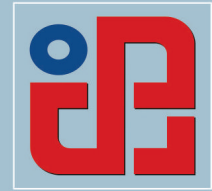




University of Novi Sad  
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**CIRCULAR ECONOMY AND  
ENVIRONMENTAL LABELLING**

**CEEL 2021**

**BOOK OF ABSTRACTS**

Visegrad+ Grant No. 21920002

**INNOVATIONS IN CIRCULAR ECONOMY –  
ENVIRONMENTAL LABELS AND DECLARATIONS**

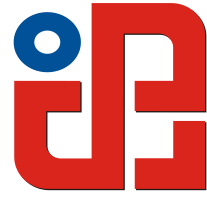
Novi Sad, 29th January 2021





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First Scientific Conference with International Participation

**CIRCULAR ECONOMY AND  
ENVIRONMENTAL LABELLING**

**CEEL 2021**

**BOOK OF ABSTRACTS**

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Novi Sad, 29<sup>th</sup> January 2021

BOOK OF ABSTRACTS FOR THE SCIENTIFIC CONFERENCE WITH INTERNATIONAL  
PARTICIPATION  
**CIRCULAR ECONOMY AND ENVIRONMENTAL LABELLING**  
**CEEL 2021**  
**Novi Sad 2021**

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**CEEL 2021**

**SCIENTIFIC CONFERENCE WITH INTERNATIONAL  
PARTICIPATION  
NOVI SAD, SERBIA, 29<sup>TH</sup> JANUARY, 2021**

**CIRKULARNA EKONOMIJA I OZNAČAVANJE O ZAŠTITI ŽIVOTNE SREDINE  
CIRCULAR ECONOMY AND ENVIRONMENTAL LABELLING**

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**NOVI SAD, SERBIA, 29<sup>TH</sup> JANUARY, 2021**

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## ***Predgovor***

*Naučna konferencija sa međunarodnim učešćem CIRKULARNA EKONOMIJA I OZNAČAVANJE O ZAŠTITI ŽIVOTNE SREDINE - CEEL 2021 organizovana je u okviru međunarodnog projekta Inovacije u cirkularnoj ekonomiji – označavanje o zaštiti životne sredine (Ecolabelling) finansiranog od strane Višegradskog fonda (Innovations in circular economy – environmental labels and declarations, Visegrad 21920002, 2019-2021). Cilj Ecolabelling projekta je povećanje socijalnog znanja o oznakama o zaštiti životne sredine, razvoj edukativnih koncepta i alata za visokoškolske ustanove, objavljivanje naučnih radova, organizovanje naučnih konferencija i trening predavanja. Konzorcijum Ecolabelling projekta sastoji se od visokoškolskih institucija iz četiri zemlje Višegradske grupe (Poljska, Slovačka, Češka i Mađarska) i Srbije. Tehnički univerzitet Rzeszów iz Poljske je zadužen za koordinaciju projekta, a partnerske institucije su Tehnički univerzitet iz Košica, Institut tehnologije i biznisa iz České Budějovice, Széchenyi István univerzitet Audi Mađarska i Fakultet tehničkih nauka sa Univerziteta u Novom Sadu. Ecolabelling projekat je započet 2019. godine i završava se 2021. godine, a aktivnosti projekta i rezultati istraživanja su dostupni na <https://ecolabelling.w.prz.edu.pl/en/>.*

*Kao što je to koncipirano u cilju Ecolabelling projekta, konferencija je osmišljena kao podsticaj istraživanju u oblasti cirkularne ekonomije i u cilju podizanja svesti o označavanju o zaštiti životne sredine. Konferencija CEEL 2021 je strukturirana u dve tematske celine:*

- 1. Cirkularna ekonomija i zaštita životne sredine i*
- 2. Cirkularna ekonomija i označavanje o zaštite životne sredine.*

*Prva tematska oblast obuhvata istraživanja i inovacije u multidisciplinarnim oblastima cirkularne ekonomije i zaštite životne sredine. U drugoj tematskoj oblasti izloženi su rezultati istraživanja vezanih za označavanje o zaštite životne sredine, kao i rezultati istraživanja realizovanih u okviru Višegradskog projekta – ankete na nacionalnom nivou o označavanju o zaštiti životne sredine država Poljske, Slovačke, Češke, Mađarske i Srbije.*

*Na konferenciji CEEL 2021 prezentovano je ukupno 21 naučna apstrakata od strane više od 50 autora i koautora iz akademskih institucija i privrede iz šest evropskih zemalja: Poljske, Slovačke, Češke, Mađarske, Bosne i Hercegovine i Srbije.*

## ***Foreword***

*Scientific conference with international participation CIRCULAR ECONOMY AND ENVIRONMENTAL LABELING - CEEL 2021 was organized within the international project Innovations in circular economy – environmental labels and declarations (Ecolabelling) funded by the Visegrad Fund (Visegrad grant No. 21920002, 2019-2021). The goal of the Ecolabelling project is to increase social knowledge about environmental labels, develop educational concepts and tools for higher educational institutions, publish scientific papers, organize scientific conferences and train lectures. The consortium of the Ecolabelling project consists of higher educational institutions from four countries of the Visegrad Group (Poland, Slovakia, the Czech Republic and Hungary) and Serbia. The Technical University of Rzeszów in Poland is in charge of coordinating the project, and the partner institutions are the Technical University of Košice, the Institute of Technology and Business of České Budějovice, Széchenyi István University of Audi Hungary and Faculty of Technical Sciences of the University of Novi Sad. The Ecolabelling project started in 2019 and ends in 2021, and the project activities and research results are available at <https://ecolabelling.w.prz.edu.pl/en/>.*

*Following the purpose of the Ecolabelling project, the conference is designed to advance research in the field of circular economy and to raise awareness of environmental labelling. The CEEL 2021 conference is structured in two thematic sections:*

