad, and they operate through a representative office in Turkey. However, when the production profiles are examined, it is observed that the total capacity utilization rate is below half of the capacity [30]. Also, Turkey has 8.6 million tons of oil equivalent (Mtoe) biomass waste potential, and it is estimated that 1.5 to 2 Mtoe could be used for biogas production [31]. Furthermore, the largest livestock production in Turkey belongs to cattle farms, and in 2019, the number of bovine animals reached approximately 17 million. When this number is compared with the data of 2010, it is seen that there is an increase of 56%. Approximately 22 million tons of milk are produced with dairy cattle. In addition, according to 2019 data, an annual average of 1 million tons of meat was produced in the country [32]. Animal breeding and agricultural activities, which are carried out especially on an industrial scale, are seen as one of the main sources of natural environmental pollution for Turkey and the global level. For this reason, it is significant to recycle animal and agricultural wastes/residues with biogas facilities that can be established in the country. On the other hand, the food sector is the most important bio-based value chain which consumes over 80% of agricultural production [33]. Turkey has significant biodegradable waste potential due to being a large country. Research conducted by Salihoglu et al. [34] showed that total edible food loss and waste was calculated as 26.04 million tons/year. The study emphasized that Turkey could satisfy an important share of its energy needs by using biodegradable waste which originated from the food supply chain. Also, according to BEFS Assessment for
Turkey report [35], considering techno-economic assessment, cattle manure, poultry manure and sunflower heads can be used for biogas.

7. CONCLUSION

The holistic approach of producing renewable biological resources and converting them into value-added products and bioenergy are necessary for sustainable energy policy. However, due to urbanization, industrialization, unsustainable farming practices, depletion of soil organic matter and climate change, large areas of arable land are no longer used. Nonetheless, the government has a significant role in developing efficient strategies for the bioenergy, incentives, and financial support for R&D. Also, while lack of knowledge and awareness of biomass limit the potential use of this resource, lack of data on the current biomass resource and uses are the most significant obstructions of its utilization. For this reason, residue’s type and net available resources should be identified. Also, the mobilization and use of residues should be stated. At this point, Turkey needs to build its "green network” well to a continuous supply of raw materials.

The evolution of the renewable energy can be described as a “vibrant megatrend across the world” which adapts in different climates, societies, political regimes, and socio-economic environments. To achieve sustainable energy markets and guarantee traceability, safety, and provide confidence to the final consumer, the relevant norms, standards, certification, and labelling are needed [36]. In this point, to satisfy the energy market, regulation of the relevant norms play an important role. On the other hand, in Turkey, there is a lack of coordination across the agriculture, environment, and energy policymakers. A super-departmental body could coordinate activities and deal with problems in the form of dissimilar approaches of individual ministries [37].

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Mineral raw materials in war and peace

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KEYWORDS - Mineral raw materials, strategic mineral raw materials, war, peace, military economy

ABSTRACT
The study of mineral raw materials carries with it a very great importance for the economy, society, technological development and various types of industries that use them. In this regard, we can say that they play a significant role in the survival of humanity. One of the most important industries in which certain mineral raw materials are used is the military industry. The military industry calls certain mineral raw materials strategic mineral raw materials. The reason for this is that they are used in the actual production of weapons, equipment and other necessary military equipment used by the defense system in both peacetime and wartime conditions. Given that we live in a time of intolerance and insecurity, almost all countries of the world pay more and more attention to the military industry. Economically developed and powerful countries have the same military industry that produces increasingly powerful and modern weapons for their own needs, but also for the needs of other economically weaker and underdeveloped countries that are forced to buy and import weapons for their defense from the powerful. As the military industry grows stronger, so does the required amount of strategic mineral raw materials, which by nature are unevenly distributed and non-renewable. This fact is key to many important questions that are raised, some of which are: How to rationally and evenly use mineral raw materials for military purposes? How to ensure a sufficient amount of mineral raw materials for military needs when we know that they are non-renewable and unevenly distributed? How can we make equally powerful and modern weapons with a smaller amount of available mineral raw materials?

1 INTRODUCTION
The topic of mineral raw materials is very complex, topical and always insufficiently researched. Technological and economic progress is determined by the distribution of mineral resources, and this leads to the establishment of new relations of forces and power centers, whereby the future of all countries of the world, especially small and underdeveloped ones, becomes more uncertain.

The mineral raw materials themselves are unevenly distributed, which means that some countries have them for export, while others do not have enough of them or none at all.
There are also raw materials of mineral origin that are more or less available in every country (gravel, sand).
The largest number of mineral resources (oil, gas) is limited to certain geological areas, i.e. regions, and this fact puts the countries of those regions in a good strategic
and economic position in terms of foreign trade, social and economic development, defense capabilities and overall stability.

Because of mineral raw materials or products of their processing, wars were often fought, and in addition to other factors, the outcome of the war is mostly decided by weapons as well as a stable and powerful economic base, which to the greatest extent enables mineral raw materials.

In the practice carried out by military science, it has been confirmed that the main role in conflicts is played by military technology, its quantity and quality, because it determines the general character of armed combat, increases the combat capabilities of the army that has it and establishes new forms of combat with the enemy.

The quantity and quality of military equipment is largely determined by the selection of mineral raw materials that will be used in the production and use of weapons.

2 STRATEGIC SIGNIFICANCE OF MINERAL RAW MATERIALS

Various minerals and raw materials such as metals, non-metals as well as their ores and processing products, oil and coal are of inestimable importance for every country because they represent the basis of economic development, diverse production of weapons and equipment for the needs of the armed forces.

In modern conditions and wars, one of the priority tasks is the provision of strategic mineral raw materials. Given that we have in mind the fact that the deposits of mineral raw materials are exhaustible and non-renewable, and that their demand continues to increase, and the available fund is decreasing, the strategic importance of these natural resources becomes more and more acute and prominent.

Due to the uneven distribution of mineral resources, countries that do not have them are in a dependent position with numerous consequences, while countries that possess this natural wealth are of great interest.

2.1 Strategic development in a broader sense

This approach implies that mineral raw materials are important factors in the development and production of assets. The production of raw materials alone ensures an extraordinary impact on the harmonization of the economic structure and stable economic development of the country, which further reflects on the defense power, material, equipment and ability to defend against threats to independence and security.

Also, this approach requires a specific order of mineral raw materials, which are arranged according to their importance:

1. Energy raw materials (oil, coal and natural gas)
2. Iron ores (iron and steel)
3. Colored metals (manganese, chromium and titanium)
4. Various non-metals (quartz sand and magnesites)

2.2 Strategic importance in the narrower sense

This approach is based on the fact that mineral raw materials are the basis of the production of various weapons, ammunition, mine-explosive and other means and
equipment used by the armed forces. Also, these raw materials include propellant materials, either in raw or processed state, that propel combat and non-combat assets of the armed parties.

According to the strategic importance of mineral raw materials in the narrower sense, we can distinguish:

- **Strategic mineral raw materials** – include mineral raw materials and their primary processing that are necessary for the war industry.
- **Primary (priority) mineral raw materials** – a group of mineral raw materials that is very heterogeneous in its composition, because the priority importance of certain raw materials in the military industry is measured through the improvement of technology and science.
- **Secondary (secondary) mineral raw materials** – have importance for the military industry, but it is less important than primary mineral raw materials.
- **Critical (deficit) mineral raw materials** – includes mineral raw materials with which a certain country, wider or narrower region is not fully provided or is partially provided.

### 3 MILITARY MINERAL ECONOMY

There has always been a strong connection between the economic base, the armed forces and warfare. The reliance of the participants on the economic base during war conflicts is inevitable. The economy in the military sector began to play an increasingly crucial role before the beginning of World War I and II, and it has the task of providing all the necessary material conditions for the realization of the military-political goals of the planned or started war.

During the war, the disproportion between limited economic possibilities and truly great military and political ambitions led to defeat, and the economy adapted over time to the demand that this should not happen. This is where the term military economy was born.

#### 3.1 Economics and armaments

The improvement of weapons is taking place at a high speed, and new or improved types and models of weapons are constantly appearing in all types of armed forces (land army, air force, floats, as well as all types of missile – nuclear means).

The giant arms industries of developed countries encourage the export of modern weapons and use them to maintain international tension. This fact is evidenced by the supply of weapons and equipment to a number of countries without any restrictions, but at the same time they are also supplied to others that are in hostile relations with them.

The armament of the great powers threatens small and underdeveloped countries and thus forces them to invest in armaments instead of investing in economic and social development, which further leads to greater indebtedness of those countries and unemployment within them.

Militarization of mineral resources is mostly carried out by economically developed countries that have an equally developed economy and production.
3.2 Concept and objectives of the military economy of mineral resources

Military economics of mineral resources studies the complex military-strategic aspect of mineral resources, and also expresses the general attitude of each country towards mineral resources as minerals used for military purposes and war needs.

Very complex problems of the military economy of mineral resources can be considered in peacetime and wartime conditions:

- In peacetime, the tasks and goals of the military economy are to supply the military industry and the armed forces with mineral raw materials that are necessary for the production of weapons and military equipment, as well as for the very functioning of the defense system of the states.
- In war conditions, it is much more difficult to fulfill the tasks and objectives of the military economy because there are specific limiting factors that are most manifested in the disproportion of the constantly growing need for mineral raw materials and difficult supply conditions.

4 MILITARY-INDUSTRIAL SIGNIFICANCE OF MINERAL RAW MATERIALS

Oil

Oil (black gold) is a mineral without which there is no life today, due to its wide range of uses and the use of its derivatives, but also because of its significant use in many industries, including the military.

Neither war nor peace can be imagined without oil. In peacetime, the lack of oil is equated with an economic disaster, while war experiences show that deficits of oil or its derivatives have an increased and sometimes decisive influence on the final outcome of the war.

In the military industry, oil and its derivatives are widely used because without it it would not be possible to start combat and non-combat motor vehicles, airplanes, helicopters, ships, engineering machines and other assets that are crucial for the army and defense itself.

Uranium

In 1898, Marie and Pierre Curie extracted Uranium from the mineral Pehblende, and in the rest of the material they found two new elements, Radium and Polonium.

The discovery of Radium and radioactivity led to the intensive use of Uranium and thus opened the Atomic Era, which marked the beginning of the use of Uranium for military purposes.

In the military industry, Uranium is used in the production of nuclear weapons (weapons of mass destruction), missile weapons, in the development of missile guidance, control and launch systems, as well as in the production of other assets such as mobile ground launchers, reconnaissance and guidance assets, and also and for electronic jamming.
Titanium

Titanium was found in 1871, but it gained its real practical use in 1948, when it began to be used in the sphere of aviation and war technology.

Many experts call Titan the „child of war“ because it entered mass consumption thanks to the needs of the military industry (over 90% of applications).

In the military industry, it is used for the creation of smoke screens, the production of bombs, radio lamps, the production of rockets, airplanes and other means of transport.

Metal materials

A metal is a substance that consists of atoms of metallic chemical elements. Its materials are alloys of two or more elements in various combinations and thus has a wide range of applications in the military industry.

It is used for the production of a wide variety of weapons, parts of combat, non-combat and transport vehicles, gratings, and they are also good conductors of electricity and heat.

Molybdenum

Molybdenum was discovered in 1778, but it did not come into significant widespread use for more than a century.

It was intensively used in the military industry during the Second World War and thus it was counted among the 23 mineral raw materials that are of great importance for the war.

The most important areas of Molybdenum consumption for military purposes are the production of aircraft, the production of strategically important artillery machines, as well as the production of radar equipment.

Lithium

Lithium is a type of metal. In nature, over 150 minerals contain lithium, but only four (Spodumene, Lepidolite, Perilite and Cinwaldik) are used in practice.

Lithium was discovered in 1817, but has been widely used since 1917. It is also one of the most important strategic elements.

In the military industry Lithium is used as a metal in the form of alloys and various compounds. It is most often used in the production of jet aircraft, but it is also successfully used in the construction of aircraft and rocket technology.

It is very present in pyrotechnics, electrical engineering and electronics.

Incendiary weapons

An incendiary weapon consists of an inflammable substance, a launching device, a device for causing a fire and dispersing matter in order to inflict the most severe consequences on the living force, materially – by technical means and objects.

Flammable substances are chemical compounds or mixtures that ignite artificially or in contact with air.

When burning, they develop a high temperature and ignite various materials, material and technical means and objects, causing various damages.
The basic requirements for the use of flammable substances are that they are easily flammable, that they burn well, that they are difficult to extinguish with fire extinguishers, that they are economical in production, that they are harmless during transport and storage, that they can be used from different means and in different weather and other conditions.

Strategic materials used for incendiary weapons such as flamethrowers, incendiary aerial bombs, incendiary artillery shells are:

- Napalm
- Pyrogel
- White phosphorus
- Alkali metals
- Goop
- Ethylene oxide

CONCLUSION

In the system of natural resources, the mineral resources of energy, metallic and non-metallic mineral raw materials and water have a very important position, they are also an essential element of national wealth, the basis of military industry and the material basis for the defense of the country and its independence.

All mineral goods have a very wide application in military science, industry and practice. A country that possesses more mineral wealth is economically, militarily and strategically stronger because it is understood that its weapons are far more numerous and advanced due to the amount and use of raw materials from which they are made. In this regard, they have a better defense mechanism and a higher threshold for the security of the country itself.