- 1. Circular economy and environmental protection and*
- 2. Circular economy and environmental labelling.*

*The first thematic area includes research and innovations in multidisciplinary fields of circular economy and environmental protection. In the second thematic area, the results of research related to environmental labelling are presented, as well as the results of research conducted within the Visegrad project - a national survey on environmental labelling in Poland, Slovakia, Czech Republic, Hungary and Serbia.*

*At the CEEL 2021 conference, a total of 20 scientific abstracts were presented by more than 50 authors and co-authors from academic and business institutions from six European countries: Poland, Slovakia, Czech Republic, Hungary, Bosnia and Herzegovina and Serbia.*

*Novi Sad, January 2021      PROGRAMME AND ORGANIZING COMMITTEE*

**CEEL 2021**

**SCIENTIFIC CONFERENCE WITH  
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SCIENTIFIC CONFERENCE WITH INTERNATIONAL  
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BOOK OF ABSTRACTS

**Session 1:**  
**CIRCULAR ECONOMY AND ENVIRONMENTAL  
PROTECTION**

Chairman (session 1a):

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Novi Sad, 29<sup>th</sup> January 2021

## **ISO STANDARDIZATION IN SERBIA AND POLAND AS THE INDICATOR OF INNOVATION ACTIVITY IN CIRCULAR ECONOMY**

Marzena Hajduk-Stelmachowicz<sup>1</sup>

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**Abstract:** The level of standardisation is taken into consideration as one of the indicators of sustainable development in the circular economy. This elaboration aims to test the links between the components of the innovation index of an economy according to the European Innovation Scoreboard, and the added features that regulate the innovation level in Poland and Serbia (with particular consideration given to those indices which refer to the index of the number of ISO certification: environmental management systems, energy management systems, quality management systems, information management systems, food safety management systems, medical devices – quality management systems). Applied methodologies: the analysis of the correlations, the mid-rank method, the Ward's method and the Kruskal-Wallis ANOVA test. Serbia and Poland are very similar to each other in terms of certain features that determine the innovation performance. All the indicators such as innovation dimensions (ISO 9001, ISO 14001, ISO 27001, ISO 50001, ISO 22000, ISO 13485, Human Resources, Research systems, Innovation - friendly environment, Finance and support, Firm, Investments, Innovators, Linkages, Intellectual assets, Employment impacts, Sales Impacts) in Poland and Serbia are well below the average level (they oscillate around half of this level). Only one indicator connected with the ISO 22000 certification is near to the average. At a level which reaches more or less two-thirds of the average is the frequency of certification based on ISO 14001, ISO 9001 and ISO 27001. The levels of indicators referring both to the certification of ISO 13485 and ISO 50001 are at a level which approximates 1/3 of the average value. When comparing Poland and Serbia to the other countries, it is important to notice that it is actually this group of countries in which the level of the Innovators indicator is the lowest

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(0.39). The similar situation like in Poland and in Serbia is in Bulgaria, Romania, Ukraine, Croatia, The Former Yugoslav Republic of Macedonia and in Turkey.

**Key words:** ISO norms, innovation activity index, ISO 14001, ISO 50001, ISO 27001

## ENERGIJSKO CERTIFICIRANJE OBJEKTA STUDENTSKOG CENTRA ZENICA PRIMENOM SOFTVERA KI EXPERT PLUS

Nusret Imamović<sup>1</sup>, Vehid Birdahić<sup>1</sup>, Muvedet Šišić<sup>1</sup>

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**Apstrakt:** U radu je predstavljena metodologija obavljanja energijskog audita i izrade energijskog sertifikata na objektu Studentskog centra u Zenici, u cilju utvrđivanja postojećeg stanja sa aspekta energijske efikasnosti i definisanja mera za njegovo poboljšanje. Nakon završenog energijskog audita, ažurirani podaci su uneseni u softverski paket KI Expert Plus, pomoću kojeg je proračunato i modelirano stanje objekta te uneseni podesni scenariji mera za poboljšanje energijske efikasnosti i uštedu energije. Proračunom je utvrđeno sledeće: zid prema tlu ima jako visok koeficijent provođenja toplote 2,53 W/m<sup>2</sup>K (maksimalno dozvoljeni koeficijent 0,40 W/m<sup>2</sup>K), najveći toplotni gubici su u zimskom periodu (za januar  $Q_{ht}=73,08$  kWh) a najmanji u letnom periodu, najveći toplotni dobici (korištenje energije iz solarnih izvora) su u mesecu julu ( $Q_{sol}=42,24$  kWh), emisije CO<sub>2</sub> nastaju isključivo kao posledica sistema daljinskog grejanja, termotehnički sistemi ne zadovoljavaju potrebnu količinu energije. Predložene mere za poboljšanja energijske efikasnosti su: promena sistema grejanja, značajnije korištenje energije iz obnovljivih izvora, poboljšanje termoizolacije građevnih delova (krovnna konstrukcija, terasa, zid prema tlu), ugradnja regulatora mlaza vode za slavine i tuševne. Na osnovu dobivenog energijskog sertifikata, zaključeno je da bi stanje objekta sa aspekta energijske efikasnosti nakon provedenih predloženih mera bilo značajno poboljšano, čime bi se upotpunio celokupni ugođaj boravka studenata i osoblja u ovom objektu, te postigle značajne finansijske uštede i smanjenje ukupne potrošnje energije.

**Ključne reči:** energijsko certificiranje, KI Expert Plus, energijska efikasnost.

## **CHARACTERIZATION OF WASTE COMPUTER PROCESSORS AND PROPOSAL OF THE METALS VALORIZATION PROCESS**

Andjela Milošević<sup>1</sup>, Željko Kamberović<sup>1</sup>, Vaso Manojlović<sup>1</sup>, Jovana Djokić<sup>2</sup>, Nataša Gajić<sup>3</sup>

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**Abstract:** Given the constant development of the high-tech industry, consumer-oriented societies, and reduced electronic equipment's lifespan, the outcome of growth and accumulation of waste is inevitable. Yet, specific electronic equipment components, such as central processing unit (CPU), are carriers of valuable metals, primarily precious, so waste electronic equipment becomes of recyclable interest. However, inadequate technological processing, particularly in the informal recycling sectors, leads to valuable metals losses. This approach has a negative economic and environmental impact: valuable material is usually considered as waste and landfilled with metals trapped in it, while because of increasing demand, metals are being exploited from natural resources. In this sense, there is an unquestionable need for an innovative recycling approach and adequate waste management that would lead to i) the decrease of natural exploitation, ii) the removal of waste accumulated in the environment, and iii) better utilisation of material flows. The aim of this paper is an evaluation of the potential of waste CPU acid leaching residue as secondary material and the proposal of the innovative design of an adequate technological process for CPU recycling and recovery of valuable metals while minimising their loss. The first part of the study included the characterisation of the CPU acid leaching residue. Results of the research point out that precious metals content is significant, and material could be further exploited as secondary raw material. However, further optimisation of process parameters is needed to achieve the most efficient

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valorisation. A conceptual proposal of the technological scheme for metal recovery is given in the second part, considering two approaches: hydro- and pyrometallurgical methods. An innovative approach for recycling and waste management can contribute to the ultimate goal nowadays globally set as an imperative: achieving a circular economy through improved material flows management.

**Keywords:** electronic waste, central processing unit, recycling, precious metals, circular economy

## **SELF-DRIVING CAR AND LEGAL REGULATION**

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**Abstract:** The self-driving cars (SDC), which represent the fifth level of autonomous vehicles according to the standard of the Society of Automative Engineers SAE, would be used on public roads soon. Although the automatising and artificial intelligence of the vehicle is already technically solved, important problems based on legal regulation are still open. In this paper, some of them would be mentioned and suggestion for their solving is offered. To write cohesive laws for SDC is very difficult and even impossible, as there is not a unification in transportation and also in road traffic. Besides, the navigation of the SDC requires a significant number of private data of the passenger. The annexe to GDPR has to be prepared to give privacy barriers and data protection. Protocols for protection of user's privacy have to be established and the producer of SDC has to be aware of them. The key question is how legal to regulate the traffic accident done by SDC. The responsibility of the vehicle producer and the in-built software or hardware has to be determined. Besides, the question is whether the data applied for SDC can be used for this type of legal evidence. At the other side, legal regulation for forming corresponding digital infrastructure is necessary to prevent the SDC of hackers and to increase the level of cybersecurity.

**Key words:** self-driving car, cyber security, data protection, GDPR, traffic accident, law

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## **ADSORPCIJA KORISNIH METALA IZ KONDENZATA DOBIJENOG VAKUUM PIROLIZOM BATERIJA NA ALUMOSILIKATNIM MINERALIMA**

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**Apstrakt:** Baterije su jedan od najčešće korišćenih izvora energije. Međutim, nakon upotrebe, one predstavljaju ekološki problem. Kao rešenje, nameće se reciklaža kojom iskorišćene baterije postaju sekundarni izvori korisnih metala što njihovu proizvodnju čini ekonomski značajno isplativijom. Da bi se postupak reciklaže prilagodio očuvanju životne sredine neophodno je pronalaženje ekološki prihvatljivih i efikasnih postupaka. Kao moguće rešenje nameće se postupak kojim bi se, nakon vakuum pirolize baterija, korisni metali vezali na odgovarajući adsorbent te ponovo iskoristili. Kao adsorbenti ispitani su alumosilikatni minerali: lako dostupan i ekonomski isplativ prirodni zeolit ležišta Zlatokop, Vranjska Banja, i sintetički zeolit A, dobijen laboratorijskom sintezom iz otpadnog letećeg pepela deponije termoelektrane Morava, Svilajnac. Rendgenskom difrakcijom praha potvrđeno je da sintetisani uzorak pripada strukturnom tipu LTA, odnosno zeolitu A, kao i da u zeolitnom tufu dominira klinoptilolit, najzastupljeniji prirodni zeolit. Ispitivanjem termičkih svojstava pokazno je da su oba zeolita stabilna do 800 °C. Efikasnost adsorpcije ispitana je iz višekomponentnog kondenzata u kome su bili prisutni joni Cd(II), Pb(II) i Hg(II). Dobijeni rezultati pokazali su da prirodni zeolit ima najveći afinitet prema kadmijumu (98%), zatim prema olovu (65%) i živi (45%). Jedino u slučaju žive brzina mešanja pozitivno utiče na stepen adsorpcije. Zeolit A pokazao je maksimalnu efikasnost (100%) u odnosu na olovo(II) i kadmijum(II), dok živu(II) nije vezao što bi se moglo pripisati kompeticiji prisutnih jona u rastvoru, manjoj specifičnoj površini, kao i manjem kapacitetu katjonske izmene u poređenju sa prirodnim zeolitom. Podaci dobijeni ispitivanjem kinetike adsorpcije pokazali su da se maksimalna efikasnost ostvaruje za vrlo kratko vreme korišćenjem kako prirodnog, tako i zeolita dobijenog iz

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otapadnih sirovina čime je moguće valorizovati korisne metale iz istrošenih baterija i na taj način produžiti njihov vek trajanja.

**Ključne reči:** baterije, reciklaža, zeolit, adsorpcija

## **CIRCULAR ECONOMY OF POLYMERIC MATERIALS**

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**Abstract:** Plastic pollution is one of the key environmental problems of the present. The major problem is influenced by single use packaging like plastic bags, foils, films, cups, straws and similar products, which are made from non-degradable fossil-based polymer materials, with linear end-of-life. These products are likely to be found anywhere in nature and huge amounts end in the oceans, affecting their flora and fauna. Many efforts are put for overcoming this problem, including laws, strategies and many other initiatives. This work is summarising the current state of the art in the field of circularity of polymeric materials and making the comparison between EU and Serbian market.