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Environmental and Energy Security towards European Green Deal

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KEYWORDS – environmental security, assessment, trend, European Green Deal

ABSTRACT

Many environmental problems such as air and water pollution, problems of waste water, disposal and recycling of waste, climate changes, flood management, deforestation, droughts, extreme disasters are endangering our environmental security. In addition, trends in oil, coal and gas consumption further threaten energy security and achieving European Green Deal. Therefore, international cooperation is necessary in implementing European Green Deal and preservation of environmental and energy security.

1 INTRODUCTION

European countries, especially non-EU countries, are facing with numerous environmental problems which endanger environmental and energy security. The qualitative content analysis is used and the subject of this paper refers to European Green Deal approved 2020 as a set of policy initiatives by the European Commission with the overarching aim of making the European Union (EU) climate neutral in 2050.

2 ENDANGERING ENVIRONMENTAL AND ENERGY SECURITY

Our civilization is facing severe environmental problems such as air and water pollution, problems of waste water, climate changes, flood management, deforestation, droughts, extreme disasters and others. If we choose a flood, twenty years ago in EU has implemented concept ‘living with floods’ after severe floods in Southern France, Austria, the Czech Republic and Germany (WWF, 2004). Although the flood damages in 2014 in Bosnia and Herzegovina is estimated at around € 2 billion, and for the Republic of Serbia are around € 1.5 billion (Al Jazeera, 2015), flood management and preventive measures are not adequate. Besides, in many Balkan countries, the banks and riverbeds are not regulated, and in rivers or on the river banks are large amount of waste. Unlike clean rivers and lakes in EU, many rivers in Western Balkan (WB) are polluted by garbage dumps, or by dumping unfiltered pollutants, etc., which threatens the water supply for millions of people. Sava river is a natural border between Croatia and Bosnia and Herzegovina, with a lot of waste at both riverbanks. In February last year, several tens of thousands of cubic meters of waste were extracted in Lim River and Potpec Lake, which threaten the environmental security of the three countries Montenegro, Bosnia and Herzegovina and Serbia. Lim flows through, and form an artificial reservoir Potpec Lake, with two hydropower plants (BBC, 2021).

Also, at the same time islands of garbage were floating near Visegrad hydroelectric plant on river Drina between Serbia and Bosnia and Herzegovina. "Landfills near riverbanks in Serbia, Montenegro, and Bosnia and Herzegovina are the
main cause of the formation of the garbage islands. According to some estimates, between 6,000 and 8,000 cubic tons of waste ends up in Drina every year" (Djordjevic, N., 2021).

Many countries will be facing water shortages due to poorly maintained drinking water supply systems, pollution or water scarcity. Serbia and Bosnia and Herzegovina are facing with landfills and lack of wastewater treatment and those are the biggest causes of water pollution. More than 120 000 residents of Serbian town Zrenjanin and nearby places have problems with water quality more than 30 years. Also, wastewater treatment in the region is often poor or nonexistent. As Western Balkan countries want to access to the EU, they will need to meet higher standards of EU legislation such as the revised Drinking Water Directive (European Commission, 2020) and the Urban Wastewater Treatment Directive (European Commission, 2014). The costs of implementation of those directives in WB countries will be high. "According to recent estimates made in Albania, for example, about USD 1.7 billion will be needed in the coming decade to establish adequate services" (EEA, 2010, p. 121).

Also, air pollution is huge environmental problem due to industrial production, including electricity production, household heating and transport. Although many old power plants in Western Balkan countries provide cheap energy, it contributes to air pollution. Several international organizations have been monitoring air quality near old power plants in Tuzla and Gacko – Bosnia and Herzegovina, Drmno – Serbia, Pljevlja – Montenegro, and Bitola and Novaci – North Macedonia. Also, badly operated or abandoned mining sites cause severe pollution, "some with impacts spilling across national boundaries: heavy metal spills from Sasa tailings in Macedonia; and various releases at Majdanpek and Veliki Majdan in Serbia, and Mojkovac in Montenegro" (GRIDA, 2007; Bankwatch Network, 2021). Industrial production contributes to air pollution by increasing levels of "SO2, O3 and NO2 are the air pollutants which levels are most frequently above the legislation limits in the WB. ...Among these are PM10, PM2.5 and SO2 emitted by coal burning in obsolete and inefficient power plants and industrial facilities" (European Commission, 2020). Many of these environmental problems such as resource scarcity, or inadequately urban environment, have socio-economic consequences to human health or quality of life. Upon some research, air pollution aggravates a number of chronic diseases and has caused about 30,000 deaths each year in WB countries (Maglovski, M., 2022).

Besides, negative effect of air pollution is the growth of unplanned (unnecessary) economic costs. The report of the Health and Environmental Alliance calculated the costs incurred by treatment, lost working days and other consequences caused by the negative impact of thermal power plants on WB. Thus, based on modeled cost estimates from air pollution caused by thermal power plants alone, costs in the range of € 6.1 to € 11.5 billion are generated annually. Upon different approaches applied in this analysis, which indicated the framework of cost trends, it is important to point out that they are based on the application of methodologies used by the European Commission and the World Health Organization (Huscher, J.; Smith D., 2013). Besides, due to Ukraine crises and clashes near Zaporizhzhia, one of the largest of Ukraine's nuclear power plants (Reuters, 2022), it can endanger not only environmental and energy security, but the humanity itself. Therefore, it is necessary to stop clashes
and to improve cooperation towards sustainability, education, research and energy efficiency.

3 INCREASING COOPERATION TOWARDS SUSTAINABILITY

Cooperation and progress in this region is often seen through the prism of EU integration. Therefore, one of the main processes is the harmonization and implementation of EU policies, which is an extremely comprehensive process. In the field of environment, the cooperation in WB countries is not sufficiently developed but there are some good examples. In order to decrease air pollution, capitals in North Macedonia and Bosnia and Herzegovina have started programs for financing households to buy inverter air conditioners and replace their furnaces and boilers. The Sarajevo Canton started preparing the strategy for restricting the use of coal and other solid fuels for the period 2021-2031 and their heating plant recently started a geothermal energy research project to replace natural gas in the district heating system (Balkan green energy news, 2021). Regarding measuring impacts on ecosystem, there are many quantitative and qualitative methods for valuing ecosystem. In Guidelines for Conducting Integrated Environmental Assessments, the value refers to environmental conditions, and this value can be measured and reported in different context, such as monetary, social or cultural context (Arezina, V.; Spasojevic, N., 2020, p. 130). The key areas for increasing cooperation were energy efficiency and trade but also the development of transport and infrastructure. Some of the most important forms of cooperation are the Stability Pact for Southeastern Europe, the Cooperation Process of the countries of Southeast Europe and the Regional Cooperation Council and others (Lopandić, D.; Kronja, J, 2010).

Although the Agreement on the Establishment of the Energy Community was signed in 2005, with aims to improve numerous issues in the field of energy, and thus energy efficiency, little has been done comparing to increasing energy demand. Instead of improving energy efficiency, we spend energy to maintain so many unnecessary services or products such as decorative lighting of many public buildings, etc. This is reflected in the awareness that the actors of the WB region are in a very unfavorable position caused by dependence in the field of energy, but also numerous sources of pollution that affect the quality of life in this region on a daily basis. Therefore, it is important to increase cooperation between WB and other countries (Energy Community, 2022). Also, implementation of Sustainable Development Goals, as well as education and research may mitigate many environmental problems.

EUROMED is a good example for improving cooperation towards sustainability. Euro-Mediterranean Partnership - EUROMED has been established in 1995 upon the Barcelona Convention for the protection of the Marine Environment and the Coastal Region of the Mediterranean as well as the UNEP Mediterranean Action Plan. The main aim of EUROMED is to improve bilateral and multilateral cooperation between EU and Mediterranen countries, with the exception of Syria and Libya, in the area of peace and stability, economy, enviroment and culture. It will mitigate the risks of environmental migration (Arezina, 2006, 961) due to the negative impact of climate on their places of residence. EUROMED has conducted several regional and national projects aiming to prevent and mitigate climate changes, reduce pollution, enhance
capacity building, as well as sustainable water integrated management and marine protected areas, such as Environment and Climate Regional Accession Network - ECRAN for Western Balkans and Turkey, El Ekaider Dump Site in Jordan, Tangier Solid Waste Management in Morocco, Lake Bizerte Integrated De pollution in Tunisia, Development of a Mediterranean Marine and Coastal Protected Areas Network, etc. (Arezina V.; Spasojevic N., 2020, p. 132-133).

4 IMPORTANCE OF EUROPEAN GREEN DEAL

The European Green Deal was approved 2020 as set of policy initiatives by the European Commission with the overarching aim of making the European Union (EU) climate neutral in 2050. It is also an impact assessed plan aiming to increase the EU’s greenhouse gas emission reductions target for 2030 to at least 50% and towards 55% compared with 1990 levels. The importance of the European Green Deal is for the European Union to become _climate-neutral_ by 2050. It has goals extending to many different sectors including climate change, biodiversity, energy, circular economy, building renovation, transport and food. Also, European Green Deal includes potential carbon tariffs for countries that don't curtail their greenhouse gas pollution at the same rate. The mechanism to achieve this is called _the Carbon Border Adjustment Mechanism_ (European Commission, May 2020). It includes:

- **European Climate Pact** and **Sustainable Strategy** to engage citizens and all parts of society in climate action,
- **2030 Climate Target Plan** to further reduce net greenhouse gas emissions by at least 55% by 2030,
- **New EU Strategy on Climate Adaptation** to make Europe a climate-resilient society by 2050, fully adapted to the unavoidable impacts of climate change,
- **European Climate Law** to enshrine the 2050 climate-neutrality objective into EU law,
- Review and, if it is necessary, revision of the all relevant climate-related policy instruments, including the **Emissions Trading System**,
- **Circular economy action plan**, to meet the new EU Climate Law,
- Revision of the **Energy Taxation Directive** which is looking closely at fossil fuel subsidies and tax exemptions (aviation, shipping),
- **EU forest strategy** and forest preservation and restoration in Europe,
- **Farm to Fork strategy** along with a focus shift from compliance to performance, which will reward farmers for improved nutrient management, reducing emissions, etc. (European Commission, March 2020).

5 CONCLUSIONS

Environmental problems such as air and water pollution, problems of wastewater, climate changes, flood management, resource scarcity, deforestation, droughts, extreme disasters and others endanger our environmental and energy security. Many of these environmental problems already have socio-economic consequences to human health, quality of life or increased economic costs. Therefore, implementation of Sustainable Development Goals, as well as education and research may mitigate many environmental problems. Also, it is important to increase cooperation between countries, such as EUROMED or European Green Deal as an
impact assessed the importance of the European Green Deal is for the EU to become climate-neutral by 2050. It refers to many different sectors including climate change, biodiversity, energy, circular economy, building renovation, transport and food.

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Circular economy in the Republic of Serbia
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KEYWORDS - Circular economy, Republic of Serbia, Gross Domestic Product

ABSTRACT
The world's population will be 9.2 billion by 2050, according to the United Nations (UN). Today, around 50% of the world's population 3.6 billion, is middle class, and prediction is 5.3 billion people by 2030. Life standard rising will directly mean consumption rising, so demand for goods with more resources. Lacy and along with the other authors predict that global demand is expected to increase by 35% for food, 40% for water and 50% for energy by 2030. Human beings consume about 1.75 times the capacity of the Earth, or 75% more natural resources than are renewed each year. Human's appetite for scarce resources is expected to grow in the coming decades. The UN's Sustainable Development Goals (SDGs) by 2030 and stay within the boundaries outlined in the Paris Agreement.

The Circular economy (CE) presents model that is being obligation, if this generation would like to leave something for next generations, and this paper presents movement to circular model in the Western Balkan countries. This paper will present some of activities in the field of reaching model of circular economy in the Republic of Serbia (Serbia).

1 INTRODUCTION
The circular economy represents a regenerative economic system in which production resources, waste, waste emissions and energy outflow are significantly reduced by slowing down, rounding off and extending energy and material cycles (life cycles) in production. This is achieved primarily by designing and creating products in such a way as to maximize their life span, but also by maintenance, servicing and recycling.

The circular economy model is in complete contrast to the currently dominant linear economy, which promotes the concept of production called "take (from nature), make (in the production process), use, discard (to waste)".

Strong argument in favor of the affirmation of the idea of circular economy is its basic premise that achieving sustainable development on a global level does not imply a change in the quality of life of people, nor a drop in production and profit on the producer's side, but that the circular model can and must be just as profitable as the linear one, as and to enable consumers to enjoy products and services equally.

46 Lacy P. et al., Te Circular Economy Handbook, https://doi.org/10.1057/978-1-349-95968-6_1
48 The Western Balkan countries include Albania, Bosnia and Herzegovina, Montenegro, North Macedonia and Serbia. Kosovo, as specific region, will not be a part of research.
49 https://cirkularnaekonomija.org/sta-je-cirkularna-ekonomija/koncept/
In order to establish economically and ecologically sustainable development models and thus achieve the goals of the circular economy, this discipline emphasizes innovative thinking in all production processes (design thinking), systems thinking, extending the life of products, as and recycling.

In 2017, the European Commission published a document called the "Manifesto for a Resource-Efficient Europe" which clearly emphasizes that "in a world of growing pressure on natural resources and the environment, the European Union has no choice but to follow the path transition towards a resource-efficient and ultimately regenerative circular economy model".

Same year activities on the field of circular economy in Serbia started. They are presented in the "National Profile of Serbia 2018". The profile was prepared by the Environmental Protection Agency of the Republic of Serbia at the request of the European Environment Agency (EEA). The Serbian Environmental Protection Agency (SEPA) is in charge and responsible for reporting on the state of the environment in the Republic of Serbia (SOER), and reporting is based on the National List of Indicators (NLI), adopted in 2011.

2 WAST MANAGEMENT PROGRAM IN SERBIA

In 2022, the Government of Serbia has adopted the Waste Management Program for 2022-2031 (Program). As part of the negotiations about the accession to the EU, through Chapter 27, the country started the process of establishing a system of waste management and its harmonization with the objectives and acquis of the EU.

The main problems and challenges related to waste management are an insufficient coverage with services of municipal waste collection (86.4%), an inadequately implemented collection of recyclable waste, the disposal of waste at unsanitary landfills, the fact that a system of facilities for the treatment of hazardous waste has not been established, that construction and demolition waste recycling is not developed and so on.

Not harmonizing the national legislation with the EU acquis, Serbia risks for the trend of lagging behind the countries in the region and the EU in waste management to continue and for environmental pollution, as well as continuing the degradation of the space.

Considering that the disposal of one ton of untreated waste at a landfill contributes to an emission of 0.83 t CO₂ eq, if the practice continued, the total amount of waste that would be disposed of at landfills in 2030 would be 29,188,330. That would contribute to a CO₂ eq emission of 24,226,314 t.

In the upcoming period, priority measures pertain to the selection of waste at the source, the increasing of the degree of waste recycling and the construction of the missing infrastructure, in order to create the conditions for the meeting of the set goals, cited in the key EU directives pertaining to the waste sector.

The “polluter pays principle” is defined in the Program too. In order to ensure a financially sustainable activity in waste management, the “polluter pays principle” will be implemented. Polluters need to shoulder the full costs of the consequences of their activities. The costs of the collection, treatment and disposal of waste therefore need to
be included in the product price. The principle of a full recovery of the costs of the services of waste collection and disposal should be implemented, and instruments of financial stimulation for the reuse and recycling of waste should be introduced.

The construction of a facility for the incineration of municipal waste in Belgrade with an incineration capacity of 340,000 tons per year, installed production power of 25 MW and production of heating energy of 56 MW and the construction of facilities for the thermal treatment (thermal valorization) of non-recyclable waste in Nis and Kragujevac, with the production of electrical and heating energy, have been recognized as the necessary infrastructure for utility waste management. Forming of regions for waste management, which are established through cooperation of local self-government units, and the construction of a regional waste management infrastructure will continue.

The approach of creating a network of centers for the collection of waste throughout the country is proposed. The construction of centers for waste collection must begin in 2022 in all municipalities within Phase One. Waste collection centers are currently established in some municipalities, and by 2032, all municipalities should have established and functional waste collection centers.

The reaching of the goals regarding the recycling of municipal waste in Serbia is planned in the following time periods: by the end of 2025, the rate of recycling municipal waste will increase to a total of 25% per weight, and by the end of 2030, to 35% per weight.

A separate collection and the construction of one location per municipality for the outdoor composting of green waste is planned within Phase One. On a municipal level, the capacities of the composting facility will range from 500 to 5,000 tons per year (small facilities for biological treatment).

Facilities for getting fuel from waste provide an option for the production of fuel derived from waste (RDF), combined with biological treatment in the biggest waste management regions (for example, Novi Sad), where they can be afforded.

The construction of infrastructure for the treatment of large amounts of biodegradable waste, in Serbia is planned for II phase. Facilities of a total capacity of 380,000 tons per year are necessary for ensuring a proper implementation of the EU directives. Beginning from 2022, the regions which collect more than 85,000 tons of municipal waste need to prepare feasibility studies for the treatment of separately collected biowaste in large facilities for biological treatment. The necessary capacity must be installed by 2037. The capacities of large facilities for biological treatment should range between 50,000 and 100,000 tons a year. In order to realize a greater economic benefit, equipment for the utilization of biogas and its use for own or public needs should be secured.

The component of “home composting” is a package of support to local authorities and citizens for the treatment of biodegradable waste in home conditions and the reduction of the amount of waste that enters the waste collection system from the households, which reduces the taking of free space at the landfill and the disposal fees. This measure focuses of rural areas, where more room for home composting is available and where the benefit from the reduction of separate collection and transportation costs is the biggest. All households in rural areas will be supplied with
home composters and use their own compost. Home composting must begin from 2022 in all municipalities within Phase One.

It is not necessary for all regions to have regional landfills. Some regions will use regional landfills which are located in neighboring regions. The second phase of the infrastructure will be fully built and operational by the end of 2039. Phase Three is planned for a later period and includes the recultivation of old landfills and the taking of environmental protection measures, the covering of landfills and the securing of conditions for the growth of vegetation harmonized with the surrounding nature. The recultivation also includes the removal of waste from smaller landfills and disposal sites to larger landfills. Following the recultivation, the former landfills and disposal sites can be used for other purposes. The infrastructure for the management of hazardous waste will be developed through investments of primarily the private sector. These investments must be carried out in line with the “polluter pays principle”.

When it comes to hazardous waste, among other things, the plan is to build two facilities for physical-chemical treatment, with a capacity of 50,000 tons per year. When it comes to the establishment of capacities for the incineration of organic industrial and medical waste (incinerators), combined with the capacities for the preparation of fuel from waste (RDF); a facility with a capacity of around 30,000 tons per year and the construction of a landfill for the disposal of non-organic industrial hazardous waste, combined with capacities for the solidification of the sludges from hazardous waste flows, with a capacity of 28,000-38,000 tons per year, are planned.

Central regional hazardous waste storage sites are planned in the following districts: City of Belgrade, Central Banat, Danube, Macva and Nisava.

The construction of facilities for physical-chemical treatment of hazardous waste and sludges and facilities for the storage of liquid flows of industrial waste (solvents, acids, bases) and sludges, is planned in the districts of Raska, Rasina, Bor and Zajecar. At the moment, there are no approved locations for a landfill of hazardous waste in the Republic of Serbia. When the locations are identified and approved, new facilities will be built in line with the EU requests.

For the purpose of establishing a system of the collection of spent batteries, the following is necessary:
1) one mobile center for waste collection in each waste management region, 26 in total;
2) one regional storage site in each waste management region, 26 in total;

For the purpose of the management of construction and demolition waste, the following is necessary:
1) mobile facilities for the treatment of construction and demolition waste; one mobile facility is planned in each waste management region; 26 in total;
2) a facility for the treatment of construction and demolition waste; at least one facility in Belgrade, with a capacity of 200,000 tons per year;
3) the securing of adequate locations for the treatment of construction and demolition waste and the storage of this waste following the treatment in each local self-government.

For the purpose of establishing a system of collection of waste vehicles, it is necessary to build stations for the collection of waste vehicles established in bigger
cities (Uzice, Kraljevo, Novi Sad, Valjevo and Nis), five collection stations in Belgrade and two in each of the other waste management regions.

The current tariffs for households in Serbia, for the services of waste management reflect a generally very low, non-harmonized infrastructure, it is said. The tariffs differ greatly, mostly hovering around 0.5% of the household’s income. They will inevitably have to increase with the construction of infrastructure. The availability threshold is considered to be 1.5% of the household’s income. Targeted tariffs (such as the “pay-as-you-throw” scheme) will be implemented in order to enable the further development of the basic infrastructure and administrative systems.

The system of deposit recovery will most likely contribute to an increase in the collected and recycled amounts of packaging waste, the document reads.

“Pay-as-you-throw” fees are an implementation of the “polluter pays principle”. The purpose of this fee is for households and legal entities to be able to influence the amount of money paid for the services of moving out municipal waste proportional to the amount of waste they create. If they separate waste in the location it is created in, if they compost and so on, they can request a small portion of waste fees. Although this kind of waste fees is more easily implemented in areas with family houses, for the time being, it is more frequently implemented in urban areas.

Table 1. Costs according to environmental protection activities in the Republic of Serbia (in RSD million)

<table>
<thead>
<tr>
<th>Activities</th>
<th>Total, mil RSD</th>
<th>Share, %</th>
<th>Changes compared to previous year</th>
<th>Growth rate, %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2019</td>
<td>2020</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environmental protection Costs (a+b)</td>
<td>42,367.8</td>
<td>46,698.1</td>
<td>100</td>
<td>10.2</td>
</tr>
<tr>
<td>Air protection</td>
<td>4,584.2</td>
<td>10,643.5</td>
<td>22.8</td>
<td>132.2</td>
</tr>
<tr>
<td>Waste water management</td>
<td>5,817.1</td>
<td>5,741.8</td>
<td>12.3</td>
<td>-1.3</td>
</tr>
<tr>
<td>Waste management</td>
<td>26,307.4</td>
<td>23,991.4</td>
<td>51.4</td>
<td>-8.8</td>
</tr>
<tr>
<td>Other*</td>
<td>5,659.2</td>
<td>6,321.2</td>
<td>13.5</td>
<td>11.7</td>
</tr>
<tr>
<td>a) Environmental protection investments</td>
<td>11,606.4</td>
<td>18,470.6</td>
<td>100</td>
<td>59.1</td>
</tr>
<tr>
<td>Air protection</td>
<td>4,199.2</td>
<td>10,134.3</td>
<td>54.9</td>
<td>141.3</td>
</tr>
<tr>
<td>Waste water management</td>
<td>1,381.7</td>
<td>2,670.9</td>
<td>14.5</td>
<td>93.3</td>
</tr>
<tr>
<td>Waste management</td>
<td>4,292.2</td>
<td>3,124.0</td>
<td>16.9</td>
<td>-27.2</td>
</tr>
<tr>
<td>Other*</td>
<td>1,733.3</td>
<td>2,541.3</td>
<td>13.8</td>
<td>46.6</td>
</tr>
<tr>
<td>b) Environmental protection current costs</td>
<td>30,761.5</td>
<td>28,227.5</td>
<td>100</td>
<td>-8.2</td>
</tr>
<tr>
<td>Air protection</td>
<td>385.0</td>
<td>509.2</td>
<td>1.8</td>
<td>32.3</td>
</tr>
<tr>
<td>Waste water management</td>
<td>4,435.4</td>
<td>3,070.9</td>
<td>10.9</td>
<td>-30.8</td>
</tr>
<tr>
<td>Waste management</td>
<td>22,015.2</td>
<td>20,867.5</td>
<td>73.9</td>
<td>-5.2</td>
</tr>
<tr>
<td>Other*</td>
<td>3,925.9</td>
<td>3,779.9</td>
<td>13.4</td>
<td>-3.7</td>
</tr>
</tbody>
</table>

* Protection and remediation of land, groundwater and surface water. Protection against noise and vibration; Protection of nature; Other activities related to environmental protection.


Estimation is that the total economic activity in the Republic of Serbia in 2020, measured by the real movement of gross domestic product (GDP), achieved a growth of 1.1% compared to 2019. In 2020, the share of environmental costs in gross domestic
product was 0.8% (Table 1). Serbia is investing resources in establishing a circular market starting in 2017, through increasing the institutional capacity to support such development, raising social capacity to accept the same, change in the economic system to a cleaner, circular economy, and by 2035, this way of doing business becomes the dominant business paradigm in Serbia, with which it approaches all world trends.

A partial reform of education affects the creation of a new one profiles of workers who will be more educated in the field of CE, while the market becomes professional independently. By investing in renewable energy sources, the state and the market become more independent from the import of fossil fuels. The creation of a modern market for services (rather than products) is becoming evident. Such a market is growing rapidly in the world and predictions are that it will transition to such a market ensure the creation of products for services, which have from 2 up to 10 times the market value. Thus, Serbia is moving away from the process industry and applying this model leads to a service type of economy.

The Serbian economy is coming out of recession, and is moving more towards encouraging entrepreneurship and, along with GDP growth, the unemployment rate is slowly falling. It is important to note that there is still a noticeable shortage of professionally educated workers in Serbia, and the lack of jobs for classically educated personnel is also obvious. This information can lead to the conclusion that profiles of workers are created in the Serbian education system that do not meet modern business trends, and despite high unemployment rates, a market dependent on imports. Growth of total investments records a positive trend in the last five years, however, strategic determination for the improvement of modern systems generally does not exist. So, for example, no there is an infrastructure for creating a stimulating environment, which promotes investments in "green" technologies, waste management, as well as investments in manufacturing systems that generate energy from renewable energy sources (RES). Although it is Serbia rather energy independent (only 27.6% of energy is imported), we cannot come to the conclusion that we generate enough energy within the borders of the country, since industrial activities are still very weak. An increase in industrial activity would potentially lead to an increase in energy use; considering that Serbian businessmen are currently not paying too much attention to energy efficiency, at all is the expected gradual increase in energy needs. On the other hand, only 25-30% of renewable resources are used for energy generation, while the energy use profile shows a low percentage of RES energy use (about 21%). This leaves a lot of room for business improvement in that market has two visible benefits: increasing the country's energy independence and increasing energy capacity while ensuring cleaner production. Specifically, close 40% of hydro capacity is unused, while biomass potential exceeds 80% unused capacity. Energy production from water and biomass are defined as national priorities, whose share in the generation of electricity from RES should to be increased.

The growth of industrial production, as well as entrepreneurial activities, was recorded. Growth and the development of a predominantly process industry represents the declared goal of the industry development strategy until 2020 and as such enables the increase and revitalization traditional business systems. However, it somewhat
hinders the introduction of the most modern technical and technological systems that would enable a faster transition to circular economy.