**Key words:** plastic pollution, polymeric materials, circular economy, strategy

## **PAKOVANJE OPASNIH MATERIJIA U PROPISANU AMBALAŽU**

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**Apstrakt:** Bez obzira na opasnosti koje prouzrokuju, opasne materije nalaze sve veću primenu kako u privredi, tako i u svakodnevnom životu. Godišnje se proizvode značajne količine opasnih materija i time stvaraju visoki rizici po život i zdravlje ljudi, životnu sredinu i materijalna dobra. Jedan od načina za smanjenje rizika je upotreba sertifikovane ambalaže za pakovanje opasnih materija. Standardi koje mora ispuniti ambalaža za opasne materije prevazilaze zahteve koji se postavljaju pred transport drugih vrsta robe. Neophodno je ispuniti sve bezbednosne zahteve definisane u odgovarajućim pravnim aktima koji se odnose na pakovanje, transport i distribuciju ove vrste robe. U oblasti pakovanja opasnih materija to se odnosi na upotrebu odgovarajuće ambalaže za datu materiju, ocena usaglašenosti i periodično kontrolisanje ambalaže, kao i adekvatno obeležavanje i označavanje ambalaže.

**Ključne reči:** sertifikovana ambalaža, opasne materije, obeležavanje i označavanje ambalaže.

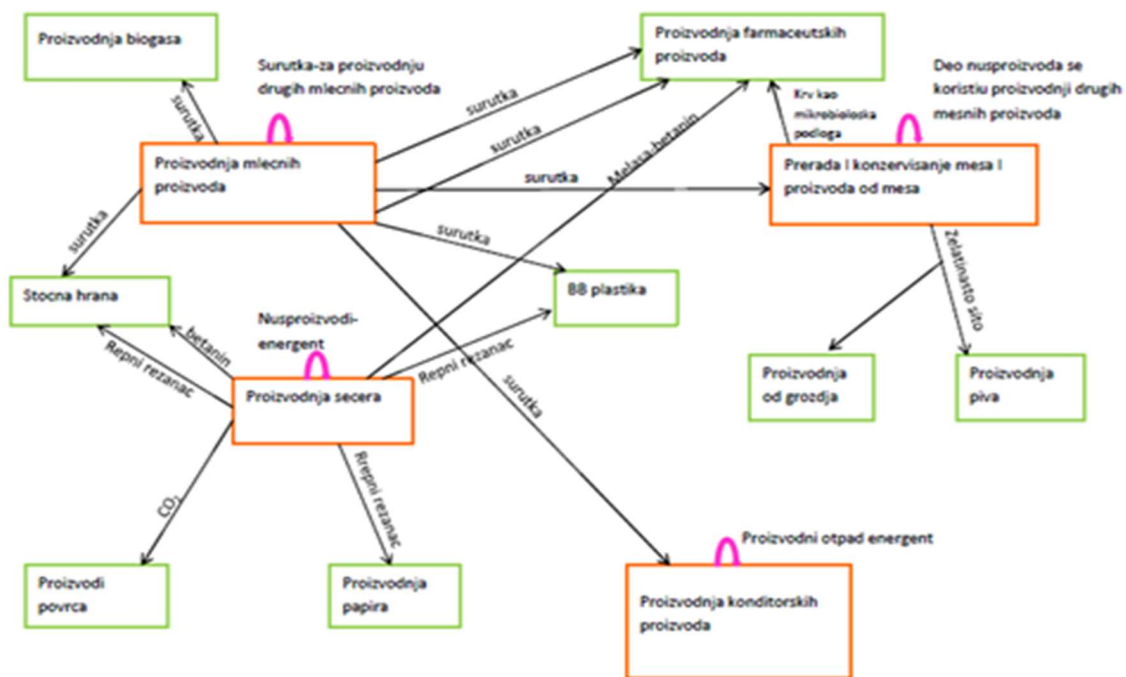
## **PRILOG KONCEPTU CIRKULARNE EKONOMIJE ODREĐENIH FABRIKA NA TERITORIJI OPŠINE VRBAS**

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**Apstrakt:** Jedna od oblasti prerađivačke industrije u okviru koje nastaju značajne količine otpada i nusproizvoda je proizvodnja prehrambenih proizvoda i pića. Otpad (reziduali) koji nastaju u prehrambenoj industriji sadrže značajne količine organske komponente, sa visokom nutritivnom vrednošću (npr. surutka, melasa itd.), te se kao takvi mogu iskoristiti u drugoj prerađivačkoj industriji (ili npr. proizvodnji stočne hrane), što bi imalo pozitivne ekološke efekte, kako smanjenja otpada koji se odlaže na deponije, tako i smanjenje ekonomskog utroška za samu industriju. Ono što je karakteristično za opštinu Vrbas je upravo prehrambena industrija. Zastupljene grane prehrambene industrije u opštini su: industrija mesa, industrija mleka i mlečnih proizvoda, industrija šećera i industrija konditorskih proizvoda. Rad će dati uprošćen prikaz mogućnosti povezivanja inputa i outputa industrija u ovom regionu poznatom kao vrlo nepovoljnom sa aspekta zagađena Velikog Bačkog kanala. Pored opšte poznatih zadataka cirkularne ekonomije jednostavne inovacije u proizvodnji u ovom regionu bi delimično doprinele i smanjenju opterećenja ovog gotovo potpuno devastiranog vodotoka. Analizirane su četiri ključne oblasti prehrambene industrije: mesna industrija, industrija mleka, proizvodnja šećera i proizvodnja konditorskih proizvoda sa aspekta analize uticaja njihovog rada na životnu sredinu, a potom je dat i načelni predlog o mogućnosti protoka nusproizvoda i otpada među ovim preduzećima.



**Ključne reči:** prehrambena industrija, cirkularna ekonomija, opština Vrbas

## POTENCIJAL IMPLEMENTACIJE PRINCIPA CIRKULARNE EKONOMIJE U TEHNOLOGIJU PROIZVODNJE BIOLOŠKIH AGENASA NA TERITORIJI AP VOJVODINE

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**Apstrakt:** Prema podacima Ministarstva zaštite životne sredine princip cirkularnosti na svetskom nivou iznosi svega 9%. U Srbiji je potencijal za tranziciju sa linearnog na cirkularni model proizvodnje u industriji veliki, ali zahteva uključivanje akademske zajednice kroz inovacije. S druge strane, potencijalne opasnosti upotrebe sintetičkih hemijskih preparata za zaštitu bilja uzroci su rastućeg interesa naučne, stručne i šire javnosti za razvoj bioloških agenasa za zaštitu poljoprivrednih useva. Postoje primeri visoko efikasnih bioloških agenasa čija proizvodnja nije zaživele u praksi usled nekonkurentnosti. Stoga je predmet ovog istraživanja analiza potencijala implementacije principa cirkularne ekonomije u tehnologiju proizvodnje bioloških agenasa sa ciljem razvoja tehnološki održive proizvodnje čija bi komercijalizacija imala uticaj na bezbednost hrane, očuvanje životne sredine kao i uvećanje konkurentnosti poljoprivrednog i prehrambenog sektora. S tim ciljem ispitani su različiti izvori ugljenika odnosno glukoza, saharoza, laktoza, skrob i glicerol kao nutrijenti za biosintezu bioloških agenasa pomoću različitih izolata soja *Bacillus*. Ovi izvori ugljenika se najčešće nalaze u sastavu industrijskih otpadnih tokova te su analizirani kako bi se procenio potencijal primene otpadnih tokova iz prerade voća i povrća, proizvodnje vina, prerade šećerne repe, industrije mleka, prerade žitarica i krompira kao i industrije biogoriva u tehnologiji proizvodnje bioloških agenasa. Rezultati ovih istraživanja ukazuju da otpadne tokove velikog dela industrijske proizvodnje AP Vojvodine ne treba tretirati kao balast, već da oni predstavljaju značajan potencijal kojim raspolazemo. Dokazana mogućnost njihove primene kao sirovine za biotehnošku proizvodnju ukazuje da uz opravdana materijalna ulaganja, one mogu biti osiromašene u pogledu organskih i neorganskih izvora zagađenja uz istovremeni nastanak proizvoda sa dodatom vrednošću. Takođe, održiva proizvodnja bioloških agenasa uz minimizaciju troškova proizvodnje obezbeđuje nižu cenu konačnog

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proizvoda čime se prevazilazi ovaj ograničavajući faktor njihove široke praktične primene. Primena bioloških agenasa u zaštiti bilja rezultovala bi plasmanom zdravstveno bezbednih plodova na tržište, koji ostvaruju višu cenu i veći izvozni potencijal.

**Ključne reči:** valorizacija otpada, biološki agensi, biotehnoška proizvodnja, zaštita bilja

**Zahvalnica:** Istraživanja iz okvira ovog rada realizovana su uz finansijsku podršku Pokrajinskog sekretarijata za visoko obrazovanje i naučnoistraživačku delatnost u okviru kratkoročnog projekta od posebnog interesa za održivi razvoj AP Vojvodine „Implementacija principa cirkularne ekonomije u tehnologiju proizvodnje bioloških agenasa“ broj 142-451-3243/2020-03.



## CIRKULARNA EKONOMIJA NA PRIMERU PROIZVODNJE ZUPČASTIH PUMPI

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**Apstrakt:** Zupčaste pumpe, sa spoljnim evolventnim ozubljenjem, karakteriše jednostavno konstruktivno rešenje, pouzdan i dug radni vek. Literaturni podaci i vlastito iskustvo pokazuju da se njima, kao izvorima pogonske energije, rešava više od 80% potreba u industriji. Njihova primena dobija na značaju mogućnošću ostvarivanja servo pogona tj. sa ugradnjom frekventnih regulatora. Samim time će potreba za njima i dalje biti još značajnija, pa se iz tog razloga mora voditi računa o smanjenju svih proizvodnih troškova a smaim time i optimizirati njihova proizvodnja. Proizvodnja zupčastih pumpi, danas, se slobodno može smatrati pravim primerom zadovoljenja zahteva cirkularne ekonomije. Analizom stepena iskorišćenja materijala tj. odnosa težine gotovog i sirovog dela daće se trenutno stanje i predlog mera za smanjenje otpadnog materijala u proizvodnji svih njenih delova. Time će se, pored zadovoljenje zahteva “4E”, težiti ispunjenju i zahteva “6R”. On se odnosi na promenu načina razmišljanja i racionalnu upotrebu resusu, tj njihovo smanjenje i ponovno vraćanje sirovine u novu proizvodnju, kroz proces reciklaže. Analiziraće se proizvodnja zupčastih pumpi u PPT – Hidraulika AD u Trsteniku, poznatog proizvođača istih već više od 70 godina. To je, možda jedini uređaj koji po svojim tehničkim karakteristikama ne zaostaje od konkurencije, tj. svetski poznatih proizvođača istih. Međutim, evidentni su problemi u velikoserijskoj proizvodnji i samostalnom plasmanu u uslovima značajnog prisustva konkurencije.