Finally, the activities from the end of 2015 and the beginning of 2016, which are being improved institutional framework for regulating business in the field of waste management, environmental protection and generation, show positive developments. Around that, through the project "IMPACT" through the joint initiative of the German Organization for International Cooperation (GIZ), the OSCE Mission in Serbia, the Ministry of Agriculture and of Environmental Protection and the Chamber of Commerce of Serbia, a series of roundtables was implemented tables in the course of which are in five cities across Serbia (Sremska Mitrovica, Subotica, Kragujevac, Niš and Novi Pazar) gathered interested parties in order to raise their capacities and awareness of the importance of implementing the circular economy in Serbia. By this overall action they will gradually be animated and then strengthened institutional and social capacities for the transition to CE.

At the same time, following the recommendations of the European Commission, an initiative was launched at the national level to assess the strategic importance of the transition of the Serbian economy towards this model by the Chamber of Commerce of Serbia, the Ministry of Agriculture and Environmental Protection and the Ministry of Economy of the Republic of Serbia, and with supported by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH through the project "Management of waste and wastewater in municipalities – IMPACT".

It can be concluded that the capacity to implement the new philosophy is slowly strengthening business; however, structural obstacles and outdated strategic national determinations somewhat hinder the circular economy, which is in line with modern European and world aspirations for the future.

3 GOOD PRACTICE REPRESENTATIVES

Tetrapak recycling - waterproof eco-board Waterproof EKO panels are a construction material consisting of pressed pieces of recycled tetrapak. They meet extremely high requirements related to constancy of form, homogeneity and minimal changes in properties, providing excellent opportunities for modern construction and a whole range of other types of application. In the countries of the European Union, from the entire packaging that is placed on the market recycles a total of 30%. First place in the recycling of multi-layer cardboard packaging held by Germany, with a recycling percentage of 68%. It is generated annually in Serbia about 12,000 tons of multi-layer cardboard packaging. The recycling process is multi-layered cardboard packaging, is similar to the paper recycling process - the collected packaging is put into a pulper (a large mixer) to which water is added. Tetrapak contains 75% paper, 20% polyethylene (plastic) and 5% aluminum. Agency for Environmental Protection Agency (EPA) has proven that paper recycling leads to 35%- og reduction of water pollution and 74% less air pollution compared to primary paper production. The panels that are made in the factory "Feplo" d.o.o., Čačak, are waterproof, and the process of their production is completely ecological because no glues, additives are used. and formaldehydes. Waste tetrapak is used as a raw material, which until now has been used ended up in landfills, so the product is 100% ecological. To make a "Feplo" panels of 2.5 square meters, it is
necessary to use up to 20 kg of tetrapak, so the company its use cares for and preserves the environment. Monthly into production eco-panel installs 250 tons of waste tetrapak. The machines for the production of these plates were constructed by the engineers of the company "Feplo" and this production process is unique in Serbia and this part of Europe. The field of application of waterproof EKO boards is wide and includes: elements of roof and mezzanine constructions, sandwich panels of walls and ceilings, constructions of external and internal walls, various types of floors, final wall coverings and ceilings, sheet material for repairs and reconstruction, housing superstructure buildings, carpentry and carpentry work, formwork, production of mezzanine supports, temporary fences of buildings, construction of sales exhibition stands, podiums, production of billboards, etc. They represent a good heat-insulating material, and physical damage tests performed showed that these products meet the requirements construction requirements and standards\(^\text{50}\).

Recycling of multilayer packaging for packaging beverages and liquid food. In Serbia, there are two significant plants for the production of multilayer packaging for packaging of liquid food and beverages: "Tetrapak" in Gornji Milanovac and "Elopak" in Zemun. Serbia is the leading consumer of this packaging in the region, it is used annually about 12,000 tons of this type of packaging. The problem of collecting multilayer packaging for liquid food and beverage packaging is that until recently this type of packaging waste was completely uninteresting for collectors and the only way to dispose of this type of packaging was its landfilling or incineration in cement plants, where it was used as an alternative fuel. Export for recycling was economically very expensive because they are the closest plants located in the Czech Republic, Germany and the Netherlands, which increased costs. Current plant capacity for multilayer packaging recycling of liquid food and beverages in Serbia is 7,500 tons per year, but there is a possibility capacity expansion to 15,000 tons annually.

Multi-layer cardboard packaging for liquid food and beverage packaging is a material which consists of three components whose share on average in a tetrapack is: paper 74%, polyethylene 22% and aluminum 4%. All materials used in the production of multilayer packaging for liquid food and beverage packaging are of very high quality because they are intended for food packaging, so after using the substance that was packed in this type of packaging, it retains all its high properties and quality. Accordingly therefore, it is in the general interest that, after this type of packaging becomes packaging waste, all the materials that are an integral part of it are used to the maximum, by to return to industrial production, instead of being thrown into the landfill. This reduces the greenhouse effect, which this type of waste causes when released methane into the air. In addition to this practical benefit, there is also a legal obligation to reduce bio-waste in landfills, based on the Directive on Landfills of the European Union which obliges to reduce the total amount of bio-waste that is deposited. Due to the high prevalence of paper, recycled paper fibers are used for the production of various paper products. Currently, through processing in the facilities of Swiss papier d.o.o. in Rača they get paper for towels and smooth on one side paper for product packaging and bag production. Tetrapak recycling has a very important

\(^{50}\) More information can be obtained on the website: http://www.feplo.rs/index.html [20.08.2022.]
environmental significance in terms of complete utilization of secondary raw materials, which affects the reduction of the use of new raw materials and savings. Heating on a briquette of coffee chaff Coffee chaff is a silver membrane that separates from the coffee fruit during the process its processing and is actually a by-product of the frying process. In order to make it easier to dispose of and store, coffee grounds are compressed into briquettes, i.e. into cylindrical pressed pieces. In the search for ways to reuse this amount of waste, it was discovered that coffee grounds burn extremely well and its heating power was tested in laboratories of the Faculty of Mechanical Engineering and the Vinca Institute. The results of the research are showed that coffee chaff has exceptional thermal power and represents a classic example of biomass. That discovery encouraged the representatives of the company "Strauss Adriatic" d.o.o. Šimanovci, establish cooperation with the Innovation Center of the Faculty of Mechanical Engineering in the making of the boiler house project for heating briquettes of coffee chaff. Since it is 140 tons of annually produced coffee chaff briquettes are enough for about three months heating, the boiler house is designed to burn other forms of biomass. From the On November 1, 2011, "Strauss Adriatic" d.o.o. Šimanovci applies a unique heating system to biomass, more precisely to coffee chaff briquettes. Thanks to the savings that this heating system brings have fully paid off the investment in less than a year and a half. This kind of heating can be said to be unique, because there is no information that coffee chaff is used anywhere in the region, even beyond. used in a similar way. The most important effect of this type of heating is the reduced emission of carbon dioxide the atmosphere, i.e. gases that cause the greenhouse effect. Specifically, the total the annual emission of these gases into the atmosphere from the factory in Šimanovci reduced is by about 14% or 341 tons of CO2e, compared to the previous results, because they are biomass combustion products are completely environmentally acceptable and without harmful effects around the area. Also, based on the project and techno-economic analysis, it was determined that the annual savings will be between 65 and 90 thousand euros. The financial savings depend on the price of propane-butane (LPG) on the market, which in the company "Strauss Adriatic" previously used as an energy source for heating. Also, complete supporting equipment and boiler for burning briquettes of 800 kW are in accordance with European standards and produced in Serbia. By modernizing the flue gas purification system on one of the two of the roaster, the total energy consumption per ton of the finished product was also reduced by 3%, which led to a reduction in CO2 emissions by 3%. A reduction is also planned of water consumption, which is the most difficult thing to do, because most of the consumption is sanitary water, and the production process is already optimized. Also, efforts are being made to reduce communal waste, by increasing the types of waste that are recycled or in other ways take care of. Thanks to cooperation with licensed management companies waste, as well as the introduced ISO14000 standard, this company now collects and hands over to authorized companies for management cardboard, nylon, metal, wood, plastic, waste batteries and accumulators, electronic waste, spent cartridges and toners, waste oils.
4 CONCLUSION

Serbia has to develop other national strategic documents for the circular economy, in order to save resources and encourage next generations living in the country.

Also economy and citizens in Serbia have the think and practice implementation of the concept of circular economy in order to make preconditions for a sustainable future, which is equally important for the life of all living beings.

ACKNOWLEDGMENT

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Intelligent hybrid system for own energy consumption in a residential building

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KEYWORDS - renewable energy, hybrid systems, photovoltaic systems, energy efficiency.

ABSTRACT
Climate change is the greatest challenge of our time. Environmental degradation threatens the very existence of Europe and the world. As a result of increased dependence on energy and scarcity of energy resources, there is a tendency to accelerate the construction of new capacities from renewable energy sources. This process helps reduce greenhouse gas emissions, thereby contributing to climate change mitigation [1,2,3]. The mass introduction of power generation systems from photovoltaic systems that are not built and managed effectively also causes a number of negative consequences [4,5,6]. This report looks at ways to improve the energy efficiency of these systems. Building systems have a significant share in the carbon footprint. That is why the main attention is paid to the construction of intelligent hybrid systems of own production and energy consumption in residential buildings.

1 INTRODUCTION
The traditional scheme of power systems from the very beginning of their formation is predetermined by the simultaneity of the processes of production and consumption of electricity and the need to maintain a balance between the generated and consumed power at any time under conditions of random consumption values. [7,8,9,10,11].

After changes in the legislation and policies of the European Union (EU), significant qualitative changes are taking place in the composition and structure of energy systems. First of all, this is due to a significant and constantly growing share of production using renewable energy sources (RES) and the development of distributed generation. Given the difficult-to-predict nature of renewable energy generation, its complete dependence on weather conditions, to ensure a guaranteed balance, a sufficient amount of reserve capacity is needed, which is currently being implemented mainly through traditional production. This way of maintaining the balance has its technical and economic limitations and generally does not solve the problem of RES integration into the traditional energy system [12,13,14].
Technology does not stand still, and today everyone knows about the ability of scientists to create things that could previously be fiction of science fiction and were only described in books and shown in movies. It used to be from the realm of fantasy that a kettle could boil without your participation in the process. And today it is quite real and very common. All this thanks to the technology “intelligent hybrid system”.

2 INTELLIGENT HYBRID SYSTEM

This terminology refers to such a thing as the automation of household systems. The system was created to make our life easier. Thanks to the “intelligent hybrid system”, routine tasks no longer cause irritation and fatigue for home owners. But it is important to understand that the smart home system is much more than automation in activating the kettle. "Intelligent hybrid system" includes control of heating systems, hot water supply, security systems, video surveillance, etc. The principle of operation of the system is based on a number of commands (options) that can be given by both a person and a machine. Activation of a specific command can also be performed on request, directed by a person or a sensor. Let's take a closer look at these two options for activating the system.

- The first option can be done by voice request or by launching a specific device through applications. The application is installed on a smartphone and launched in simple steps. For example, you can express a request to make tea, make a toast, turn off the heating, turn on the air conditioner. Or you can get a multifunctional control panel or open an app on your smartphone and click on the desired command. After processing your request, the smart home system sends your request to the device to turn on Fig.1

![Figure 1. Mobile application for hybrid system control](image-url)
- The second option does not require your presence directly in the house or apartment. Because everything with this option is programmed. That is, when installing the system, certain parameters are set on a specific device in the house. And at a certain time it is activated. For example, every day at 07:30 the kettle is turned on or at 12:00 the heating system is turned on. Also in this option, such control as independent decision-making by the system is possible. This means that, based on statistics, the system itself decides when to turn on or off the heating or boil water (Fig. 2).

![Figure 2. Example of preset temperatures](image)

In addition to comfort, the intelligent hybrid system has the task of optimizing the use of the minimum amount of energy in the home. At the heart of a smart hybrid system is the ability to control the flow of energy in a home to make the most of electricity generated from renewable sources. The model shown uses 6 pcs. monocristalline photovoltaic modules, each with a peak power of 375 W or a total power of 2 kW and a photothermal thermal (PV-T) panel with a flow rate of 50 l/h per m² of collector area. The photovoltaic modules and the photothermal flat collector are oriented to the south and installed at an angle of 30°.
Figure 3. Schematic diagram

The main goal of the system is to use the electrical energy generated by the sun as efficiently as possible. The electricity produced by the photovoltaic (PV) installation is fed into a network parallel to the existing one in the building, passing through an intelligent controller to manage the energy flows. Thus, the most energy-intensive consumers are covered. All electrical consumers are switched on in order of importance.

Heating/cooling of the building is supplied first. This is mainly carried out by a pellet boiler with a buffer tank and a connected electric heat exchanger, powered only by a photovoltaic system. The building maintains a constant temperature of 22°C. The role of the electric heat exchanger is to support the operation of the pellet boiler. When the predetermined criteria are met, the hybrid system directs the electricity to the hot water supply. After domestic hot water demand is met, the energy from the photovoltaic system is directed to a buffer tank. It stores electrical energy in the form of hot water.
The solar photothermal system for hot water supply is implemented with a flat plate solar thermal collector with forced circulation. Low ambient temperature during the cold months of the year has a negative impact and reduces the efficiency of the photothermal system, as can be seen from Fig.4 and Fig.5.

Figure 4. Diagram of generated energy

Figure 5. Average temperature chart

For this reason, the photothermal system is mainly used during the warmer months of the year. This makes it possible to direct electricity from the photovoltaic system to other electricity consumers.