**Ključne reči:** zupčasta pumpa, težinski odnosi, cirkularna ekonomija, ekologija, efikasnost, ekonomija, racionalno iskorišćenje resursa

## **INVESTICIJE U UPRAVLJANJE ČVRSTIM OTPADOM U SRBIJI**

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**Apstrakt:** Problem uspostavljanja efektivnog sistema upravljanja čvrstim otpadom kompleksan je i još uvek nerešen u srpskim opštinama, gradovima i naseljenim mestima. Većina deponija u Srbiji ne zadovoljava osnovne sanitarne standarde i na njima se često može naći i otpad opasan po život i zdravlje ljudi, biljaka i životinja, a često se baca i otpad koji je moguće reciklirati. I pored usvojene Strategije upravljanja otpadom, Srbija se i dalje bori sa ekološkim problemima, a manjak društvene svesti i nedovoljna privatna ulaganja u zaštitu životne sredine mogući su uzročnik ovih problema. Cilj ovog rada je sagledavanje odnosa između generisanja otpada i privatnih investicija u upravljanje istim. Veliki je broj naučnih istraživanja koja su se bavila analizom pomenutog odnosa, ali oskudan je broj takvih istraživanja na primeru Srbije. Rezultati istraživanja mogli bi biti od koristi državnim upravama Republike Srbije.

**Ključne reči:** investicije, komunalni otpad, generisanje otpada, korelaciona analiza

**PROTECTIVE DISPOSABLE FACE MASKS -EFFECTIVE  
EQUIPMENT AGAINST COVID-19 TRANSMISSION: A  
POTENTIAL SOURCE OF POLLUTION OF THE ENVIRONMENT  
AS PART OF CRITICAL INFRASTRUCTURE**

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**Abstract:** According to the current situation, the year 2020 was certainly marked by the COVID-19 outbreak, which is still spreading to the entire world. This catastrophic event caused many infected people, diseased and dead, regardless of gender, age, the material standard, and status. The World Health Organization has recommended disposable protective masks as the most effective device against virus transmission. This has increased the production and use of disposable protective masks worldwide. Considering that disposable protective masks are produced from a wide range of polymeric materials, we can already assume that COVID-19 will be a long-term challenge for future generations, which will impact environmental safety. COVID-19 is not just a virus that threatens human health. It represents a genuine threat to the ecosystem, which is reflected in the pollution of land and waterways, as a consequence of the inadequate recycling process. This paper aims to review the potential implications of microplastic pollution on the environment as part of critical infrastructure. In this paper, the authors analysed the use of disposable face masks in major cities in Serbia according to the number of daily usages of population. Based on the results of the research, the authors at the end of research gave opinions, recommendations, and suggestions for implementing a strategy recycling and disposing of medical masks and reducing environmental pollution to a minimum during COVID-19 and in the post-pandemic period.

**Key words:** disposable face masks, environment, critical infrastructure, pollution, covid-19, recycling

## **ISPITIVANJE MOGUĆNOSTI PRELASKA NA CIRKULARNU EKONOMIJU U GRAĐEVINSKOJ INDUSTRIJI UPOTREBOM OTPADNOG STAKLA**

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**Apstrakt:** Intezivna eksploatacija prirodnih resursa, zajedno sa neefikasnom upotrebom materijala nakon isteka životnog veka, rezultira stvaranjem ogromnih količina otpada, u kojima svakako prednjači otpadna staklena ambalaža. Poslednjih godina, poboljšanja u tehnološkom razvoju i životnom standardu doveli su do povećane proizvodnje i potrošnje staklenih flaša i tegli za jednokratnu upotrebu. Degradacija na deponijama je zanemarljiva, što povratno, stvara veliki problem na deponijama iz razloga što se količina otpadnog stakla povećava, ukoliko se ne preduzimaju prethodno određeni koraci sanacije ove vrste čvrstog otpada. Trenutni procenat reciklaže staklene ambalaže u Srbiji znatno je niži naspram zastupljenih procenata reciklaže u zemljama Evrope, s toga je potrebno istražiti i primeniti nove načine reciklaže staklenog ambalažnog otpada. U radu je analizirana upotreba otpadne staklene ambalaže, u određenom masenom udelu, kao sekundarne sirovine u procesu dobijanja bloka od gline u građevinskoj industriji materijala. Na osnovu poznatih ciljeva cirkularne ekonomije, ciljevi predmetnog istraživanja su: eksperimentalno dobijanje blokova od gline sa različitim masenim udelom staklenog reciklata, kao poboljšanog dizajniranog građevinskog materijala, sa akcentom na analizi procene uticaja na životnu sredinu i analizi ekonomskog faktora prilikom proizvodnje novog građevinskog materijala. Za realizaciju postavljenih ciljeva primenjene su sledeće metode: mlevenje uzoraka u poluindustrijskom mlinu i analiza granulometrijskog sastava dobijenog praha na mehaničkom uređaju za prosejavanje, metode ispitivanja svojstava novih uzoraka, Analiza tokova materijala i Ocenjivanje životnog ciklusa. Sprovedenjem eksperimentalnog dela istraživanja zaključeno je da se staklena ambalaža kao sekundarna sirovina može iskoristiti za dobijanje blokova od gline, ako se kao kriterijum uzimaju kvalitet dobijenih uzoraka eksperimentalnih blokova sa staklenim reciklatom i postojeći standardi. Rezultati istraživanja takođe ukazuju da je

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ovakvim načinom dobijanja novog proizvoda u građevinskoj industriji, moguće ostvariti merljivu ekonomsku dobit a samim tim i dodatnu korist po životnu sredinu, čime su potvrđeni osnovni ciljevi cirkularne ekonomije.

**Ključne reči:** otpadno staklo, blok od gline, cirkularna ekonomija

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**BETWEEN DECLARATION AND ACTION – AN ANALYSIS OF  
THE RESULTS OF RESEARCH ON CIRCULAR BEHAVIOR  
UNDERTAKEN BY HOUSEHOLDS**

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**Abstract:** The subject of the presentation is an analysis of the frequency of households' circular behaviours concerning the benefits therefrom. The main aim of the speech is to present the concept of circular behaviours undertaken by households and to present the results of that behaviour, declared by respondents and the real benefits obtained by households thus such behaviours. The presentation shows the results of a survey conducted among 266 Polish respondents. The results were statistically analysed using Pearson's linear correlation coefficient to investigate whether the declared behaviour was accompanied by real benefits. The results obtained confirmed the correctness of the assumed hypothesis, moreover, the correlation between variables is statistically significant, which may confirm that the respondents undertook the declared behaviours.

**Key words:** circular behaviors, households, circular economy, statistical analysis

## **COMPARISON OF PRODUCT CATEGORIES FROM DIFFERENT EPD PROGRAM OPERATORS**

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**Abstract:** Environmental product declarations (EPDs), also known as type III ecolabels, are documents that provide quantitative data about the influence of the product on the environment such as ozone depletion, the formation of smog, greenhouse gases emission, etc. Rules, procedures, and schemes for EPDs are established in ISO 14025. Based on the information in EPDs, consumers and producers can compare various products and make a product selection. To ease comparison, EPDs are categorised by functions of the products they describe into groups called product categories. Many institutions around the world provide EPDs, these institutions are called program operators. Their role is to conduct, administer, and supervise the development of EPDs. Although EPDs must comply with ISO 14025 standard, the differences between EPDs in the same product categories, and among the different operator programs, are noticeable. In this research, EPDs from different program operators were compared and their distribution in product categories was presented. Among the analyzed program operators International EPD System and Institut Bauen und Umwelt e.V. stand out with a high number of published EPDs. The product category for construction and building materials has the highest number of EPDs compared to other product categories. Most of the analysed program operators provide EPDs in up to five product categories, which leads to the conclusion that there are still many areas of industry that can introduce EPDs for their products.

**Key words:** environment product declaration, product categories, ecolabel



## **ECOLABEL CRITERIA FOR TEXTILE PRODUCTS WITH FOCUS ON CHEMICALS IN PRINTING PROCESSES**

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**Abstract:** Textile sector should meet contemporary ecological and safety requirements, and ecolabeling encourage the development of the sustainable textiles in general. Ecolabels are becoming a differentiating factor in textile markets, because consumers are becoming increasingly concerned with the environment and their health. This is resulting in adoption of greener substances and textile manufacturing processes. The dominant sources of pollution in the textile production are the finishing processes, from initial scouring and bleaching, through mercerization and dyeing, to final finishing processes such as printing. From the pollution aspect, textile printing is one of the very intensive production phases of textile manufacturing. Thus, there are a lot of process criteria which are applied to this production stage. Specially, substances such as printing dyes, pigments, pastes and plastisol binders have restrictions for application in the field of textile environmental excellence products. Hazardous chemicals and mixtures applied to textile during printing processes, which remain on the final product, shall not be used, because they can evaporate or penetrate through the skin. According to EU Ecolabel criteria for Textile products, printing pastes shall not contain more than 5% Volatile Organic Compounds (VOC's). These may include: aliphatic hydrocarbons, monomers such as acrylates, vinyl acetates, styrene, acrylonitrile, acrylamide, butadiene, alcohols, esters, polyols, formaldehyde, phosphoric acid esters, benzene or ammonia. Also, plastisol additives to print binders, including polyvinyl chloride and restricted phthalates, shall not be used. The present is one example of good practice for a lesser polluting textile production, with strict restrictions on the use of hazardous chemicals, which develops identifying of high performing greener textiles.

**Key words:** Environmentally friendly textiles, Ecolabeling requirements, Hazardous chemicals, Printing processes.

## **DETERMINANTS OF SOCIAL INTEREST IN ENVIRONMENTAL LABELS AND DECLARATIONS IN POLAND**

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**Abstract:** The research was conducted in the year 2020 to identify the determinants of consumer interest in environmental labels and declarations in Poland. This study aims to analyse the relationship between selected factors in terms of their impact on the opinions and attitudes of respondents regarding the studied issue. The study included a group of 306 students, 59% of whom were women. Most of the respondents live in the countryside (51%), declare no income (66%) and no employment (58%). It was investigated whether gender, age, place of residence, and membership in environmental and consumer organizations, as well as the frequency of searching for ecolabels on products, impact on the interest in environmental labels and declarations. The study used the ANOVA Kruskal Wallis test, which allows assessing whether the relationship or differences between the selected features are statistically significant. The significance level  $\alpha = 0.05$  was adopted for the research. A higher level of environmental awareness of consumers positively influences their interest in environmental labels and declarations. People associated with environmental organisations do not consider the current costs of environmental labelling as a significant barrier to the dissemination of ecolabels. The respondents from this group do not see the communication effectiveness of ecolabels as a problem that significantly limits the development of environmental labels. Gender is a strong determinant of attitudes towards ecolabelling. Compared to men, women rate their knowledge of environmental labels higher. This assessment also depends on the place of residence (the highest among people living in the countryside) and the frequency of searching for ecolabels on products. When assessing the interest in environmental labels across various consumer groups (customers, enterprises, universities, and the R&D sector, own organisations), women show greater optimism. Significant correlations emerged between gender, place of residence and the frequency of searching for ecolabels on products, and

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the assessment of some factors facilitating and hindering the dissemination of environmental labels and the needs in this scope.