In the event that the electricity from the photovoltaic system does not reach, the difference is added by the pellet boiler and, in extreme cases, the external electrical network.
The results of commissioning and research of an intelligent hybrid self-consumption system are shown in Fig.6. The total energy savings for the study period is 3227 kWh.

3 FINDINGS

From the results obtained, it is clearly seen that the intelligent hybrid system of self-consumption of energy in a residential building, although with a small installed capacity, provides great energy savings. The big advantage of the presented and investigated model is low investment costs and low operating costs. At the heart of energy saving lies the intelligent control of the hybrid system. The ability to customize control algorithms, real-time control and constant feedback are the main functions of an intelligent hybrid system that allows you to optimize all processes in a residential building. From all of the above, we can conclude that the intelligent hybrid system is available to a very wide range of people.

Residential buildings in the European Union account for over 30% of our carbon footprint. The mass introduction of such systems will lead to a reduction in electricity costs in residential buildings and a significant reduction in harmful emissions into the environment.

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Problems of developing a supplier of last resort in the context of the liberalization of the electricity market in Bulgaria

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KEYWORDS - supplier of last resort, liberalized electricity market, energy security

ABSTRACT
The development of energy processes in the European Union is regulated by modern European legislation. The European Union and the Member States have decided to gradually open these markets to competition. The first liberalization directives (the first energy package) were adopted in 1996 (electricity) and 1998 (natural gas) and were to be transposed into the legal systems of the Member States by 1998 (electricity) and 2000 (natural gas). The second energy package was adopted in 2003 and its directives were to be transposed into national legislation by Member States by 2004, with some provisions only coming into force in 2007. In April 2009, the third legislative package was adopted aimed at further liberalizing the domestic electricity and natural gas market. An integral part of this legal framework is DIRECTIVE 2003/54/EO OF THE EUROPEAN PARLIAMENT of 26 June 2003 on common rules for the internal electricity market.

With the introduction of market mechanisms and the liberalization of the electricity market, new entities appear in the power industry system. These are both independent electricity traders who buy and sell on the free electricity market through an electricity exchange, and guaranteeing suppliers who guarantee the supply of electricity to consumers who, for one reason or another, were left without a trader and supplier on the electricity market. free market, liberalized electricity market [2]. This report analyzes the problems encountered in the implementation of these directives in the Republic of Bulgaria, in particular the problems associated with providers of last resort.

1 INTRODUCTION

The provider of last resort (PLO) is intended for cases where the consumer is left without a supplier in the free market for reasons beyond his control.

The PIP acts as an "emergency assistant" and starts supplying you with electricity from the moment your trader turns off the supply until you select a new licensed trader on the open market. Thus, your property/object continues to be supplied with electricity normally, and you have time to find another, more reliable partner.

For households and medium and low voltage companies, Bulgarian legislation obliges the end-suppliers to enter the relevant geographical area as a PIP.
Also, in some countries, PIP provides protection for customers who are having difficulty paying, and also provides protection for inactive customers.

2 PPI REGULATION

In the 1990s, when most national electricity and natural gas markets were still monopolies, the European Union and its member states decided to gradually open up these markets to competition. The first liberalization directives (the first energy package) were adopted in 1996 (electricity) and 1998 (natural gas) and were to be transposed into the legal systems of the Member States by 1998 (electricity) and 2000 (natural gas).

The second energy package was adopted in 2003 and by 2004 member states had to incorporate its directives into national legislation, and some provisions only came into force in 2007. Industrial consumers and households now had the opportunity to choose natural gas and electricity suppliers from a wider range of competitors. It was with the Second Energy Package and the adoption of Directive 2003/54/EC that the term "Supplier of Last Resort" first appeared. Already in the introductory part in paragraph (27), the concept of a supplier of last resort is regulated as follows [3]:
- Member States may designate a supplier of last resort.
- This supplier may be the sales department of a vertically integrated enterprise that also performs distribution functions, provided that it complies with the requirements of this unbundling directive.

CHAPTER II "GENERAL RULES FOR THE ORGANIZATION OF THE INDUSTRY", article 3 Obligations related to public services and consumer protection, paragraph three, regulates the following:
- Member States shall ensure that all household users and, where Member States consider it appropriate, small enterprises (namely, enterprises with less than 50 employees and an annual turnover or balance sheet not exceeding 10 million euros) enjoy the right to universal service, which is the right to receive electricity of a certain quality in its territory at reasonable, easily and clearly comparable and transparent prices.
- To ensure the provision of universal services, Member States may designate a provider of last resort.

3 METHODOLOGY FOR DETERMINING PRICES FOR ELECTRICITY FROM PPI

After the adoption of the Directive and its gradual integration, a methodology for determining the price of electricity of a supplier of last resort is created. The main formula that forms the price is as follows: In accordance with it, the average selling price of electricity intended for sale to consumers by the last resort supplier is formed according to the following formula:

$$\Pi_{\PiPP} = (0.80 \times \Pi_{ПДН} + 0.20 \times \Pi_{ПИЛ}) \times (1 + K_d)$$

where:
- $\Pi_{ПППИ}$ - average selling price of electricity, BGN/MWh;
\( \Pi_{\text{длд}} \) – the price of electricity on the day-ahead market for the corresponding hour, in BGN/MWh;
\( \Pi_{\text{нбп}} \) – the price of the deficit of the balancing market for the respective hour, in BGN/MWh;
\( K_{\text{д}} \) – component by type of activity "delivery of electric energy from PPI", in %
Component for the type of activity "Delivery of electric energy from PPI" in the amount of 5 percent.

Figure 1. Map of the territories of the Republic of Bulgaria served by electricity distribution companies.

On Fig. 1 shows the areas served by electricity distribution companies in the Republic of Bulgaria.

Accordingly, the licenses issued in 2013 for the supply of electricity to PIP (subsequently supplemented with rights and obligations related to the activities of the “special balancing group coordinator”) are as follows:
- National Electric Company EAD - License No. L-408-17.07.01.2013 for a period of 26 years;
- ENERGO-PRO Sales AD - License No. L-410-17.07.01.2013 for a period of 26 years;
- CEZ Electro Bulgaria AD - License No. L-409-17/01.07.2013 for a period of 26 years.
- EVN Elektrosnabdevane EAD - License No.-413 dated July 8, 2013 for a period of 26 years;
- EKZ Golden Sands LLC - License No. L-411-17/01/07/2013 for a period of 26 years.

It is obvious that in fact only electricity distribution companies have a license for PIP.
Between 1 January 2022 and 1 January 2025, Member States must submit reports to the Commission on the implementation of DIRECTIVE (EU) 2019/944 on uniform rules for the internal electricity market, as well as an assessment of progress in achieving effective competition between suppliers and the transition to market prices. Member States applying regulated prices in accordance with paragraph 6 shall report on the fulfillment of the conditions referred to in paragraph 7, including their fulfillment by suppliers, necessary for the implementation of such interventions, and on the impact of regulated prices on the financial position of these suppliers.

By 31 December 2025, the Commission shall consider and submit to the European Parliament and the Council a report on the implementation of this Article in order to achieve market retail prices for electricity; this report is accompanied or accompanied by a legislative proposal, if appropriate. This offer law may provide for an end date for the application of regulated prices.

The implementation of the measures envisaged by the directive for a phased transition to a liberalized electricity market for all electricity consumers without adequate information campaigns has led to a number of problems and distortions.

On Fig. 2. shows the change in the average price at which electricity was sold by the supplier of last resort and the price formed by the Bulgarian Independent Energy Exchange over the past four years.

Figure 2. Change in the average FDI price and the price formed by the Bulgarian Independent Energy Exchange (BNEB).
On Fig. 3 and Fig. 4 shows the change by months of the average price at which electricity was sold by the last resort supplier and the price formed by the Bulgarian Independent Energy Exchange over the past four years.

The analyzed period is from 2019 to mid-2022 and covers the period of transition from supplies at fixed prices to supplies from the liberalized electricity market to small non-residential consumers.

The charts clearly show a higher price of electricity from the supplier of last resort, which is detrimental to consumers.

The process of liberalization of this significant segment of the electricity market, in which future participants were not informed in a timely manner, distorts the market mechanisms for the formation and regulation of prices in this market.

![Figure 3. Monthly change in the average FDI price.](image)

Those consumers who have not chosen their independent licensed electricity trader during the specified period to supply them with electricity at market rates are served by a supplier of last resort at inflated rates. In many cases, the same vendor is licensed to provide both services. Thus, the consumer receives energy from the same operator, but not at regulated prices, but at inflated prices, according to the tariff of the supplier of last resort.

This process largely coincided with the period of the energy crisis caused by external factors, and led to an increase in demand and an increase in exports of electricity. The combination of external and internal factors in the absence of a serious analysis of electricity consumption [4,5,6] further distorted the process of market liberalization and led to the entry into an upward spiral of electricity price growth, which is also observed from the presented graphs.
5 FINDINGS

Compliance with European legislation, but the distortion of the algorithm for introducing a supplier of last resort creates a number of problems for small non-domestic consumers.

The transition to a liberalized electricity market for small non-residential consumers should take place after a lengthy information campaign.

These conditions, during the transition to a liberalized market, caused damage not only to small businesses, but also to the existing large group of household consumers with unfinished residential property (residential buildings without the so-called act 16).

![Figure 4. Change by months of the average price formed by BNEB.](image)

A significant proportion of affected consumers are also those who rent housing with seasonal operation (guest houses).

Lack of awareness among non-residential consumers leads to an excessive increase in electricity costs due to the untimely choice of an independent electricity trader.

The shortcomings of the system of transition to a liberalized market, which have been identified so far, should be carefully analyzed and eliminated in the next phase of liberalization, which is also for residential consumers.

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Research and innovation for the European Green Deal: Western Balkans

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KEYWORDS - European Green Deal, research and innovation, funding mechanisms, Green Agenda for the Western Balkans, Western Balkans.

ABSTRACT

At the European level a number of environmental policies were adopted in order to support the environmentally friendly economy, protect Europe’s natural resources and preserve the health and well-being of citizens. The European Green Deal was published in 2019 as a roadmap showing the way to a sustainable economy in Europe. Following the EU policies, a number of policies at the regional and national levels were published with the aim to eliminate or reduce the negative impact of human activity on the environment. The research and innovation as one of the elements of the European Green Deal underpins the other elements: climate action, clean energy, sustainable industry, environmentally friendly buildings and renovations, sustainable mobility, eliminating pollution, promoting "farm to fork" agriculture, preserving biodiversity, and preventing unfair competition from carbon leakage. In this paper, the analyses of funding mechanisms of the research and innovation on EU, regional and national level was performed. The specific focus was on funding opportunities in Western Balkans countries and there are a wide range of different sources for financing the various aspects which can improve the environmental position of Europe. In this context, presented state-of-the-art of the existing opportunities can be very useful for researchers and developers with various knowledge, expertise, infrastructure and capacity to find appropriate financial support for the realisation of the idea which can lead to greener Europe.

1 INTRODUCTION

In response to the growing environmental problems, the European Union (EU) has taken strategic actions to eliminate or reduce the negative impact of human activity on the environment in the long-term perspective. In December 2019 the European Green Deal was presented as the EU main new growth strategy to transition the EU economy to a sustainable economic model. The strategy implementation intends to ensure resource efficiency in a circular economy, protect biodiversity and reduce pollution [1]

The overarching objective of the EU Green Deal is for the EU to become the first climate neutral continent by 2050, resulting in a cleaner environment, more
affordable energy, smarter transport, new jobs and an overall better quality of life. To help meet this target, the EU has agreed to reduce its net greenhouse gas emissions by at least 55% by 2030, compared to 1990 levels. This increased level of ambition requires action in all sectors of the economy. To achieve this, the European Commission’s latest Green Deal proposals recognise the importance of research and innovation, and of the Innovation Principle, in promoting smart, future-oriented policies and encouraging technological and social innovation [2].

The main elements of the EU Green Deal are climate action, clean energy, sustainable industry, environmentally friendly buildings and renovations, sustainable mobility, eliminating pollution, promoting "farm to fork" agriculture, preserving biodiversity, prioritising research and development and preventing unfair competition from carbon leakage [3].

Taking into account that the research and development activities is considered as a horizontal activity that provides support to other elements, in this paper the research and innovation for the European Green Deal will be analysed with the special focus on the financing of this segment in the Western Balkan countries.

2 RESEARCH AND INNOVATION FOR THE EUROPEAN GREEN DEAL

2.1 The European Green Deal strategy

The main goal of the European Green Deal strategy is to place sustainability and human well-being at the centre of economic policy and as a fundamental dimension of all policy decisions and the resulting actions. Achieving the goal of climate neutrality will only be possible with the participation of all stakeholders from different sectors, such as construction, biodiversity, energy, transport, agriculture and food [4]. Fields of European Green Deal strategy interest are presented in Figure 1.

Figure 1: The European Green Deal

As presented in Figure 1, research and innovation underpins each element of the EU Green Deal. Many of the EU Green Deal initiatives require harnessing new technologies and transforming financial models and supply chains.

Research and innovation will play a central role in:

- accelerating and navigating the necessary transitions,
- deploying, demonstrating and de-risking solutions,
- engaging citizens in social innovation [5].

2.2 Financing of the European Green Deal

Ambitious goals of the European Green Deal strategy will be possible to achieve by developing new technologies, sustainable solutions and breakthrough innovations. To keep its competitive advantage in clean technologies, the EU needs to increase significantly the large-scale deployment and demonstration of new technologies across sectors and across the single market, building new innovative value chains. The EU also regards it as very important to encourage green economic growth, especially the one based on the relations of the economy that rely on knowledge and innovations [4]. This requires a tremendous amount of intellectual effort and financial support to the research and innovation system [5].