**Key words:** environmental labels and declarations, determinants, consumer interest in ecolabels, Poland

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## **CONSUMERS' KNOWLEDGE ON ENVIRONMENTAL LABELS AND DECLARATIONS IN POLAND**

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**Abstract:** Research context. In 2020, a nationwide study was carried out to diagnose the level of consumer awareness of environmental labels and declarations and environmental labelling (ecolabelling) in Poland. Respondent profile. 306 students participated in the research. Most of them were women (59%). The research group is characterising costs proportional to the place of residence; slightly more than half of the respondents (51%) lived in the countryside. The respondents were people not working (58%) and not declaring income (66%). Results. Reflection on the environmental impact of the purchasing decisions is relatively rare among the respondents. When assessing the ex-post and ex-ante impact of their own purchasing choices on the environment, most respondents declared no opinion, it was 25% for 2015 and 20% for 2025, respectively. The greatest interest in the impact of purchasing decisions on the environment was revealed in 2020 and was assessed as medium (usually 5 points). In the case of knowledge about environmental labels, the declared level was on average 4,5 (within the scale from 1 to 10), and most often 5 (23%). As many as 36% of the surveyed students (N = 306) did not pay attention to the label on products, 23% did it sometimes, and only every fifth person (20%) did it always. The research showed little interest in the development of ecolabelling programs because as many as 75% of respondents were not able to indicate a group of products that deserve priority support in creating policy instruments for the development of environmental labels and declarations. A significant problem for the development of ecolabelling in Poland is a low knowledge or lack of knowledge about environmental labels among consumers and entrepreneurs. When assessing the negative impact of this problem, 72% of responses scored above the average value. This corresponds to the assessment of the needs for the development of ecolabelling programs, the most important of which was to increase the environmental awareness of the society

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(the average significance was 7.1). The development of the circular economy (recycling, repair, and reuse) was considered the major opportunity for the dissemination of environmental labels and declarations.

**Keywords:** ecolabelling, labels, knowledge, environmental awareness.

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## **RATING OF THE PROBLEMS AND OPPORTUNITIES OF THE DISSEMINATION OF ECOLABELS IN SLOVAKIA**

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**Abstract:** Ecolabels on consumer goods are a kind of information tool directed at consumers to enable their environmentally friendly shopping decisions. They have been developing since the late 1970s and currently, hundreds of ecolabels (including Slovak national ecolabel) could be identified. The aim of this research is knowledge generation on the determinants of environmental labelling development in Slovakia. This research is based on a questionnaire survey. The sample of Slovak respondents includes respondents from the public sector, NGOs, R&D and others (mainly the education sector). All respondents have higher education, 72% are female and 28% are male, and around half of the respondents are members of an environmental organisation. The age of respondents varies between 30 and 53 with an average of 41 years. The answers of the respondents brought the following results. The respondents estimate that the environmental impact of their own buying decisions and also buying decisions of their organisations will not change in the next 5 years and will stay around the middle of the provided impact scale. As the most promising product groups for ecolabelling in Slovakia, respondents mentioned mainly drugstore/cosmetic products, home/electronic appliances, textile/clothing, food, buildings, etc. As expected, NGOs are perceived (among different actors/types of organisations) as the organisations with the greatest interest in ecolabels and businesses and governments as the organisations/actors with the least interest. From the provided ratings of respondents on the list of problems with a negative impact on the dissemination of ecolabels the low political and external motivation to support ecolabels is perceived as a major problem. Interesting is that respondents select from the list of opportunities for the dissemination of ecolabels the development of the circular economy as the most important opportunity.

**Key words:** ecolabels, dissemination, Slovakia, survey

## **NATIONAL SURVEY IN THE FIELD OF PUBLIC AWARENESS OF ENVIRONMENTAL LABELING IN THE CZECH REPUBLIC**

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**Abstract:** Ecolabels are a globally recognised and developing concept in the form of voluntary information tools, their goal is to increase the demand and supply of environmental products. The biggest problem is the lack of information about environmental labelling. In the Czech Republic, an online survey was conducted through a questionnaire, which was specially designed for finding answers for using ecolabeling. The national survey is part of an international project aimed at raising education on environmental labelling through the Visegrad Fund. In the Czech Republic, 128 respondents participated in the survey. The questionnaire was intended for the general public. The survey covered the impact of respondents' purchasing decisions on the environment, where individuals were rather neutral and only 3% of respondents were positive about environmental protection. This is also based on the fact that 59% of respondents do not look at information about the eco-label on products at all and do not look for environmentally friendly products. This is also because the public has insufficient knowledge of eco-labels (22% of responses) and therefore do not search for products labelled in this way. 78% of respondents confirmed the importance of increasing the company's environmental awareness of ecolabelling. The survey also showed that eco-labels are considered a guarantee of environmental protection and simplifying and unifying the standards and laws on ecolabels would make it easier for 65% of respondents to understand and use them. This is also related to the use of eco-labels in organisations, where 50% of participants in the business survey said that eco-labels improve the competitiveness of business and thus their use leads to improved market position. 100% of respondents are therefore inclined to raise awareness and see a positive impact on the use of ecolabels.

**Key words:** ecolabeling, education, environment, friendly product

## **THE IMPACT OF ENVIRONMENTAL LABELS PRESENCE AND AWARENESS AMONG CONSUMERS IN REPUBLIC OF SERBIA**

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**Abstract:** Environmental labelling is a tool that promotes products and services that are less harmful to the environment. Eco-labels can be marketing efficient, but require some knowledge and awareness not only from consumers but also from the producers. This study presents the results of a national research survey about environmental labels in the Republic of Serbia. The aim was to acquire knowledge about the directions of eco-label development, and also about position, awareness, familiarity and information that the labels provide among consumers and producers, through the quantitative analysis. Statistical analysis of the survey showed that in the Republic of Serbia 42% of respondents never search for ecolabelling information on products, and 38% have poorly rated their knowledge about ecolabels. At the same time, from the sample, even 53% have a higher level of education. On many questions in the survey, a large number of respondents did not know how to rate the environmental impacts of buying decisions and the level of interest of among different groups (customers, enterprises, governments, NGOs, Universities, R&D). The research also showed that there is a need to increase knowledge in this field. The most important for the dissemination of ecolabels are growing demand for ecolabelled products, development of circular economy and that ecolabels guarantee environmental protection. Respondents identified that the biggest problem with dissemination of ecolabels is low political and external motivation to support ecolabels. Even 44% of respondents recognized the importance of increasing environmental consciousness of society.

**Key words:** environmental labelling, eco awareness, survey, statistic

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