Research, development and innovation activities in the light of solving environmental issues have been supported by various EU and national programs. More than 30 years ago, the European Commission began to foster sustainable urban development through the framework programmes FP5, FP6 and FP7 [4]. The European Commission efforts towards the greener Europe, continued with Horizon 2020 program, which was the biggest EU Research and Innovation program funded with nearly EUR 80 billion and it lasted seven years, from 2014 to 2020. By combining research and innovation, it was a financial tool to ensure that Europe produced world-class science, removed barriers to innovation and facilitated collaboration between the public and private sectors in delivering innovation. The Horizon 2020 Programme was divided into three main pillars: Excellent Science, Industrial Leadership and Societal Challenges. The third pillar was focused on many challenges such as health, food security, climate actions, smart and green transport, secure society and clean energy. This pillar aims at improving energy efficiency, enhancing low carbon technologies such as renewable energy sources or alternative fuels and developing smart city technologies and services [7].

Under the Green Deal call – the last and biggest call under Horizon 2020 program, the Commission made €1 billion for 73 selected projects. It is expected that awarded projects will contribute to the EU’s response to the climate crisis and help protect Europe’s unique ecosystems and biodiversity [8]. The Horizon 2020 Green Deal Call, which opened on 17 September 2020 and closed on 27 January 2021, confirmed the readiness of the research community to take on the challenges at hand with an impact focused approach. For this call, 1550 proposals were submitted with around 28000 participants from 100 countries around the world [9]. The projects in the spotlight from this call are presented in the Table 1.
Table 2 Horizon 2020 Green Deal Call - project in the spotlight

<table>
<thead>
<tr>
<th>Project acronym</th>
<th>Project coordinator</th>
<th>Short description</th>
</tr>
</thead>
<tbody>
<tr>
<td>MERLIN</td>
<td>University of Duisburg-Essen - Germany</td>
<td>Freshwaters ecosystems in Europe are under threat, as recent droughts and floods in Europe show. Their capacity to deliver ecosystem services decreases as their biodiversity declines dramatically. The project looks at restoration actions, which can significantly help our mitigation and adaptation efforts, across Europe with the aim to replicate best practices elsewhere and to identify areas with high potential for freshwater restoration.</td>
</tr>
<tr>
<td>REFHYNE II</td>
<td>SINTEF AS - Norway</td>
<td>The project will install a 100MW PEM electrolyser at Rheinland refinery in Cologne, Germany, using renewable power to produce green hydrogen and oxygen, which will be fed into the existing refinery networks to decarbonise refinery operations. It will demonstrate the potential of 100MW electrolyser to decarbonise the operations of refineries and other industrial sites.</td>
</tr>
<tr>
<td>SchoolFood4Change</td>
<td>ICLEI EUROPEAN SECRETARIAT GMBH - Germany</td>
<td>This project looks at creating a shift towards more sustainable and healthier school meals by engaging with multiple stakeholders (incl. cooks, teachers, children) and addressing at the same time territorial, social and environmental resilience.</td>
</tr>
<tr>
<td>FIRE-RES</td>
<td>CONSORCI CENTRE DE CIENCIA I TECNOLOGIA FORESTAL DE CATALUNYA - Spain</td>
<td>Extreme wildfires are ravaging not only Southern Europe, but increasingly also Central, Eastern and Northern Europe. The population exposed to this threat increases as well as the severity of extreme wildfire events (EWE) as the climate becomes more and more conducive to such events. The aim of the project is to predict, fend off and manage EWE with innovative processes and technologies.</td>
</tr>
<tr>
<td>STARGATE</td>
<td>BRUSSELS AIRPORT COMPANY - Belgium</td>
<td>As travel resume, the project addresses a growing concern: how to make travel by air more sustainable. The project, led by Brussels Airport, aims to create green airports as multimodal hubs for sustainable and smart mobility, while strengthening the competitiveness of the European air transport sector.</td>
</tr>
</tbody>
</table>
Further, the projects funded under the Erasmus+ programme could contribute to European actions on climate by developing innovative learning methods in non-formal and formal education to teach about sustainability issues and climate change. Under the priority Environment and fight against climate change, the Erasmus+ programme will be a key instrument for building knowledge, skills, and attitudes on climate change and support sustainable development both within the European Union and beyond in the period 2020-2027. The programme emphasizes the use of innovative practices to make learners and staff true factors of change in the green transition. The programme will increase the number of mobility opportunities in green forward-looking domains which foster the development of competences, enhance career prospects and engage participants in areas which are strategic for sustainable growth, with special attention to rural development (sustainable farming, management of natural resources, soil protection, bio-agriculture). Moreover, Erasmus+, with mobility at its core, should strive for carbon-neutrality by promoting sustainable transport modes and more environmentally responsible behaviour [6].

The Green Deal strategy is also supported by Horizon Europe as a EU’s key funding programme for research and innovation until 2027. Horizon Europe, in synergy with other EU programmes, will play a pivotal role in leveraging national public and private investments. At least 35% of the budget of Horizon Europe (€95.5 billion) will fund new solutions for climate, which are relevant for implementing the Green Deal [7]. Under Horizon Europe, the EU will form green partnerships with various industries and its member states to focus on key areas such as batteries, clean hydrogen, low-carbon steel, the built environment and biodiversity [11].

The full range of instruments available under the Horizon Europe programme will support the research and innovation efforts needed. Four Green Deal Missions will help deliver large-scale changes in areas such as adaptation to climate change, oceans, cities and soil. These missions will bring together a wide range of stakeholders including regions and citizens. Partnerships with industry and Member States will support research and innovation on transport, including batteries, clean hydrogen, low-carbon steel making, circular bio-based sectors and the built environment. The knowledge and innovation communities run by the European Institute of Innovation and Technology will continue to promote collaboration among higher education institutions, research organizations and companies on climate change, sustainable energy, food for the future, and smart, environmentally-friendly and integrated urban transport. The European Innovation Council will dedicate funding, equity investment and business acceleration services to high potential start-ups and SMEs for them to achieve breakthrough Green Deal innovation that can be scaled up rapidly on global markets. The Horizon Europe programme will also involve local communities in working towards a more sustainable future, in initiatives that seek to combine societal pull and technology push [7].
The impacts of global environmental changes are also affecting the environment in the Western Balkans, as well as its economy and society. The Green Agenda for the Western Balkans is a new growth strategy for the region, leaping from a traditional economic model to a sustainable economy, in line with the European Green Deal. It is embedded in the Economic and Investment Plan, which has a truly transformative potential and aims to support the long-term recovery of the Western Balkans and their economic convergence with the EU. The Green Agenda is fully owned by the Western Balkan region: the six leaders adopted the Sofia Declaration on the Green Agenda for the Western Balkans at the Sofia Summit in November 2020, in the context of the Berlin process [12]. The Agenda emphasizes regional cooperation and harmonization with EU policies and obligations in the process of European integration, so that green transformation, sustainable development, efficiency resources, nature protection and the fight against climate change are the centre of economic activities, in order to turn the challenges in these areas into development opportunities. The long-term concept of sustainable development implies constant economic growth, which, in addition to economic efficiency, technological progress, cleaner technologies, innovation of the whole society and socially responsible business, ensures poverty reduction, long-term better conservation of resources, improvement of health conditions and quality of life, reduction of pollution to a level that can withstand environmental factors, prevent new pollution and preserve biodiversity [13].

The EU proposed 5 Green agendas that need to be fulfilled by the Western Balkan countries: de-carbonizing, clean energy production with sustainable development, recycling, biodiversity, and decreasing air/water/soil pollution. The implementation of an ambitious Green Agenda for the Western Balkans will require substantial public and private funding, at national, regional and international level. The EU will support financially the implementation of the ambitious Green Agenda through the Instrument for Pre-Accession (IPAIII), the Western Balkans Investment Framework, the European Fund for Sustainable Development Plus (EFSD+), and other instruments, which will be the main implementing mechanisms in this regard [12]. The Western Balkans are already participating in Horizon 2020 – the EU’s Framework Programme for Research and Innovation – with around 200 stakeholders and EUR 30 million funding awarded in 2019. The new Horizon Europe Framework Programme for Research and Innovation will have a stronger focus on spreading excellence and reducing the research and innovation divide, which will specifically benefit the Western Balkans economies. The green strategy in Western Balkans will also be supported by Erasmus+ program. Two EU macroregional strategies with a strong innovation component are implemented in the Western Balkans: the Danube Strategy and the Adriatic-Ionian Strategy, and they should continue [12].

Moreover, additional support from EU Member States and own funds from the beneficiary parties will need to be mobilised. To this extent, the Commission can consider supporting innovative financial instruments, such as green bonds, that can mobilise public and private investments at the scale needed for the implementation of the Green Agenda. Some previous researches suggest that environmental, social,
governance/sustainability-linked bonds and debt-for-climate swap investments as innovative financial instruments that hold promise in leveraging additional finance to support the sustainability goals in Western Balkans [14].

Beside previously mentioned funding instruments and funds on the EU and regional level, there are also significant funds available at the national level for funding of a green economy. For example, the research and innovation activities in Serbia are financially supported by programs of: the competent ministries, The Innovation Fund of the Republic of Serbia, The Science Fund of the Republic of Serbia. In June 2022, The Science fund announced Green program of cooperation between science and industry with the aim to support sustainable development and raise the level of environmental quality by solving problems that lead to unwanted climate changes, environmental pollution, loss of biodiversity and unsustainable use of natural resources; enable better monitoring, reporting and prevention of pollution of air, water, soil and consumer products, bearing in mind zero pollution, a cleaner circular economy and restoration of biodiversity as strategic national goals. By financial support through the mentioned programs in previous period the Serbian enterprises achieve significant development, mitigate financial constraints, develop innovation capacities and at the macro level it has contributed to achieving sustainable development goals and long-term growth based on innovation [15].

4 CONCLUSION

Biodiversity loss, climate change and natural resource depletion are major concerns at local and global levels. Addressing these challenges depends largely on the implementation of the relevant EU, regional and national environmental policies. The European Green Deal was adopted in 2019 with the aim to guide the transition of the EU economy to a green and sustainable one. Following this strategy, a number of documents were published on the regional and national levels in order to encourage innovation, create new, green jobs and sustainable economic growth, which are necessary for a green transition that should reduce pressure on natural resources and improve the quality of life in accordance with EU standards.

The research and innovation segment provide a great support to all other elements of the European Green Deal strategy and act as one of the mechanisms for the implementation of the environmental strategies. There are a number of the European Framework Programmes for Research and Innovation with the goal to help addressing the social challenges faced at the European level. Besides EU programs, Instrument for Pre-Accession Assistance III and Danube Region Programme 2021-2027 are designed to provide support at the region level. Moreover, the research and innovation activities in the alignment with the directions of "green" and "digital" transition, as two horizontal elements of all economic policies, are being financed from national resources.

Within this paper, several possibilities for funding of the research and innovation activities in terms of solving of the environmental issues were presented. This overview can guide new researchers and developers in this field, but also policymakers, researchers and industries, and represents a useful tool for everyone who wants to understand the status of the research in this field better. It can also support the funding
bodies to advertise more the existing opportunities in order to reach the experts from various fields who can contribute to the environmental protection and sustainable development bringing benefits and opportunities for different stakeholders – citizens, governments, funding bodies, economies.

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Energy policy in Southeast Europe: Legal regulatory issues

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KEYWORDS – energy policy; Southeastern Europe; law aspects

ABSTRACT

The main goal of this paper is to present the position of the countries of Southeast Europe through legal aspects, following the energy policy and its influences. Given that economic competitiveness is increasingly affecting the development of the countries of Southeast Europe, and therefore their citizens and the general well-being of the community, it is important to investigate the aspects that favorably or unfavorably affect it. A safe way of regulating issues and relations is legal regulation of them, in international relations this means additional security and better mutual functioning of countries that have set themselves the same tasks, in order to improve their position and achieve their goals. One of the most important steps towards achieving a stable legal regulation governing relations in this part of Europe is the establishment of the Energy Community, because it represents the creation of a stable market, which is unique, built in a way to attract investments in energy infrastructure, all with the aim of achieving access to energy capacities from member countries. For Serbia, the Treaty on the Establishment of the Energy Community is the first step towards real integration and membership in the European Union. Harmonizing the regulations of Serbia with the regulations of the European Community in the field of energy means the implementation of the legal system of the European Community in the entirety of the legal system of Serbia, because it is not possible to comprehensively regulate relations in the field of energy, and not cover the regulations on companies, public enterprises, competition, consumer protection, the middle. It is impossible to comprehensively apply to the entire legal system the principles of public work, non-discrimination, competition, equal legal status of all market participants (not only energy). The significance of this contract for the European integration of Serbia was later confirmed by the ratification of the Stabilization and Association Agreement from September 2008. In this agreement, the necessity of cooperation between Serbia and the European Union on the development of the achievements of the Energy Community and the integration of Serbia into the energy market of the European Union was underlined.

1 INTRODUCTION

The importance of legal regulation is important both domestically and internationally, that is why the establishment of the Energy Community is of great importance within the Energy Policy, which enables further legal regulation of this issue, with mutual consultations between countries and joint influence on the adoption of effective solutions and adequate regulations. The Energy Community is an international organization that brings together the European Union and its neighbors to create an integrated pan-European energy market. By signing the Treaty on the Energy
Community, the contracting parties undertook to implement key EU laws on energy and the environment, to develop an adequate legal framework and to liberalize their energy markets.

2 THE COUNTRIES OF SOUTHEASTERN EUROPE AND THEIR ENERGY SITUATION

When we talk about the countries of Southeastern Europe, we usually talk about Serbia, Bulgaria, Bosnia and Herzegovina, North Macedonia, Montenegro, Albania, Greece and Croatia.

The Southeastern Europe region consists of a total of ten countries with a total population of 61 inhabitants. The region of Southeast Europe plays a major role for the energy security of a large part of Europe due to its energy resources and specific geographical location.

Although the governments of the countries of Southeast Europe, which at the beginning of 2000 expressed their willingness to restructure the sector and establish an energy market, and then joined the Energy Community, many activities are not taking place at the speed and in the way that was foreseen, which is directly reflected in the reduced the inflow of investments, that is, it slows down the construction and development of new capacities. There are many opportunities for investment in this region, but these countries must strictly adhere to the Treaty on the Energy of Southeast European Countries and apply the directives of the European Union.

The current situation in the region of Southeast Europe is far from the expected results, energy security is in decline, the prices of electricity, gas, oil and oil derivatives are neither expected nor competitive, and the share of greenhouse gas emissions in the production and consumption of energy sources is constantly increasing.

What is the position of the countries of Southeast Europe?

Geographically, Southeast Europe is located between energy-rich regions such as Russia, the Caspian region and the Middle East, and the main energy consumers, Western and Central Europe, and this region is of great geopolitical importance. The chance that the region of Southeast Europe has, to become the largest transit from the Middle East, Central Asia and the Caspian region to the consumers of the European Union, can only be realized with a well-developed infrastructure.

Regardless of the fact that the energy market of Southeast Europe exists and is not negligible, from the perspective of the energy security of the European Union, this region is much more important due to its transit character, which is why investing in the development of energy infrastructure is a big challenge, which primarily refers to the infrastructure for transport natural gas.

The basic characteristics of the gas economy in the region of Southeast Europe are particularly reflected in the lack of storage facilities, the non-existent and underdeveloped gas pipeline network, low gas consumption, but also in the high dependence on one supplier - the Russian Federation. Although the countries of Southeast Europe decided to reform the gas economy, the changes are much slower
than expected, and they are additionally slowed down by the complex political relations between the countries of the region.\textsuperscript{51}

\section*{3 ENERGY COMMUNITY FOR SOUTHEAST EUROPE}

The Energy Community for Southeast Europe (SE) was established by the Agreement on the Establishment of the Energy Community, which was signed on October 25\textsuperscript{th}, 2005 in Athens, and entered into force on July 1\textsuperscript{st}, 2006. The contracting parties are the European Community on one side, and on the other the Republic of Albania, the Republic of Bosnia and Herzegovina, the Republic of Croatia, the Former Yugoslav Republic of Macedonia, the Republic of Montenegro, Romania, the Republic of Serbia and the United Nations Interim Mission in Kosovo in accordance with Resolution 1244 of the UN Security Council.

The Republic of Serbia ratified this Agreement on July 14\textsuperscript{th}, 2006 ("Official Gazette of RS" No. 62/2006).

This document opens up the possibility of establishing stronger mutual ties in the energy sector between the Contracting Parties from Southeast Europe (SEE), as well as ties with Austria, Italy, Slovenia, Hungary and Greece. Moldova (since May 2010), Ukraine (since February 2011) and Georgia (since July 2017) became full members by joining the Treaty on the Establishment of the Energy Community.

With their membership in the European Union, the Republic of Bulgaria, Romania and the Republic of Croatia ceased to be contracting parties of the Energy Community, while Armenia, Norway and Turkey participate as observers. In the previously described manner, regional connection in the energy sector is also enabled. What reasons influenced the establishment of the Energy Community for Southeast Europe?

The main reasons for the establishment of the Energy Community arose first at the level of the European Community. By developing the internal market for gas and electricity, the EU is starting to promote sustainable development and stability in Southeastern Europe. For these reasons, an initiative is being launched in which the need to institutionalize EU cooperation with SEE countries in the field of energy is being launched, in order to establish a unique legislative framework and to integrate the countries of the region into the Union's internal gas and electricity market.

The basis for cooperation in the field of energy policies was provided by: Directive 2003/54/EC (better known as the First EU Electricity Directive), which revised and repealed Directive 96/92/EC; Directive 2003/55/EC (known as the First EU Gas Directive), which revised and repealed Directive 98/30/EC.\textsuperscript{52}

The first agreement was reached in June 2002 and is known as the "Memorandum of Understanding on the regional electricity market in SEE and its inclusion in the EU internal electricity market" dated November 15, 2002. Not long after, the Athens process also included the gas market, with the adoption of the Athens Memorandum, which includes the issue of creating a regional gas market (from

\textsuperscript{51} Mirjana T. Radovanović, Energy security

\textsuperscript{52} https://www.mei.gov.rs/srl/obuka/e-obuke/kurs-sporazum-o-stabilizaciji-i-pridruživanju/energetska-zajednica-za-jugoistocnu-evropu/?fbclid=IwAR363PZMJLZXo70HRZG6eNIxUNbVS1UQ50XrBp9y3PnBG5n---782wYps

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December 8th, 2003), which laid the foundations for the further process of creating a pan-European electricity and gas market, i.e. conclusion of the Agreement on the establishment of the Energy Community.

The Treaty on the Establishment of the Energy Community creates the conditions for the creation of a single energy market, prescribes mechanisms for the operation of network markets, establishes the institutions of the Energy Community and determines the decision-making process within the Energy Community.

3.1. Goals of the Energy Community for Southeast Europe

There are numerous goals for which the Energy Community was formed. All of them were recognized by the European Council in Copenhagen in 2002, as well as in Thessaloniki in 2003 in the "Thessalonica Plan for the Western Balkans: on the road to European integration", then also within the process of the Euro-Mediterranean Partnership and the European Neighborhood Policy, as well as the Pact for stability in SEE and can, in principle, be divided into two groups.

One group consists of the general goals of interstate cooperation and the aspiration of the contracting parties to join the EU, and they include:

- Further strengthening of good-neighborly relations between the EU and Southeast Europe, which on the one hand enables the inflow of new investments and development of infrastructure in the countries of Southeast Europe, and on the other hand increases competition and diversification of EU supply sources;
- Creating a legally binding agreement for the development of the Southeast European energy market;
- Strengthening cooperation between the countries of Southeast Europe;
- Creating conditions for peace, stability and economic growth in the region. The second group consists of those goals related to energy and security of supply, environmental protection and competitiveness, which include:

- Creating an integrated and coherent natural gas and electricity market;
- Creation of integrated markets of other energy sources (especially liquid natural gas, fuel, hydrogen and other essential network infrastructures);
- Creation of a stable and uniform regulatory and market framework;
- Attracting investments in gas networks, power generation and energy transmission networks;
- Improving the state of the environment in the region in the context of the supply of energy and energy products, as well as encouraging the improvement of energy efficiency and the use of renewable energy sources and
- The development of a competitive energy market.  

3.2. Area of work of the Energy Community in accordance with the signed Agreement

The Founding Agreement consists of:

- Preambles;
- Twelve titles;

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53 https://www.mei.gov.rs/srl/obuka/e-obuke/kurs-sporazum-o-stabilizaciji-i-primrivanju/energetska-zajednica-zajugoistocnu-evropu/?fbclid=IwAR363PZMJLZXo70HRZGe65eNiIUNbVS1UQ50XrBp9y3PnBG5n--782wYps
Three annexes.

The first part of the text of the Agreement refers to the basic principles on which the activities of the Energy Community are based, as well as the tasks that it should perform in order to realize the established goals. The next part refers to the acquis communitaire in the field of energy, as well as in other related areas - environmental protection, competition and renewable energy sources.

It is precisely in this part that the first of the basic obligations of the contracting parties is foreseen, which is the implementation of the acquis communitaire in accordance with the defined time frame.

The next part concerns the creation of mechanisms for the operation of the grid energy market. Another basic obligation of the contracting parties is foreseen here, namely the establishment of a regulatory framework in this area. In addition to these two, the Agreement foresees a third basic obligation - the liberalization of the energy market.

3.3. Introduction of new legal regulations into the legislative framework of the Energy Community

The originally defined legal acquis included the regulation of electricity, gas, environmental protection, competition and renewable energy sources. With the need to strengthen the energy market and further develop regional cooperation and interconnection, the areas of activity of the Energy Community have expanded over time.

Nowadays, the Energy Community carries out activities in the following areas of energy policy:

a) Implementation of the common framework of legal acquis, which implies harmonization/harmonization of laws recognized by the Energy Community as those that will contribute to the achievement of the intended goals;
b) Electrical energy - which was primarily regulated and which led to the establishment of the Energy Community;
c) Gas - with a special emphasis on the development of gas infrastructure with the aim of security of supply;
d) Encouraging investments in the area of making plans for priority infrastructure projects in order to achieve set goals;
e) Security of supply of all available energy sources, taking into account diversification of supply, technological security and geographical origin of energy sources;
f) Renewable energy sources - i.e. their promotion with the goal of more economical production and consumption, as well as environmental protection;
g) Energy efficiency - provided for in Article 35 of the Agreement, which enables the adoption of measures for further development in this area;
h) Environmental protection in order to control pollution from the consequences of energy activities;

54 https://www.mei.gov.rs/srl/obuka/e-obuke/kurs-sporazum-o-stabilizaciji-i-pridruzivanju/energetska-zajednica-za-jugoistocnu-evropu/?fbclid=IwAR363PZMLZx070HRZGe56eNlXUNbVS1UQ50XrBp9yP3nBG5n---782wYps
i) Competition, especially in the field of state aid, and all with the aim of preserving the single market and attracting investors;
j) Social issues, with special reference to public health and
k) Oil - with special reference to the provision of mandatory oil reserves.

The Treaty on the Establishment of the Energy Community foresees the following institutions:
Council of Ministers, Secretariat, permanent high-level group. In addition to these basic institutions, there are also 4 forums: Electricity Forum, Gas Forum, Social Forum and Oil Forum.

The energy community adopts acts in the form of recommendations, decisions and procedural acts. 55

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Circular economy in the Western Balkans countries

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KEYWORDS - economy, western balkan countries, waste, gdp

ABSTRACT

Since the publication of the first report (Towards The Circular Economy, Ellen MacArthur Foundation) quantifying the possibility of a circular economy at the World Economic Forum in 2012, the idea has been embraced with remarkable speed. This model has captured the interest of business leaders, emerging innovators, governments and cities, designers and scientists around the world. The attractiveness of the idea may be due to the compelling logic and economic rationale of the circular economy, as well as its potential for value creation and competitive advantage. At the same time, the harmful effects of the one-way linear system of "take-make-waste" become fully apparent. By 2050, the size of global economies is predicted to increase fourfold, and the world's population is expected to increase by 10 billion, with developing markets accounting for two-thirds of global consumption. The negative impacts of the linear economy in terms of waste, pollution, depletion of finite resources, degradation of natural systems and climate change will (if the concept of business and human behaviour are not directed) be catastrophic (Lacy P. et al., 2020).

According to the United Nations (UN), the world's population will reach 9.2 billion by 2050⁵⁶. Half of the world's population (3.6 billion) is now considered middle class, which will increase to 5.3 billion by 2030. According to predictions, how life standard rises, so will consumption and demand for goods with more resources (e.g., meat, housing and vehicles). By 2030, global demand is expected to increase by 35% for food, 40% for water and 50% for energy. This competition for resources is set against a backdrop of persistent economic inequality and intensifying geopolitical tensions. Even as we have become more efficient at extracting value from raw materials, improvements have not kept pace with the rise in consumption. We consume about 1.75 times the capacity of the Earth, or 75% more natural resources than are renewed each year. Human's appetite for scarce resources is expected to grow in the coming decades. For example, production of mined metals is expected to increase by as much as 250% by 2030 to meet demand, and other commodities are under similar pressure. Nothing less will meet the urgency of the moment if the world is to achieve the UN's Sustainable Development Goals (SDGs) by 2030 and stay within the boundaries outlined in the Paris Agreement. (Lacy P. et al., 4, 2020).

⁵⁶ Lacy P. et al., The Circular Economy Handbook, https://doi.org/10.1057/978-1-349-95968-6_1
The Circular economy\textsuperscript{57} represents a model that is being obligated, if this generation would like to leave something for next generations, and this paper presents movement to circular model in the Western Balkan\textsuperscript{58} countries.

1 INTRODUCTION

Concerning to the economic, geopolitical status, the Western Balkans countries (WB) have Stabilisation and Association Agreements with the EU. WB is opening up trade and aligning the region with EU standards. The overall framework for the relations of the EU with the WB provides The Stabilisation and Association Agreements. The EU provides political as well as financial support for the countries of the region, fostering good neighbourly relations and building shared prosperity through regional integration. Addition its strong political support for the WB and the Berlin Process, the EU supports regional co-operation organisations, boosts economic development, improves connectivity, enhances security and many other benefits all over the region.

The leading trade partner for all Western Balkans is EU (cca.70\% of the region's total trade). In 10 years period (2011 to 2021), EU trade with the WB has grown by almost 130\%, while WB exports to the EU have increased by 207\%.

The Western Balkans partners are provided with political, financial and technical support, by EU, in order to help them in implementation of necessary reforms and align with EU regulations and rules.

Security challenges are also shared between regions. In crisis, the EU has shown solidarity with its Western Balkan countries (vaccines delivery).

Real GDP growth for WB countries presents that all the countries of the region had recession during 2020 (the biggest in Montenegro -15,3), and that predictions and forecasts for the years after that are years of region’s recovery (Table 1.).

Table 1. Western Balkans Outlook, 2019–2024, Real GDP growth (percent)

<table>
<thead>
<tr>
<th>Year</th>
<th>2019</th>
<th>2020</th>
<th>2021p</th>
<th>2022f</th>
<th>2023f</th>
<th>2024f</th>
</tr>
</thead>
<tbody>
<tr>
<td>Albania</td>
<td>2,2</td>
<td>-3,5</td>
<td>8,5</td>
<td>3,2</td>
<td>3,5</td>
<td>3,5</td>
</tr>
<tr>
<td>Bosnia and Herzegovina</td>
<td>2,8</td>
<td>-3,1</td>
<td>7,1</td>
<td>2,7</td>
<td>3,1</td>
<td>3,5</td>
</tr>
<tr>
<td>North Macedonia</td>
<td>3,9</td>
<td>-6,1</td>
<td>4,0</td>
<td>2,7</td>
<td>3,1</td>
<td>3,2</td>
</tr>
<tr>
<td>Montenegro</td>
<td>4,1</td>
<td>-15,3</td>
<td>12,4</td>
<td>3,6</td>
<td>4,7</td>
<td>3,7</td>
</tr>
<tr>
<td>Serbia</td>
<td>4,3</td>
<td>-0,9</td>
<td>7,4</td>
<td>3,2</td>
<td>2,7</td>
<td>2,8</td>
</tr>
<tr>
<td>WB 5 (averedge)</td>
<td>3,46</td>
<td>-5,78</td>
<td>7,88</td>
<td>3,08</td>
<td>3,42</td>
<td>3,34</td>
</tr>
</tbody>
</table>

Sources:
https://openknowledge.worldbank.org/bitstream/handle/10986/37368/P17720607706c30e90841607b7d53ee8106.pdf pg5, authors averedge WB5.

\textsuperscript{57} The circular economy is a model of production and consumption, which includes sharing, leasing, reusing, repairing, restoring and recycling existing materials and products as long as possible. In this way, the life cycle of the product is extended.” European Commission Environment: https://ec.europa.eu/environment/green-growth/index_en.htm [20.okt.2021.]

\textsuperscript{58} The Western Balkan countries include Albania, Bosnia and Herzegovina, Montenegro, North Macedonia and Serbia. Kosovo, as specific region, will not be a part of research.
WB countries are exposed to have both physical and transition risks in financial sector and firms due to the impact of climate change. Physical risks come from both the gradual and abrupt effects of climate change and natural disasters—such as droughts, floods, and hurricanes—on the value of real assets as well as their underlying financial instruments. Transition risks come from efforts of climate change mitigate and improving local environmental conditions by decarbonizing the economy. This may create economic adjustment costs in a great number of sectors. Financing and investment needs exceed not only the capacity of any public resources and national budgets but would require massive private financing for sustainable investments as well59.

2 CIRCULAR ECONOMY IN WB COUNTRIES

In the area of WB ½ of the total greenhouse gas emissions come from the extraction and processing of resources. The goal of climate neutrality is not possible to be achieved without transitioning to a circular economy. The heart of the European Green Deal is the new Circular Economy Action Plan representing the EU’s road map to climate neutrality. As circular economy model, in which value and resources are kept in the economy as long as possible, as well as waste generation is minimized, reduces pressure on natural resources, encouraging sustainable growth and job creation. This can make a decisive contribution to the decarbonization of the economy. Achieving circularity means taking measures to address the entire life cycle of a product (from its design and production to consumption, repair, reuse, recycling and returning resources to the economy). The key is preventing waste generation, but once waste is generated, it needs to be transformed into high-quality resources. The region must look for options to reduce resource consumption footprint and increase the rate of material recycling. This will boost economic growth, and should be done in full cooperation with stakeholders and business.

Western Balkans economies currently find themselves at the lower end of resource productivity, with values (cca 0.35 euro/kg) much below the EU average (cca 2.07 euro/kg)60. Current recycling rates in the WB are significantly lower (under 3%) when compared to the EU average (about 44%) (Mitorvić S., 2022).

From 2010 to 2020, the Western Balkans improved significantly in terms of innovation performance. But catching up with other European regions would require sustainable GDP growth of around 7% yearly. Currently, exports are still focused on medium and low-tech products, and innovation efforts mostly involve traditionally strong sectors. Although some economies of the Western Balkans are recording an increase in patent activity, the intensity of patenting in the region is still low, while, on the other hand, the production of scientific publications shows a stable growth trend. Effective innovation measures is essential and have to be implemented. Also, research and innovation systems in the region should continue to shift their focus towards businesses balancing public and private sector. Promoting a strategic green

59 More about this https://openknowledge.worldbank.org/bitstream/handle/10986/37368/pg.36,37
approach to public procurement will enable a more responsible and sustainable way of spending public money, support investment and can help level the playing field by ensuring that all bidders have to follow the same standards.

One of the WB projects in the field of circular economy is The ENV.net3 project. This project has been implemented since December 2017. For two years, the organizations participating in the project have been monitoring the progress of the transition from a "linear" to a "circular" economy. As a general observation, the term "circular economy" is somehow most familiar to those involved, but the meaning is often misunderstood. The general public is generally not aware of what this type of economy means, but there is a growing awareness that something needs to be done to improve the economy, and at the same time, the need to care for the environment and resources, where they come from, how they are used and how the used things are managed is recognized. The impact that this project will have until the end of implementation will be known at the end of 2020, when all activities for the promotion and advocacy of the circular economy concept in the wider community will be completed. The fact is that the story has spread not only to civil society organizations through advocacy, decision-makers increasingly see the need to harmonize and monitor the latest trends in the EU and UN structures, especially in the EU accession process and the possibilities of applying the "European Green Deal" and on countries of the Western Balkans and Turkey.

The biggest regional problem is waste, sustainable management, separation and recycling, so the concern is unjustifiably duplicated and equated with the circular economy. Nevertheless, civil society organizations in the region of the Western Balkans and Turkey are certainly the best partners for decision makers in the process of introducing the circular economy into the social and economic development of communities.61

Albania

Albania has started to set its goals in the area of circular economy through changes in legislation in the area of waste management or sustainable energy. Most of the changes are happening at the level of the private sector, but the development is very slow. One of the biggest challenges in the transition to a circular economy is the waste management system. It requires dramatic changes at the national and regional level in the area of infrastructure construction and material containment. The production of municipal waste in 2019 amounted to 1,200,000 tons, which represents 381 kg of municipal waste per inhabitant per year (90.4% managed and 9.6% unmanaged). The recycling rate was 18.7%, 78% of waste deposited in landfills, 2.4% of waste illegally dumped in uncontrolled areas, 0.9% of waste incinerated. 34% of the total amount of waste year is considered as recyclable. In Albania, there are seven legal landfills (not sanitary) and 285 (wild landfills) (Maleš, et al., 2020).

61 More about project: https://ambassadors-env.com/blog/2020/03/05/env-net-i-cirkularna-ekonomija-u-regionu-zapadnog-balkana-i-turske/ [20.06.2022.]
**Bosnia and Herzegovina**

Bosnia and Herzegovina mostly deals with illegal waste treatment and illegal landfills throughout the country. There is a great desire to start the process of waste prevention and waste sorting in order to preserve the beautiful nature of this country for future generations.

Residents of Bosnia and Herzegovina produce about 354 kg of municipal waste per capita. The recycling rate is at a low level and amounts to 0.29%. Waste in legal landfills represents 75.6%, and waste in illegal landfills 23.9%, sanitary landfills: 7 (47% of habitats covered by services) Sarajevo, Tuzla, Zenica, Bihać, Banja Luka, Bijeljina (one in Mostar is not yet working ). There are 84 municipal unregulated landfills, and according to the data of the Agency for Statistics (CSOs counted over 1100 illegal landfills), there are over 850 illegal landfills throughout Bosnia and Herzegovina. Recyclable materials: paper, plastic, glass - collected by private companies and mostly exported (a small percentage is used for recycling and reuse) (Maleš, et al., 2020).

**North Macedonia**

In order to comply with the program that encourages the circular economy model, the Republic of North Macedonia will have to minimize the original waste and improve the recycling rate of used products. There is also a strong interest in reducing food waste. The production of municipal waste in 2019 amounted to an average of 456 kg per inhabitant. It increased by 10.7% compared to 2018. Municipal waste is waste collected by or on behalf of municipal authorities. It consists of household waste, including bulky waste, similar waste from commercial and trade industries, from official buildings, institutions and small businesses, garden waste, street waste, contents of waste containers and market cleaning waste. The State Bureau of Statistics collects data on the amount of collected waste through the annual reports of municipal public enterprises. Data on generated waste are calculated based on the estimate. Therefore, the amounts of municipal waste generated per capita in the period from 2010 to 2019 are taken as estimates (Maleš, et al., 2020).

Of the total amount of municipal waste collected, 522,983 tons or 83% were collected from households, and the remaining 17% from legal and natural persons (commercial waste). According to the type of waste, the largest amount of collected waste is mixed municipal waste - 542,664 tons or 85.8% - and the smallest amount is rubber waste, which is 778 tons or 0.1% of the total amount of collected waste. Regarding the total collected municipal and other non-hazardous waste in 2019, only 0.7% was reported as processed (composted waste, recycled paper, cardboard, glass, plastic and metal), which again shows a growing tendency compared to 0, 28% in 2013 (Maleš, et al., 2020).

**Serbia**

Activities in the field of circular economy until 2017 in Serbia are presented in the "National Profile of Serbia 2018", this profile was prepared by the Environmental Protection Agency of the RS at the request of the European Environment Agency
Serbia’s Environmental Protection Agency (SEPA) is in charge and responsible for reporting on the state of the environment in the Republic of Serbia (SOER), and reporting is based on the National List of Indicators (NLI), adopted in 2011.

The Group for Circular and Green Economy at the Ministry of Environmental Protection was established in November 2018, and in 2019 a multi-sectoral working group for circular economy was established (representatives of 17 different institutions, ministries and other relevant organizations). There is still no separate strategic document on the circular economy in Serbia, but documents that support the implementation of this model.

The strategy for the development of the energy sector of the Republic of Serbia until 2025 with projections until 2030 represents the goals for the development of the energy sector: provision of energy security, development of the energy market and overall transition to a sustainable energy sector (according to the recommendations of the European Commission on circular economy, amendments to the Law on Waste Management adopted in January 2016, it was possible to support the concept of a circular economy, thereby creating green jobs), Amendments to the Law on Waste Management introduce the concepts of "by-product" and "end-of-waste status". The law regulates the procedures and conditions under which a substance receives the status of a by-product, as well as the conditions and procedures under which waste can be given the status of "end of waste" and can be used as a raw material." (Mihajlov A., et al. 22., 2019).

Since 2007, dozens of projects have been implemented, both in the national and in the new Autonomous Province of Vojvodina, with the aim of implementing the circular model in the economic activity of the Republic of Serbia. Some of the project holders are the Center for Cleaner Production of Serbia, UNDP, National Operator for Serbia is represented by the Ambassadors of Sustainable Development and the Environment (AORŽS), OSCE, GIZ, Tetrapak...

The concept of the circular economy in Serbia is still in its early stages, the implementation of the circular economy in Serbia was primarily in the waste management sectors (early implementation phase of the CE model), but this model is also changing in other economic sectors (food production, catering, trade...)..

Local self-government units, incorporating the principles of circular economy and creating an environment in the direction of the development of economic entities in circular supply chains, and they are considered circular. Circular cities would aim to establish a waste generation system reduced to the smallest possible extent or completely eliminated, assets retain their value in the long term, products and materials remain in circulation, and the environment and urban environment retain their values and characteristics, so that they are available for the future generations (Glušević, Kaluderović, 2019).

The goals set in the Waste Management Strategy for the period 2010-2019. in Serbia, have not been fully achieved, primarily in the scope of organized waste collection, the level of primary waste separation and recycling, the construction of infrastructure and the cessation of waste disposal in unsanitary landfills and landfills, the application of economic instruments and the establishment of a sustainable waste management financing system. Given that these goals have not been achieved and in
the meantime new EU goals have been set in the field of waste management as part of the "green transition" for the transition to a circular economy in the EU, it is necessary to set new goals in the field of waste management in the Republic of Serbia. The general goals stated in the first Program are the development of a sustainable waste management system for the purpose of preserving resources and reducing negative impacts on the environment, human health and the degradation of space.62

3 CONCLUSION

By the Sofia Declaration on the Green Agenda for the Western Balkans from 2020, the countries of the Western Balkans have undertook to implement measures in the field of climate change and pollution prevention, energy development, transport and circular economy, as well as biodiversity development, sustainable agriculture and food production. The countries of the Western Balkans should develop national strategic documents for the circular economy, taking into account waste prevention, the entire life cycle of products, modern waste management and waste recycling, reuse, repair and remanufacturing; achieve further progress in the construction and maintenance of waste management infrastructure for cities and regions, design and implement programs to raise awareness among citizens about waste, separate collection and sustainable consumption, as well as to conclude and implement a regional agreement on the prevention of plastic pollution.

The countries of the Western Balkans and its citizens have the task of enacting and implementing strategic documents and implementing plans aligned with the concept of circular economy in order to solve not only the problem of waste management, but also to raise the awareness of the population on the rational use of resources and concern for the future of the region and the planet.

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